Published in final edited form as:

J Cardiopulm Rehabil Prev. 2014 ; 34(6): 406–419. doi:10.1097/HCR.0000000000000064.

United States Prevalence of Physical Activity and Sedentary Behavior Among Adults with Cardiovascular Disease

Kelly R. Evenson, PhD, MS¹, Eboneé N. Butler, MPH², and Wayne D. Rosamond, PhD²

Eboneé N. Butler: ebonee@live.unc.edu

¹Department of Epidemiology, Gillings School of Global Public Health, University of North Carolina – Chapel Hill, Chapel Hill, North Carolina, United States. Center for Health Promotion and Disease Prevention, University of North Carolina – Chapel Hill, Chapel Hill, North Carolina, United States

²Department of Epidemiology, Gillings School of Global Public Health, University of North Carolina – Chapel Hill, Chapel Hill, North Carolina, United States

Abstract

BACKGROUND—Physical activity (PA) is recommended for primary and secondary prevention of cardiovascular disease (CVD). This study described the prevalence of self-reported and accelerometer-measured PA and sedentary behavior using a nationally representative sample from the United States, a subset of whom had CVD, including angina, coronary heart disease (CHD), congestive heart failure (CHF), and myocardial infarction (MI).

METHODS—Using the most recently available accelerometer data (combined 2003–2006) from the National Health and Nutrition Examination Survey, the study sample included 680 adults with CVD, who completed a questionnaire and wore an ActiGraph accelerometer for 1 week. A group without CVD (n=1000) was also selected as the referent, with similar age, gender, and race/ethnic distributions as those with CVD (angina, CHD, CHF, MI) in order to compare PA and sedentary behavior estimates. Percents and means were weighted to reflect the US population from 2003–2006.

RESULTS—Among those with CVD, the proportion of individuals engaged in self-reported past-month, moderate leisure activity ranged from 39.7% (CHF) to 53.8% (CHD) and vigorous leisure activity from 12.9% (CHF) to 18.4% (CHD), with walking the most commonly reported activity. Television watching 4 hours/day ranged from 36.2% (MI) to 44.8% (CHF). Using accelerometry, moderate-to-vigorous PA ranged from 8.6 minutes/day (CHF) to 11.4 minutes/day (angina). Sedentary behavior ranged from 9.6 hours/day (angina) to 10.1 hours/day (CHF). All 4 CVD groups had lower leisure activity and moderate-to-vigorous PA, and higher television watching and sedentary behavior, when compared to the referent group.

Address for Correspondence: Kelly R. Evenson, 137 East Franklin Street, Suite 306, University of NC, Gillings School of Global Public Health, Department of Epidemiology, Chapel Hill, North Carolina, USA 27514, kelly_evenson@unc.edu; fax: 919-966-9800; phone 919-966-4187.

Conflicts: The authors have no conflicts of interest to claim.

The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

CONCLUSIONS—Further efforts are needed to encourage PA and reduce sedentary behavior for secondary prevention of CVD.

Key words or phrases

accelerometry; angina; congestive heart failure; coronary heart disease; myocardial infarction

Lack of physical activity (PA) is a major risk factor for cardiovascular disease (CVD).¹ PA is recommended for both primary and secondary prevention of CVD.² In the United States (US), CVD has been the leading cause of death for the past 80 years and is a major cause of disability.^{3,4} Coronary heart disease (CHD) is 1 type of CVD and includes myocardial infarction (MI), angina, and other atherosclerotic or ischemic heart diseases. In 2009, CHD caused about 1 of every 6 deaths in the US.⁴ Congestive heart failure (CHF) was mentioned on 1 in 9 death certificates that same year.

Several physician and nurse organizations issued a joint statement on clinical practice guidelines for ischemic heart disease patients.⁵ One of the “strong recommendations” indicated that individuals with stable ischemic heart disease should engage in 30 to 60 minutes of moderate intensity aerobic activity at least 5 days/week and preferably 7 days/week. This should be supplemented with daily activities, such as gardening and household activities, to increase cardiorespiratory fitness. Physician-directed cardiac rehabilitation and home-based programs were also recommended for at-risk individuals with ischemic heart disease following diagnosis. In addition to these patient-oriented goals, US public health goals include increasing the proportion of adult MI patients referred to cardiac rehabilitation at hospital discharge (Healthy People 2020, goal HDS-22).⁶ Cardiac rehabilitation promotes long-term positive health behaviors, including PA, following a CVD event.

With more than 80 million American adults living with CVD,⁴ it is important to document the prevalence of PA among this population since it is a major risk factor for the disease. Using a nationally representative sample, this study described the prevalence of both self-reported and objectively measured PA and sedentary behavior among those with CVD, including angina, CHD, CHF, and MI. We hypothesized that the prevalence of PA would be lower and sedentary behavior would be higher among those with CVD compared to a group without CVD. Secondarily, we explored whether the prevalence of PA and sedentary behavior differed by time since the CVD diagnosis or by the number of CVD conditions reported. We hypothesized that the prevalence of PA would be higher and sedentary behavior lower in the first year following an event as compared to subsequent years and among those with 1 CVD condition compared to those with 2 or more CVD conditions.

METHODS

Through in-person interviews and physical examinations, the National Health and Nutrition Examination Survey (NHANES) provided a cross-sectional assessment of nutrition and health of the US population. The data used in this study were obtained between 2003 and 2006, the most recently available national data with both self-reported and objectively measured PA. In order to provide sufficient statistical power, the years were combined for all analyses. Data collected from the medical conditions questionnaire, PA questionnaire,

and PA activity monitor (eg, accelerometer) examination were used to assess PA prevalence among adults with self-reported history of CVD.

Study Sample

Participants provided informed consent before completing any questionnaires or measurements⁷ and these analyses were exempted by the University of North Carolina-Chapel Hill Institutional Review Board. The medical conditions questionnaire captured information on a wide range of medical issues, including history of CVD. Study participants aged 20 years and older were asked whether they had a history of angina, CHD, CHF, and MI and, if affirmative, the age when they were first told they had the event. During the 4-year period, 998 of 10,020 participants 20 years and older reported a history of 1 or more CVD events. Those with CVD diagnoses prior to age 18 years (n=26) were excluded since pediatric disease etiology differs from that of adults. We further limited the cohort by excluding those who did not wear the accelerometer (n=210) or did not provide at least 3 days of accelerometer wear for 10 or more hours per day over a 7-day period (n=82). This left a final sample size of 680.

In order to contrast the prevalence of PA and sedentary behavior among CVD participants, we selected a group for comparison, frequency matched by age, gender, and race/ethnicity and with no reported CVD. Specifically, among 10,020 adult participants 20 years and older, we excluded 998 with prevalent CVD and 43 with missing information on CVD events. Similar to the CVD sample, we excluded those who did not wear the accelerometer (n=1561) or did not provide at least 3 days of accelerometer wear for 10 or more hours per day over a 7-day period (n=1163). This left a sample size of 6255 from which 1000 unexposed adults were randomly selected, proportional to each age*gender*race/ethnicity strata from the exposed group using proc surveyselect in SAS version 9.3 (Cary, NC). The strata included 5 age categories (20–49, 50–59, 60–69, 70–79, 80) and 4 race/ethnicity categories (Hispanic, non-Hispanic White, non-Hispanic Black, non-Hispanic Other). This group is referred to as the “referent group”.

Physical Activity Measurement by Self-Report

Respondents to the PA questionnaire were asked to report the frequency and duration of physical activities performed as part of active transportation (such as walking or bicycling to and from work or shopping), household and yard work, and leisure activity over the 30 days preceding the interview. The questionnaire defined moderate intensity as “tasks that caused light sweating or a slight to moderate increase in breathing or heart rate” and vigorous intensity as activities that “cause heavy sweating or large increases in breathing or heart rate”. Those who engaged in moderate and/or vigorous leisure activity were prompted to indicate whether they had performed any of 48 specific recreational activities. Metabolic equivalent (MET) values for the individual activities were assigned according to tables published by Ainsworth et al.⁸ Further, we grouped the individual leisure activities into ten categories⁹ and created an ‘aerobic exercise’ category that combined a subset of individual activities reported. More detail on the definition and coding of PA can be found elsewhere (http://www.unc.edu/~kevenson/_NHANES_PAQ_2003-06.pdf).

The “2008 Physical Activity Guidelines for Americans” indicated that adults should obtain at least 150 minutes/week of moderate intensity or 75 minutes/week of vigorous intensity aerobic activity, or a combination of these.¹⁰ Using these guidelines, we classified adults as meeting recommendations if they reported at least 150 minutes/week of moderate intensity aerobic activity, at least 75 minutes/week of vigorous intensity aerobic activity, or an equivalent combination of the two¹¹.

To identify indications of sedentary behavior, participants were asked to report daily duration of screen-time exposure for television, video, and computer use that were unrelated to work. Participants also answered two close-ended questions aimed to gather self-assessment of usual daily activity and activity level compared to their peers.

Physical Activity Measurement by Accelerometry—Those who participated in the PA monitor examination were asked to wear the ActiGraph accelerometer (model #AM7164) on their hip for seven consecutive days during waking hours and outside of any water-based activities.^{12, 13} Beginning at midnight on the day following the clinic visit, the accelerometer recorded 1-minute epochs of analog acceleration and converted it to a digital signal.¹⁴ Non-wear was defined by an interval of at least 60 consecutive minutes of zero counts/minute, with allowance of up to 2 minutes of nonzero counts if no counts were detected during both the 30 minutes of upstream and downstream from that interval; any nonzero counts except the allowed short intervals were considered as wear time.¹⁵ Counts in the non-wear period were set to missing.

The ActiGraph accelerometer assessed acceleration using counts as the output metric. To interpret counts, researchers use cutpoints or thresholds to characterize activities by intensity,¹⁶ which includes sedentary, light, moderate, or vigorous activity. Calibration studies are conducted to determine cutpoints that generally correspond to these intensity levels. A number of ActiGraph studies of adults provide count cutpoints to distinguish moderate to vigorous PA (MVPA) from other forms of less intense activity. We used the cutpoints originally applied to these NHANES data.¹⁷ Vigorous intensity was defined as ≥ 5999 counts/minute and moderate intensity as 2020–5998 counts/minute. A lower moderate intensity threshold was calculated based on studies that incorporated more lifestyle activities, defined as 760–2019 counts/minute.¹⁸ Light intensity PA was defined between 101–759 counts/minute and sedentary behavior was defined as ≤ 100 counts/minute.¹⁹

Other Self-reported Measures—Self-reported measures used to describe the participants used in this study included age, race/ethnicity, gender, education, household income, marital status, and cigarette smoking. Age above 85 years was top-coded before the data were released to protect confidentiality of the respondents. This meant that all individuals of that age or older were assigned an age of 85 years. Current smoking was defined as use of cigarettes on “some days” or “every day” and former smoking was defined as report of any past smoking.

Statistical Methods—To account for the differential probability of selection, all percentages were weighted to the 2000 census using the 4-year sample weights provided by NHANES (National Center for Health Statistics 2004, 2006). The data were nested (i.e.,

screeners, household interview, examination), so non-response and post-stratification adjustments were applied.

For self-reported and accelerometer measured PA, *P* values were calculated to compare those with angina, CHD, CHF, or MI to the referent group using weighted percents (using chi-square) and means Wald's *F* test. All comparisons using the accelerometer data controlled for wearing time. Proc SURVEYREG was used to compare within CVD group whether accelerometer-assessed PA or sedentary behavior differed (i) when the diagnosis occurred one year or less in comparison to 2–5 years, 6–10 years, or more than 10 years and (ii) by the number of CVD conditions, both controlling for age and accelerometer wearing time.

RESULTS

The description of those with self-reported history of angina, CHD, CHF, and MI are reported in Table 1, along with the referent group without self-reported CVD. The mean age among those with CVD was 69.6 years for angina, 70.2 years for CHD, 69.3 years for CHF, and 69.9 years for MI. For each of the CVD conditions, men comprised a higher proportion of the sample (range 53.3%–66.4%), as did non-Hispanic Whites (80.9%–86.1%).

For the CVD entire sample (*n*=680), the total number of CVD conditions was 53.9% for one, 27.2% for 2, 12.6% for 3, and 6.3% for all 4. Considering all combinations of the 4 CVD conditions, the most commonly reported was a single condition (CHF only 13.9%, CHD only 13.7%, MI only 13.4%, angina only 12.9%), followed by the combination of CHD and MI 8.4%. Time since the condition ranged from 1 year or less (range 12.8% angina to 19.2% CHF) to those having the condition more than 10 years (range 30.0% CHF to 47.0% angina).

Self-reported Physical Activity and Sedentary Behavior

Four-year prevalences (2003–2006) for the categorical PA and sedentary measures are presented in Table 2. Among those with CVD, the prevalence of any transportation activity in the past month ranged from 12.5% (CHF) to 16.7% (MI), any moderate to vigorous household activity ranged from 50.1% (CHF) to 59.6% (CHD), moderate leisure activity ranged from 39.7% (CHF) to 53.8% (CHD), and vigorous leisure activity ranged from 12.9% (CHF) to 18.4% (CHD), all in the past month. The prevalence of meeting the 2008 PA guidelines in the past month ranged from 14.6% (CHF) to 27.5% (CHD). The most common type of leisure activities reported among those with CVD was walking, followed by other recreational activities and indoor aerobic conditioning activities. The prevalence of past month household and moderate/vigorous leisure activities were all significantly lower among those with angina, CHD, CHF, and MI compared to the referent group.

The prevalence of watching 4 or more hours of television per day ranged from 36.2% (MI) to 44.8% (CHF). Television watching and time on the computer outside of work was generally higher among those with any of the CVD conditions compared to the referent group. The prevalence of “mostly sitting” during the day ranged from 30.5% (angina) to

45.3% (CHF), with all but the angina group having a significantly higher distribution compared to the referent group.

Four-year prevalences for the continuous PA measures are presented in Table 3. For example, time spent in moderate to vigorous leisure activity ranged from 2.1 hours/week (with 1.2 hours/week from aerobic exercise) among those with CHF to 2.8 hours/week (with 2.0 hours/week from aerobic exercise) among those with CHD. Similar to the categorical measures, the prevalence of PA was generally lower among those with CHF when comparing to the other CVD conditions and to the referent group without CVD.

Accelerometry Determined Physical Activity and Sedentary Behavior

The average accelerometer wear time ranged from 12.6 to 13.0 hours/day among those with CVD, with longer wear among the referent group (Table 4). Accelerometer-determined counts/minute, an indication of overall activity, ranged from 172.2 for those with CHF to 198.3 among those with angina. The referent group without CVD had higher overall activity (244.6 counts/minute) than any of the 4 CVD groups. MVPA ranged from 8.6 minutes/day among those with CHF to 11.4 minutes/day among those with angina. MVPA was significantly lower for all 4 CVD groups when compared to the referent group without CVD. Sedentary behavior ranged from 9.6 hours/day (angina) to 10.1 hours/day (CHF), with all CVD groups significantly higher than the referent group (9.2 hours/day).

Comparisons by Year Since the Condition and Number of CVD Conditions

A consistent pattern of PA by time since the condition did not emerge across CVD groups (Table 5). However, sedentary behavior was higher for MI participants 2–5 years ($P=.003$), 6–10 years ($P=.08$), and 10 years ($P=.03$) from diagnosis compared to those within 1 year of diagnosis.

Among those with CVD ($n=635$), light activity was lower with more CVD conditions (Table 6), but MVPA, lower moderate, and sedentary behavior did not significantly differ by number of CVD conditions. Consistent patterns were not observed within CVD conditions.

DISCUSSION

Using nationally representative data, this study described the prevalence of both self-reported and objectively measured PA and sedentary behavior among those with CVD. Generally those with CHF had lower PA and higher sedentary behavior than the other CVD groups. We hypothesized that PA would be lower and sedentary behavior would be higher among those with CVD in comparison to a referent group without CVD and this hypothesis was confirmed.

The prevalence of the modifiable PA and sedentary behaviors in this population at risk for a recurrent CVD event is concerning. Sedentary behavior is a distinct class of behaviors that involves sitting and low levels of energy expenditure (≤ 1.5 METS), although much less studied than PA behavior.^{20,21} Those with high amounts of sedentary behavior are at increased risk of diabetes, other chronic conditions, and mortality regardless of their levels

of MVPA.²² While the US does not yet have national recommendations for sedentary time, the absolute time spent in sedentary behavior was quite high among those with CVD.

We hypothesized that the prevalence of PA would be higher and sedentary behavior lower among those with one CVD condition compared to those with 2 or more CVD conditions, based on the severity of CVD. However, this was generally not supported. We also hypothesized that the prevalence of PA would be higher and sedentary behavior lower in the first year following a diagnosis as compared to subsequent years. This hypothesis was not confirmed and a consistent pattern was not observed, except for lower sedentary behavior for MI participants within 1 year of diagnosis compared to longer periods since diagnosis. Our hypothesis was based on the assumption that at least a proportion of those with CVD would have been referred to and attended cardiac rehabilitation, a program which includes regular PA. Cardiac rehabilitation also improves physical functioning, enhances quality of life and psychological well-being, reduces cardiac symptoms, and may lead to reductions in mortality and morbidity for those with CVD.^{23–26}

However, cardiac rehabilitation services are consistently underutilized,^{27–31} and even when patients enter cardiac rehabilitation, adherence to the program can be suboptimal.^{29,32} Barriers to participation in cardiac rehabilitation exist at multiple levels, including policy barriers such as financial/insurance issues, organizational barriers such as work conflicts and limited transportation, and intrapersonal barriers such as lack of interest and time constraints.³³ We also have limited knowledge on whether regular PA continues following cardiac rehabilitation. A Canadian study indicated that factors such as younger age, currently working full-time, and higher PA enjoyment, cardiac rehabilitation staff support, and perceived health all contributed to PA adherence 3.5 years post-cardiac rehabilitation.³⁴

Limitations

This study is subject to several limitations. Self-reported CVD depends on the participant awareness of the disease and may be affected by social desirability bias and recall bias.³⁵ This study also did not have information on cardiac rehabilitation attendance.

The PA questionnaire did not inquire about all types of MVPA, such as work or indoor household tasks, precluding us from deriving a total MVPA measure similar to the accelerometer derived metric. For the questions on moderate and vigorous leisure activities, several activities were included that require less than moderate intensity when considering assigned MET values, including yoga and stretching. However, the questions were answered based on perceived exertion, for which all activities should have at least light sweating or a slight to moderate increase in breathing or heart rate. To estimate meeting guidelines for self-reported PA, we doubled the minutes of vigorous intensity aerobic activity to contribute to this criteria, similar to others.¹¹ However, it is not known if the guidelines were intended to be calculated in this way. Moreover, we only counted aerobic leisure activities towards this guideline; it is possible that other non-leisure activities were aerobic in nature, but the prevalence is expected to be low.

The uniaxial accelerometer used by NHANES undercounts some activities, such as bicycling and weight lifting, and misses other activities, such as swimming, because the

monitor was not waterproof and participants were told to remove it for any water-based activity. It is unclear if the results were affected by the reactivity of wearing the monitor. Finally, interpretation of the associations with number and time since diagnosis was limited by the cross-sectional nature of the data.

CONCLUSION

The US prevalence of PA was generally lower and sedentary behavior higher among those with CVD compared to a similar group but without CVD. Among those with CVD, CHF participants consistently had lower PA and higher sedentary behavior. Increased and targeted efforts are needed to encourage PA and reduce sedentary behavior for secondary prevention of CVD. Continued national surveillance can track whether meaningful improvements are made to PA and sedentary behavior over time and national goals could be set to improve upon these baseline metrics.

Acknowledgments

The authors thank Fang Wen, MS, MCS, for help with data management and the statistical analysis, and the anonymous reviewers for their suggestions.

Funding Sources: This work was supported by the National Institutes of Health (NIH), National Heart, Lung, and Blood Institute #R21 HL115385.

References

1. Haskell W, Lee I, Pate R, et al. Physical activity and public health. Updating recommendations for adults from the American College of Sports Medicine and the American Heart Association. *Circulation*. 2007; 116:1081–1093. [PubMed: 17671237]
2. Swift DL, Lavie CJ, Johannsen NM, et al. Physical activity, cardiorespiratory fitness, and exercise training in primary and secondary coronary prevention. *Circulation*. 2013; 77:281–292.
3. Ward, J.; Warren, C. Silent victories: The history and practice of public health in twentieth century america. Oxford, England: Oxford University Press; 2006.
4. Go AS, Mozaffarian D, Roger VL, et al. Heart disease and stroke statistics--2013 update: A report from the American Heart Association. *Circulation*. 2013; 127:e6–e245. [PubMed: 23239837]
5. Qaseem A, Fihn SD, Dallas P, Williams S, Owens DK, Shekelle P. Clinical Guidelines Committee of the American College of Physicians. Management of stable ischemic heart disease. *Ann Intern Med*. 2012; 157:735–743. [PubMed: 23165665]
6. US Department of Health and Human Services. [Accessed October 31, 2013] Healthy People 2020. at www.healthypeople.gov
7. National Center for Health Statistics. IRB approvals for NHANES. 2006.
8. Ainsworth BE, Haskell WL, Herrmann SD, et al. 2011 compendium of physical activities: A second update of codes and MET values. *Med Sci Sports Exerc*. 2011; 43:1575–1581. [PubMed: 21681120]
9. Evenson K, Huston S, Wood J, Bors P. Does the number of leisure activities recalled change the estimated prevalence of activity? *Med Sci Sports Exerc*. 2003; 35:1882–1886. [PubMed: 14600554]
10. U.S. Department of Health and Human Services. [Accessed November 1, 2013] 2008 Physical Activity Guidelines for Americans; ODPHP publication no. U0036. 2008. p. 1-61. at <http://www.Health.Gov/paguidelines/>
11. Centers for Disease Control and Prevention. Prevalence of self-reported physically active adults - United States, 2007. *Morb Mort Week Rep*. 2008; 57:1297–1300.
12. National Center for Health Statistics. Analytic and reporting guidelines: The National Health and Nutrition Examination Survey (NHANES). 2006.

13. National Center for Health Statistics. MEC exam component: Physical activity monitor examination data. 2006. Documentation, codebook, and frequencies.
14. John D, Freedson P. Actigraph and actical physical activity monitors: A peek under the hood. *Med Sci Sports Exerc.* 2012; 44:S86–89. [PubMed: 22157779]
15. Choi L, Liu Z, Matthews CE, Buchowski MS. Validation of accelerometer wear and nonwear time classification algorithm. *Med Sci Sports Exerc.* 2011; 43:357–364. [PubMed: 20581716]
16. Pruitt LA, Glynn NW, King AC, et al. Use of accelerometry to measure physical activity in older adults at risk for mobility disability. *J Aging Phys Act.* 2008; 16:416–434. [PubMed: 19033603]
17. Troiano R, Berrigan D, Dodd K, Masse L, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc.* 2008; 40:181–188. [PubMed: 18091006]
18. Matthews C. Calibration of accelerometer output for adults. *Med Sci Sports Exerc.* 2005; 37:S512–S522. [PubMed: 16294114]
19. Matthews C, Chen K, Freedson P, et al. Amount of time spent in sedentary behaviors in the United States, 2003–2004. *Am J Epidemiol.* 2008; 167:875–881. [PubMed: 18303006]
20. Marshall S, Ramirez E. Reducing sedentary behavior: A new paradigm in physical activity promotion. *Am J Lifestyle Med.* 2011; 5:518–530.
21. Owen N, Healy G, Matthews C, Dunstan D. Too much sitting: The population health science of sedentary behavior. *Exercise Sport Sciences Rev.* 2010; 38:105–113.
22. Rhodes RE, Mark RS, Temmel CP. Adult sedentary behavior: A systematic review. *Am J Prev Med.* 2012; 42:e3–e28. [PubMed: 22341176]
23. United States Department of Health and Human Services. Clinical Practice Guideline Number 17, AHCPR Publication No. 96-0672. Agency for Health Care Policy and Research (AHCPR); Rockville, MD: 1995. Cardiac Rehabilitation.
24. American Association of Cardiovascular and Pulmonary Rehabilitation. Guidelines for Cardiac Rehabilitation and Secondary Prevention Programs. 5. Champaign, IL: Human Kinetics; 2013.
25. Haskell W. The efficacy and safety of exercise programs in cardiac rehabilitation. *Med Sci Sports Exercise.* 1994; 26:815–823.
26. Dugmore L, Tipson R, Phillips M, et al. Changes in cardiorespiratory fitness, psychological well being, quality of life, and vocational status following a 12 month cardiac exercise rehabilitation programme. *Heart.* 1999; 81:359–366. [PubMed: 10092561]
27. Evenson K, Rosamond W, Luepker R. Predictors of outpatient cardiac rehabilitation utilization: The minnesota heart survey registry. *J Cardiopulmonary Rehabil.* 1998; 18:192–198. [PubMed: 9632320]
28. Halm M, Penque S, Doll N, Beahrs M. Women and cardiac rehabilitation: Referral and compliance patterns. *J Cardiovasc Nurs.* 1999; 13:83–92. [PubMed: 10098008]
29. Benz Scott L, Ben-Or K, Allen J. Why are women missing from outpatient cardiac rehabilitation programs? A review of multilevel factors affecting referral, enrollment, and completion. *J Women Health.* 2002; 11:773–791.
30. Cortes O, Arthur H. Determinants of referral to cardiac rehabilitation programs in patients with coronary artery disease: A systematic review. *Am Heart J.* 2006; 151:249–256. [PubMed: 16442885]
31. Ayala C, Orenstein D, Greenlund K, Croft J, Neff L, Mensah G. Receipt of cardiac rehabilitation services among heart attack survivors - 19 states and the District of Columbia, 2001. *MMWR.* 2003; 52:1072–1075. [PubMed: 14603183]
32. Evenson K, Fleury J. Barriers to outpatient cardiac rehabilitation participation and adherence. *J Cardiopulm Rehabil.* 2000; 20:241–246. [PubMed: 10955265]
33. Evenson K, Johnson A, Aytur S. Five-year changes in North Carolina outpatient cardiac rehabilitation. *J Cardiopulm Rehabil.* 2006; 26:366–376. [PubMed: 17135857]
34. Bentley D, Khan S, Oh P, Grace S, Thomas S. Physical activity behavior two to six years following cardiac rehabilitation: A socioecological analysis. *Clin Cardiol.* 2013; 36:96–102. [PubMed: 23280429]

35. Moran A, Shen A, Turner-Lloveras D, et al. Utility of self-reported diagnosis and electrocardiogram q-waves for estimating myocardial infarction prevalence: An international comparison study. *Heart*. 2012; 98:1660–1666. [PubMed: 22942295]

Table 1

Weighted prevalence (WT%) and standard error (SE) of descriptive characteristics of NHANES study participants with and without a history of cardiovascular disease (CVD), NHANES 2003–2006

	Referent Group			Angina			Coronary Heart Disease			Congestive Heart Failure			Myocardial Infarction		
	n	WT%	SE	n	WT%	SE	n	WT%	SE	n	WT%	SE	n	WT%	SE
Age															
< 50	68	9.7	1.7	16	10.9	2.4	16	7.6	1.9	17	8.6	2.7	20	10.1	1.6
50–59	120	20.7	2.2	32	18.5	2.9	33	16.4	2.6	27	19.7	3.8	36	18.2	2.2
60–69	286	27.9	1.6	84	30.5	4.3	89	30.6	3.4	68	26.6	4.7	97	29.8	3.4
70–79	267	25.1	2.0	66	23.4	2.7	101	30.5	2.8	64	25.9	3.8	100	25.8	2.9
80 +	259	16.5	1.5	66	16.8	2.6	79	14.9	1.7	62	19.2	3.4	87	16.2	2.0
Race/Ethnicity															
Hispanic	123	4.2	0.9	38	4.0	1.1	35	2.9	1.0	23	2.8	0.8	38	3.4	0.7
Non-Hispanic White	663	82.4	1.9	179	82.9	2.7	230	86.1	2.2	156	80.9	2.3	236	84.5	2.1
Non-Hispanic Black	193	10.1	1.5	34	6.7	1.5	43	6.9	1.3	53	12.6	2.0	54	7.9	1.5
Other	21	3.4	0.8	13	6.4	1.8	10	4.2	1.5	6	3.8	1.9	12	4.2	1.3
Gender															
Male	577	54.6	2.0	139	53.3	3.8	218	66.4	3.3	135	55.1	3.6	232	63.7	3.8
Female	423	45.4	2.0	125	46.7	3.8	100	33.6	3.3	103	44.9	3.6	108	36.3	3.8
Education															
Less than High School	323	20.9	2.0	94	29.6	4.1	112	27.5	2.5	95	33.6	4.1	129	31.6	2.8
High School or Equivalent	246	27.9	2.3	65	24.6	2.9	82	28.4	3.6	60	25.9	2.9	83	25.9	3.1
More than High School	428	51.2	2.6	105	45.8	3.7	124	44.1	3.6	83	40.5	4.4	127	42.5	4.0
Missing	3			0			0			0			1		
Household Income															
65K +	170	24.1	2.3	37	18.0	3.1	54	21.9	3.0	32	14.8	2.9	46	18.4	3.3
35K to < 65K	256	31.8	2.0	51	26.6	4.1	62	25.7	2.3	49	24.1	3.2	65	26.3	3.5
< 35K	525	44.1	1.9	166	55.4	4.1	193	52.4	3.4	151	61.1	4.4	213	55.3	4.2

Referent Group		Angina		Coronary Heart Disease		Congestive Heart Failure		Myocardial Infarction							
(n=1000)		(n=264)		(n=318)		(n=238)		(n=340)							
n	WT%	SE	n	WT%	SE	n	WT%	SE	n	WT%	SE				
Missing	49		10		9	6		16							
Marital Status															
Married	593	64.6	1.9	152	64.0	4.2	202	67.9	3.1	109	50.5	3.4	187	57.0	3.8
Not Married	407	35.4	1.9	112	36.0	4.2	116	32.1	3.1	129	49.5	3.4	153	43.0	3.8
Smoking															
Never	452	46.4	2.5	104	37.2	3.4	106	30.8	2.9	90	35.6	4.5	104	29.3	3.4
Former	408	39.6	2.5	117	42.1	3.2	172	54.9	3.2	103	44.7	4.9	170	47.9	3.5
Current	140	14.0	1.6	43	20.6	3.8	40	14.3	2.9	45	19.7	2.4	66	22.8	2.6
Total Number of CVD Conditions															
1	82	29.4	3.9	87	26.3	2.2	88	39.7	4.7	85	23.8	3.1			
2	68	28.8	4.8	100	35.9	4.3	60	26.0	2.9	118	38.1	4.4			
3	59	26.7	3.6	72	25.4	3.3	34	16.2	3.2	75	26.1	3.2			
4	40	15.0	2.7	40	12.4	2.4	40	18.1	3.8	40	11.9	2.5			
Missing	15			19			16			22					
Time Since first Disease Occurrence															
<=1 year	28	12.8	2.5	42	15.9	2.8	40	19.2	3.4	45	17.8	2.4			
2 – 5 years	56	22.8	2.9	89	31.1	3.3	78	33.3	3.5	76	25.3	3.3			
6 – 10 years	44	17.5	2.1	66	19.6	2.6	41	17.5	2.7	57	18.9	2.2			
> 10 years	132	47.0	3.7	117	33.3	3.5	76	30.0	3.9	151	38.0	2.7			
Missing	4			4			3			11					

Table 2

Weighted prevalence (WT%) and standard error (SE) of self-reported physical activities and sedentary behaviors in the past month among participants with and without cardiovascular disease (CVD), NHANES 2003–2006

	Referent Group			Angina			Coronary Heart Disease			Congestive Heart Failure			Myocardial Infarction		
	(n=1000)			(n=264)			(n=318)			(n=238)			(n=340)		
	WT%	SE		WT%	SE	p*	WT%	SE	p*	WT%	SE	p*	WT%	SE	p*
Physical activity engagement**															
Transportation activity	19.9	2.2		12.8	2.1	0.01	15.3	2.8	0.21	12.5	2.5	0.02	16.7	2.3	0.27
Household activity	67.8	2.5		55.9	2.5	0.0004	59.6	3.4	0.04	50.1	4.5	<0.0001	55.5	3.4	0.0002
Moderate leisure activity	55.5	2.1		48.6	3.1	<0.0001	53.8	2.7	<0.0001	39.7	3.2	<0.0001	47.0	3.7	0.002
Vigorous leisure activity	22.7	1.9		14.5	2.6	<0.0001	18.4	3.4	0.02	12.9	3.2	0.0002	13.6	2.5	0.001
Aerobic exercise	54.2	2.0		46.3	3.5	0.05	52.4	2.5	0.54	39.1	3.4	0.0001	45.3	2.7	0.01
Meets physical activity recommendations***	28.2	2.0		23.2	3.5	0.30	27.5	2.5	0.82	14.6	3.2	0.002	22.3	3.0	0.10
Type of leisure activity**															
Walking	37.9	2.2		31.0	3.2	0.12	30.5	2.8	0.06	25.6	3.4	0.003	29.2	2.9	0.04
Recreational	23.4	1.6		21.6	2.1	0.46	25.5	3.6	0.56	20.1	2.7	0.28	21.8	3.2	0.64
Indoor aerobic conditioning activities	17.7	1.7		19.2	3.0	0.67	21.3	2.3	0.18	10.4	2.6	0.05	15.2	2.5	0.45
Home maintenance	1.8	0.6		0.0	0.0	?	0.0	0.0	?	0.0	0.0	?	0.4	0.3	0.03
Water activities	9.8	1.3		5.7	1.9	0.08	10.4	2.5	0.80	6.5	2.1	0.25	7.4	1.9	0.25
Jogging	3.9	0.8		0.9	0.8	0.05	1.2	0.8	0.05	0.2	0.2	<0.0001	1.0	0.7	0.03
Stretching	5.5	0.9		3.7	1.6	0.40	4.6	1.2	0.59	3.7	1.4	0.30	4.0	1.3	0.86
Strengthening	7.5	1.2		5.9	1.9	0.50	5.3	1.6	0.31	3.4	1.8	0.14	5.9	2.1	0.53
Team sports	4.4	0.8		2.0	1.0	0.12	2.2	1.0	0.11	4.0	1.4	0.84	0.8	0.4	0.001
Other	0.9	0.4		0.9	0.9	1.00	1.6	0.8	0.38	1.4	1.0	0.58	0.4	0.4	0.45
Sedentary indicators															
TV/video (h/d)				0.0004			0.02			?			0.002		
None	1.2	0.3		0.4	0.4		0.4	0.3		0			0.2	0.2	
Less than 1	11.5	1.3		5.7	1.8		9.6	2.5		8.2	1.9		8.7	1.9	
1-3	60.7	1.9		52.5	4.2		53.0	4.2		47.0	4.1		54.9	2.6	

	Referent Group			Angina			Coronary Heart Disease			Congestive Heart Failure			Myocardial Infarction		
	(n=1000)			(n=264)			(n=318)			(n=238)			(n=340)		
	WT%	SE	WT%	SE	WT%	SE	WT%	SE	WT%	SE	WT%	SE	WT%	SE	p*
4+	26.5	1.6	41.4	3.7			37.0	3.3			44.8	3.9	36.2	2.2	
<u>Computer screen time, excluding work (h/d)</u>															
None	50.8	2.4	59.9	3.0			59.0	3.5			62.6	3.9	65.7	4.2	0.002
Less than 1	22.7	2.5	18.1	3.0			20.2	3.1			19.9	3.9	18.0	3.6	
1-3	23.0	1.6	17.7	1.7			17.3	2.3			12.6	2.5	12.4	2.3	
4+	3.5	0.8	4.3	1.0			3.5	1.1			4.9	1.9	3.8	0.9	
Self assessment															
<u>Usual daily activities</u>															
Mostly sitting	23.6	1.4	30.5	3.4			32.0	3.6			45.3	4.2	33.4	3.5	0.02
Mostly standing/walking without lifting	53.3	1.8	52.8	3.7			53.2	3.6			46.9	4.1	52.2	3.8	
Carrying/lifting light load	18.7	1.6	12.2	2.3			11.4	2.2			5.3	1.3	11.0	2.2	
Heavy work/carry heavy load	4.4	0.9	4.6	1.7			3.4	1.4			2.5	1.5	3.4	1.3	
<u>Activity compared to others of the same age</u>															
More active	49.9	2.0	39.4	3.0			43.0	3.6			26.9	3.0	40.2	2.5	<0.0001
Less active	12.7	1.6	26.9	3.5			26.9	2.6			38.5	3.9	25.5	3.2	
About the same	37.4	1.8	33.7	3.5			30.1	3.6			34.6	3.4	34.3	3.4	

* Chi-Square comparing adults with CVD to the referent group.

** Each prevalence reported in this section represents at least some minutes for the specific types of physical activities.

*** Indicates the proportion meeting the 2008 US guidelines for aerobic physical activity

† Unable to approximate p-value because of zero cell.

Weighted mean and standard error (SE) of self-reported physical activities in the past month among participants with and without cardiovascular disease (CVD), NHANES 2003–2006*

Table 3

Referent Group		Angina (n=264)			Coronary Heart Disease (n=318)			Congestive Heart Failure (n=238)			Myocardial Infarction (n=340)			
		Mean	SE	p	Mean	SE	p	Mean	SE	p	Mean	SE	p	
Transportation activity														
Hours/week	0.5	0.1	0.4	0.1	0.48	0.6	0.2	0.78	0.4	0.1	0.61	0.7	0.2	0.51
Moderate to vigorous household activity														
Hours/week	2.7	0.3	1.9	0.3	0.04	2.2	0.4	0.21	1.6	0.2	0.002	2.3	0.4	0.28
Moderate Leisure Activity														
Hours/week	2.2	0.2	1.7	0.3	0.22	2.1	0.3	0.91	1.8	0.3	0.37	1.7	0.2	0.16
MET-Hours/week	7.9	0.7	6.5	1.0	0.30	8.0	1.0	0.94	6.5	1.2	0.39	6.6	0.8	0.22
Vigorous Leisure Activity														
Hours/week	0.7	0.1	0.7	0.3	0.78	0.7	0.2	0.91	0.3	0.1	0.01	0.6	0.3	0.75
MET-Hours/week	4.9	0.6	5.2	2.3	0.87	5.0	1.7	0.93	2.2	0.8	0.01	4.3	1.8	0.72
Moderate to vigorous leisure activity														
Hours/week	2.8	0.2	2.4	0.4	0.43	2.8	0.4	0.97	2.1	0.4	0.15	2.3	0.4	0.19
MET-Hours/week	12.8	1.0	11.7	2.6	0.65	13.0	2.1	0.92	8.8	1.8	0.09	10.9	2.1	0.33
Aerobic exercise														
Hours/week	1.8	0.1	1.9	0.4	0.90	2.0	0.3	0.66	1.2	0.2	0.05	1.8	0.3	0.98
MET-Hours/week	9.1	0.7	9.6	2.6	0.86	9.9	1.9	0.68	5.3	1.2	0.02	9.0	2.0	0.96
Strengthening activity														
Times/week	3.8	0.3	3.3	0.6	0.38	3.5	0.6	0.59	2.7	0.6	0.07	3.0	0.6	0.20

* Using PROC SURVEYREG and the CONTRAST statement comparing adults with cardiovascular disease to the referent group.

Table 4
Weighted mean and standard error (SE) of summarized accelerometer measures among participants with and without cardiovascular disease (CVD), NHANES 2003–2006*

	Referent Group			Angina			Coronary Heart Disease			Congestive Heart Failure			Myocardial Infarction		
	(n=1000)			(n=264)			(n=318)			(n=238)			(n=340)		
	Mean	SE		Mean	SE	p [†]	Mean	SE	p [†]	Mean	SE	p [†]	Mean	SE	p [†]
Wear-time total (hours/day) [‡]	13.2	0.1		12.6	0.2	0.04	13.0	0.2	0.57	12.6	0.3	0.10	12.7	0.2	0.10
Counts per minute	244.6	6.8		198.3	10.3	0.0001	189.5	7.9	<0.0001	172.2	9.5	<0.0001	196.6	9.0	<0.0001
Vigorous (minutes/day)	0.4	0.1		0.3	0.1	0.37	0.3	0.1	0.44	0.2	0.1	0.15	0.3	0.1	0.45
Moderate (minutes/day)	14.8	1.1		11.2	1.3	0.02	10.4	0.9	0.006	8.5	1.0	<0.0001	10.7	1.0	0.01
Moderate to vigorous (minutes/day)	15.2	1.1		11.4	1.3	0.02	10.7	1.0	0.008	8.6	1.1	0.0001	11.0	1.1	0.01
Low moderate (minutes/day)	67.2	2.0		51.0	3.9	0.0005	48.6	2.7	<0.0001	43.1	3.4	<0.0001	51.2	2.9	<0.0001
Light (minutes/day)	240.0	2.6		224.4	5.4	0.005	215.2	3.6	<0.0001	209.1	4.5	<0.0001	219.5	4.2	0.0002
Sedentary behavior (hours/day)	9.2	0.1		9.6	0.2	0.01	9.9	0.1	<0.0001	10.1	0.2	<0.0001	9.9	0.2	0.0001

* Adjusted for accelerometer wear-time.

[†] P value from Wald's F test, using PROC SURVEYREG and the LSMEANS statement comparing adults with CVD to the referent group.

[‡] Not adjusted for wear-time.

Table 5

Weighted means and standard errors of accelerometer measures by time length of their cardiovascular disease (CVD), NHANES 2003–2006*

	Angina (n=260)			Coronary Heart Disease (n=314)			Congestive Heart Failure (n=235)			Myocardial Infarction (n=329)		
	Mean	SE	p [†]	Mean	SE	p [†]	Mean	SE	p [†]	Mean	SE	p [†]
MVPA (minutes/day)												
<=1 year	11.1	3.5	R	8.4	1.9	R	5.9	1.7	R	12.6	2.3	R
2–5 years	7.3	2.5	0.43	10.6	2.3	0.53	8.3	2.0	0.30	11.0	2.3	0.67
6–10 years	11.2	3.5	0.99	11.1	2.1	0.41	8.7	2.7	0.36	4.9	1.2	0.01
>10 years	10.7	2.0	0.93	7.8	1.0	0.77	7.5	1.9	0.53	9.2	1.8	0.26
Lower moderate (minutes/day)												
<=1 year	45.8	7.0	R	40.5	4.8	R	37.0	4.4	R	54.8	6.6	R
2–5 years	37.8	4.7	0.42	42.8	3.5	0.73	43.2	4.3	0.32	46.3	4.9	0.34
6–10 years	51.4	9.0	0.60	55.7	6.8	0.07	38.4	7.3	0.87	46.7	3.8	0.35
>10 years	46.2	4.3	0.97	41.5	3.3	0.88	38.3	7.0	0.88	41.8	3.3	0.12
Light (minutes/day)												
<=1 year	227.7	9.9	R	215.4	11.7	R	188.6	13.5	R	225.3	8.7	R
2–5 years	214.3	11.1	0.27	206.7	4.7	0.47	211.3	9.6	0.23	200.0	6.7	0.02
6–10 years	232.9	14.6	0.73	219.2	11.0	0.79	211.0	11.3	0.24	223.6	7.4	0.89
>10 years	207.8	6.7	0.10	206.3	6.5	0.51	202.9	12.2	0.32	210.1	5.6	0.15
Sedentary behavior (hours/day)												
<=1 year	9.6	0.4	R	10.0	0.3	R	10.2	0.3	R	9.3	0.2	R
2–5 years	9.5	0.3	0.86	10.0	0.2	0.75	9.8	0.2	0.20	10.3	0.3	0.003
6–10 years	9.3	0.4	0.53	9.9	0.4	0.96	10.1	0.2	0.65	9.8	0.2	0.08
>10 years	9.6	0.2	0.91	10.0	0.2	0.78	10.0	0.4	0.56	10.0	0.2	0.03

* Adjusted for age and accelerometer wear-time.

† Using PROC SURVEYREG and LSMEANS comparing adults with 2 years or more to those with 1 year or less since their event (referent).

MVPA = moderate to vigorous physical activity; R = reference group; SE = standard error

Sample sizes were reduced due to excluding those missing time since CVD event.

Table 6

Weighted means and standard errors of accelerometer measures by number of disease conditions overall and by cardiovascular disease (CVD) condition, NHANES 2003–2006^{*}

All CVD			Angina			Coronary Heart Disease			Congestive Heart Failure			Myocardial Infarction			
(n=635)			(n=249)			(n=299)			(n=222)			(n=318)			
Mean	SE	p [†]	Mean	SE	p [†]	Mean	SE	p [†]	Mean	SE	p [†]	Mean	SE	p [†]	
MVPA (minutes/day)															
1 condition	8.1	0.8	R	6.9	1.2	R	9.1	1.9	R	6.5	1.3	R	9.5	1.6	R
2 conditions	9.0	1.4	0.49	12.3	2.6	0.07	7.3	1.3	0.47	4.8	0.7	0.29	9.4	1.7	0.98
3+ conditions	10.3	1.8	0.29	10.5	2.0	0.13	10.7	1.8	0.55	10.1	2.1	0.24	10.3	1.8	0.77
Lower moderate (minutes/day)															
1 condition	47.5	1.8	R	45.7	3.9	R	48.3	4.1	R	42.7	4.5	R	52.0	4.7	R
2 conditions	42.9	3.2	0.19	48.1	5.2	0.69	41.0	4.0	0.24	30.3	3.0	0.04	45.5	3.3	0.26
3+ conditions	42.8	3.1	0.19	42.2	4.0	0.44	44.4	3.1	0.48	41.3	3.0	0.82	42.6	3.6	0.13
Light (minutes/day)															
1 condition	221.2	4.2	R	242.1	7.1	R	207.9	7.8	R	212.2	5.7	R	228.0	8.2	R
2 conditions	208.8	6.6	0.14	208.8	7.5	0.001	209.8	8.7	0.86	199.9	9.0	0.25	211.5	8.3	0.27
3+ conditions	205.5	6.1	0.03	206.4	6.7	<0.0001	208.8	6.4	0.94	200.1	6.2	0.10	204.7	6.2	0.03
Sedentary behavior (hours/day)															
1 condition	9.8	0.1	R	9.3	0.2	R	10.2	0.3	R	9.9	0.2	R	9.9	0.4	R
2 conditions	10.0	0.2	0.48	9.8	0.2	0.11	10.2	0.3	0.97	10.5	0.2	0.04	10.0	0.3	0.86
3+ conditions	9.7	0.2	0.66	9.6	0.2	0.25	9.8	0.2	0.32	9.9	0.2	0.96	9.8	0.2	0.78

^{*} Adjusted for age and accelerometer wear-time.

[†] Using PROC SURVEYREG and LSMEANS comparing adults with 2 or 3+ events to 1 event (referent).

MVPA = moderate to vigorous physical activity; R = reference group; SE = standard error

Sample sizes were reduced due to excluding those missing any item on whether they had any of the four CVD events.