Published in final edited form as:
Heart Lung. 2013 ; 42(4): 235–240. doi:10.1016/j.hrtlng.2013.04.005.

Physical activity in people with COPD, using the National Health and Nutrition Evaluation Survey dataset (2003–2006)

Soo Kyung Park, PhD, RN[a,*], **Caroline R. Richardson, MD**[b,c], **Robert G. Holleman, MPH**[b,c], and **Janet L. Larson, PhD, RN**[d]

[a]College of Nursing, Korea University, 145 Anam-Ro, Seongbuk-gu, Seoul, Republic of Korea

[b]Department of Family Medicine, University of Michigan Medical School, Ann Arbor, MI, USA

[c]Center for Clinical Management Research, Health Services Research and Development Center of Excellence, Veterans Affairs Ann Arbor Healthcare System, Ann Arbor, MI, USA

[d]School of Nursing, University of Michigan, Ann Arbor, MI, USA

Abstract

Background—People with chronic obstructive pulmonary disease (COPD) are sedentary but the extent of the problem is not fully understood.

Purposes—This study examines sedentary time and physical activity (PA) and the relative effects of demographic and clinical characteristics on sedentary time and PA in a population-based sample of people with COPD and a comparison group from the general population.

Methods—Subjects were drawn from the National Health and Nutrition Examination Survey dataset (2003–2006). Physical activity was measured by accelerometry.

Results—People with COPD were sedentary and spent less time in most levels of PA. Age, gender, race, level of education, working status, shortness of breath, self-reported health, and body mass index were significantly associated with sedentary time or level of PA.

Conclusion—Findings emphasize the need to decrease sedentary time and increase PA in people with COPD.

Keywords

ActiGraph accelerometry; COPD; Physical activity; Sedentary time

Introduction

In 2008, chronic obstructive pulmonary disease (COPD) was reported to be the third leading cause of death in the United States.[1] By 2020, it is predicted to become the fifth largest contributor to disability.[2] People with COPD are notably inactive in daily life.[3] This inactivity leads to deconditioning and muscle weakness.[4] Further, growing evidence shows

*Corresponding author. Tel.: +82 10 9886 9837. sookyung.park7@gmail.com (S.K. Park).

that an inactive lifestyle is associated with negative outcomes, such as increased disability, increased risk of hospital admission due to COPD, and increased risk of death associated with respiratory disease.[5–9] Increasing overall levels of physical activity is an important goal of COPD disease management.[10] To accomplish this, a better understanding of the patterns of physical activity is needed.

Previous studies[4,8,11,12] have established that people with COPD do not meet guidelines for moderate to vigorous physical activity (MVPA), but less is known about sedentary time and light physical activity (LPA). LPA is important because it is a major source of 24-h energy expenditure and is known to affect health-related outcomes in healthy older adults and people with other chronic diseases.[13–15] The negative effect of sedentary time on adverse health-related outcomes, independent of physical activity, has also been reported in the general population.[16,17] In addition, most of what is known about PA in COPD comes from research in other countries.[4,11,18] Differences in cultures and socioeconomic status influence PA,[19] making it difficult to generalize to the United States (U.S.) population. Thus, this study describes sedentary time and different levels of physical activity based on data from a representative sample of the U.S. population.

Purposes

The purposes of this study were two: (1) to compare sedentary time and levels of physical activity in a representative sample of people with COPD with a control group without COPD, using actigraphy; and (2) to examine the relative contributions of demographic and clinical characteristics to sedentary time and time spent in LPA and MVPA in people with COPD.

Review of literature

Physical activity in people with COPD—Researchers have used a variety of activity-monitoring devices and self-reported questionnaires to measure physical activity in people with COPD.[4,11,18,20,21] Population-based studies from Spain used self-reported measures and provided strong evidence that people with COPD are very sedentary[8,12] and less active than people with other chronic diseases.[3] In studies of objectively measured physical activity, people with COPD spent less time walking and standing[4,11] and had decreased movement intensity while walking,[4] compared with healthy controls. It was also reported that time spent in MVPA differed significantly between people with moderate and severe COPD and healthy subjects.[22] Specifically, the duration, intensity, and counts of physical activity were significantly reduced in people with COPD compared with healthy subjects.[23] From the existing research it is established that people with COPD have reduced physical activity, but the extent of the problem in the U. S. is not clear because there are no population-based studies with objectively measured physical activity.

The following factors have been generally associated with total physical activity. Variables independently associated with a low total physical activity in people with COPD include female sex,[24] older age,[21,24] marital status,[21] unemployed status,[21] and lower social economic status.[24] Conflicting findings have been reported on the relationship between smoking and the level of physical activity. One study[6] reported that former smokers and

those who never smoked were more physically active; another[21] found that current smokers were associated with a higher level of physical activity. Dyspnea was negatively associated with total physical activity.[21,24–26] However, little is known about the factors that are related to different levels of physical activity (i.e., LPA vs. MVPA) in people with COPD.

Sedentary time in people with COPD—Sedentary time is defined as prolonged sitting time and the absence of whole-body movement that results in an energy expenditure of no more than 1.5 times resting energy expenditure.[27,28] Recently, the importance of decreasing sedentary time has been emphasized in studies of the general population and older adults with cancer.[14,17] Sugiyama et al[29] noted that decreasing sedentary time in the general population reduces their risk of obesity to the same degree as getting sufficient physical activity. Few studies have described sedentary time in people with COPD, but it has been reported that people with COPD spend more time sitting and lying down than healthy controls.[4,11] These findings, however, were based on only two days of monitoring. Another study of objectively measured physical activity[22] reported differences in physical activity, but no difference in time spent in sedentary activity between people with COPD and healthy subjects. Further studies are needed to examine sedentary time in people with COPD.

Methods

Design

This secondary cross-sectional study used data from the National Health and Nutrition Evaluation Survey (NHANES). NHANES is a cross-sectional, multistage, stratified, clustered probability sample of civilian, noninstitutionalized, U.S. populations conducted by the National Center for Health Statistics.[30] African Americans, low-income persons, Mexican-Americans, and those aged 60 or older were oversampled in NHANES.

Sample, settings, and procedures

Participants (n = 21,470) completed an NHANES interview between 2003 and 2006. Of those, we included only individuals (n = 427) who reported physician-diagnosed emphysema or chronic bronchitis and were aged 55 years or more. We excluded persons (n = 115) with no history of smoking and those (n = 88) with no accelerometer data. Individuals in the same NHANES dataset who did not have COPD, were aged 55 years or more, and had valid accelerometer data were included as a comparison group. Persons with no history of smoking were also excluded from the comparison group.

The NHANES survey used interviews and physical examinations to collect sociodemographic and clinical information. Demographic and clinical characteristics were collected through interviews. Interviews were conducted in participants' homes and in specially designed and equipped mobile centers that traveled to locations throughout the country. The data from physical activity monitors were obtained during the participants' visit to one of the mobile centers. A trained medical technician explained the physical activity monitor to participants, initialized the device, and fitted the device belt to each participant. Participants wore the monitor for 7 days and returned it by mail. After the data were downloaded, an NHANES contractor reviewed it for outliers and unreasonable

values.[31] The data collection process was standardized to decrease variations between different sites. The NHANES survey was approved by the Centers for Disease Control and Prevention (CDC)'s institutional review board.

Instruments

Demographic and clinical characteristics—We used data for age, gender, race, level of education, household income, working status, marital status, number of people in household, comorbid conditions, respiratory symptoms (shortness of breath, cough, phlegm, or wheezing), self-reported health, pack years of smoking, and body mass index (BMI) to describe the sample. Participants were asked to report total household income, including wages, salaries, social security or retirement benefits, and help from relatives. Work status was assessed by a simple yes/no question. The number of possible comorbidities was 14: angina, arthritis, asthma, cancer, congestive heart disease, coronary heart disease, diabetes, heart attack, hypertension, kidney disease, liver disease, osteoporosis, stroke, and thyroid problems. Participants were asked to answer *yes* or *no* if they had any of these conditions. Shortness of breath, cough, phlegm, or wheezing were assessed by asking yes/no questions, such as "Have you had shortness of breath either when hurrying on the level or walking up a slight hill?," "Do you usually cough on most days for 3 consecutive months or more during the year?," "Do you bring up phlegm on most days for 3 consecutive months or more during the year?," and "In the past 12 months have you had wheezing or whistling in your chest?" Self-reported health was evaluated by asking, "Would you say your health in general is?" Responses to this question could range from *poor* to *excellent*. All of the above information was collected during interviews.

The BMI was calculated by measuring an individual's weight and height. For weight, participants were asked to stand on a scale that was equipped with a digital read-out.[32] Height was measured using a wall-mounted stadiometer.[32] All body measurements were performed by trained health technicians using standardized examination methods and calibrated equipment.[32]

Physical activity—The ActiGraph (ActiGraph Model 7164 accelerometer, LLC; Ft. Walton Beach, FL) was used to measure the level of physical activity. Participants were asked to wear the device over their right hip on an elasticized belt for 7 days during waking hours only; they were instructed to remove it for water-related activities, such as bathing or swimming and to remove it at bedtime. Further, participants were given a toll free telephone number and informational material on the device. They were not asked to record their activity in a log. Details of the accelerometer protocol are available.[31] The uniaxial ActiGraph measures duration and intensity of physical movement (counts per minute). Accelerometer data were stored in 1-min epochs. We considered a day to be "valid" if participants wore the device for at least 10 h. Individuals who had at least 4 valid days were included in the analysis. The 4-day period was chosen for the analysis because it had been used in previous studies using the NHANES dataset,[17,33,34] and it was sufficient to describe the level of physical activity.[35] "Nonwear time" was defined as no counts for 60 min. We used the cutpoints for physical activity that Buman et al[36] recommend, but we combined high LPA and low LPA, reporting one level of LPA. Sedentary activity was defined as <100

counts per minute, LPA was 100–1951 counts per minute, and MVPA was greater than 1952 counts per minute. These cutpoints were consistent with those previously validated by Freedson et al[37] Mean activity intensity during monitoring time was also used (total accelerometer counts per total wear time).

The major limitation of accelerometry is it does not capture the full energy cost of certain activities, such as walking while carrying a load or walking uphill,[38] and certain categories of highly static activity or complex movement patterns that combine dynamic and static movements.[39] The intraclass correlation coefficient between two uniaxial accelerometers that were worn on the right hip and left hip was 0.98.[40] The correlation coefficient of time spent for light activity, moderate activity, and vigorous activity between uniaxial accelerometers and triaxial accelerometers was 0.59, 0.77, 0.50, respectively.[41]

Data analysis

We used Stata version 12.0 for data analysis, accounting for oversampling, stratification, and weighting. Certain populations were oversampled, and stratification was used in the NHANES. To insure correct and unbiased analyses of the survey dataset, one must correctly recognize the stratum codes and weight variables produced by the NHANES. Weight is assigned to each participant in the survey data and indicates how much each participant will count in a statistical procedure.[42] All continuous variables were expressed as mean and standard deviation. Categorical variables were presented as percentage and frequency. We used the chi-square test, linear regression, and the lincom procedure in Stata to compare study variables between the COPD and comparison groups. No differences between the groups were found in the days and minutes the accelerometer was worn. For further precise analysis, we reanalyzed sedentary time and time spent in different levels of physical activity as a percentage of wear time. A multiple regression model was used to examine the relative contribution of demographic and clinical characteristics to sedentary time and level of physical activity. For these multiple linear regressions, we first identified potential predictors of sedentary time and physical activity that were statistically related (i.e., more than $r = 0.10$ in Pearson's correlation analysis). All independent variables were entered together into a multivariate model. The logarithmic transformation was used for mean activity intensity and time spent in MVPA to normalize the skewed distribution of these data. A p value < 0.05 was considered statistically significant.

Results

Sample characteristics

The COPD group and the comparison group numbered 224 and 1386, respectively. The mean age of the COPD group was 70.05; the mean age of the comparison group was 69.21. Men comprised 50.9% of the COPD group and 64.3% of the comparison group. People with COPD were mainly non-Hispanic Whites, and few were working (Table 1). Significant differences were found in the proportion of men, working status, marital status, pack years of smoking, shortness of breath, self-reported health, and number of comorbidities between groups. No significant differences were found in the prevalence of hypertension and diabetes between the two groups. But participants with COPD had more arthritis, asthma,

cardiovascular disease (e.g., angina, congestive heart failure, coronary heart disease, and heart attack), kidney disease, and osteoporosis than the comparison group.

Group comparison of sedentary time and physical activity

Significant differences between the COPD and the comparison group were found in mean activity intensity, time spent in LPA and MVPA, and percent time spent in LPA and MVPA measured with accelerometer (Table 2). No significant difference was found in sedentary time between the groups. However, when wearing time was accounted for, people with COPD had a significantly greater percent sedentary time.

Factors related to sedentary time and physical activity

The relative contributions of demographic and clinical characteristics to sedentary time and the level of physical activity in people with COPD are presented in Table 3. Those who were older, had fair or poor health perception, and had a larger BMI had lower mean activity intensity (Table 3A). Those with less than a high school education, who were unemployed, and who had shortness of breath spent more sedentary time (Table 3B). Those who were non-Hispanic White had less sedentary time (Table 3B). Those who were older, had fair or poor health perception, and had a larger BMI spent less time in LPA (Table 3C). Women spent more time in LPA (Table 3C). Those who were older and female; and had shortness of breath; and fair or poor health perception spent less time in MVPA (Table 3D).

Discussion

In this study of the United States population, people with COPD were less physically active than people without COPD. When physically active, they spent most of that time in LPA. By contrast, they spent an average of 6.4 min a day in MVPA, far below the recommended duration of 30 min a day, five days a week. They also spent more time in sedentary activities than the comparison group. Age, gender, self-reported health, BMI, and shortness of breath were associated with physical activity. Different variables were associated with sedentary time: race, education, working status and shortness of breath.

The CDC and the American College of Sports Medicine recommend that adults engage in moderate-intensity physical activity for a minimum of 30 min/d for at least 5 d/wk to promote good health.[43,44] This recommendation does not address people with chronic diseases.[45] In our study, neither the COPD group nor the comparison group met the CDC guideline. People with COPD spent a greater percentage of their time in sedentary activities and less time in LPA and MVPA than people without COPD. It is possible that this finding could be explained by differences in gender and the number of comorbidities in the two groups (COPD = 51% men vs. comparison = 64% and COPD = 3 comorbid conditions versus comparison = 2 comorbid conditions). But the differences in gender and number of comorbid conditions are not large, and the differences in physical activity are consistent with the findings of other studies.[3,4,11] Compared with Swedish people with COPD,[22] this U.S. sample had lower counts per minute, more sedentary time, and less time in MVPA, although Eliason et al[22] used stricter cutpoints for MVPA (more than 2020 counts) and

different criteria for “nonwear time” (20 min). This difference is partially due to the fact that the Swedish subjects were younger than ours.

Ours is one of the first studies to examine factors related to sedentary time and different levels of physical activity in people with COPD. Age, gender, self-reported health, BMI, and shortness of breath were associated with physical activity. As expected, we found a significant cross-sectional association between age and different levels of physical activity, which is consistent with the findings of other studies.[21,24–26] Female gender was positively associated with time spent in LPA and negatively associated with time spent in MVPA. This finding provided additional confirmation about lower levels of MVPA and high levels of LPA in women,[24,46] which suggests that women may need to engage in more MVPA.

Self-rated health was negatively associated with the level of physical activity. The NHANES asked only one question on self-rated health but our finding was consistent with that of other studies.[25,47] Estaban et al[25] found that people with COPD and a low level of physical activity had poor general health compared with those with a high level of physical activity. Although the cause/effect relationship between health perception and physical activity was unclear, this finding shows that an increase in physical activity may improve self-rated health perception.

BMI was negatively associated with mean activity intensity and LPA. This was an unexpected finding because other studies have found no association between BMI and the level of physical activity in people with COPD.[24,48,49] It is likely that our findings differ from other studies of people with COPD because our participants had a higher mean BMI and wider range of BMI. Interestingly, BMI was significantly associated with LPA. And most of their physical activity time was spent in LPA. This finding suggests that people with COPD would benefit from more LPA.

Although shortness of breath was measured by a yes/no question in the NHANES, the symptom was negatively associated with MVPA. This finding confirms that dyspnea limits not only exercise capacity[50] but also limits physical activity in daily living. Of note, dyspnea was not related to time spent in LPA. Recent research has emphasized the importance of LPA with respect to health outcomes in healthy older adults and people with other chronic disease.[13,14] Replacing sedentary time with LPA has been shown to produce health benefits in the general population.[36] This might be an appropriate approach for people with COPD. If the severity of patients’ dyspnea prohibits MVPA, it may be more realistic to target increases in LPA rather than focusing on only MVPA. Emphasizing more LPA is also another way to change a sedentary lifestyle.

Different variables were associated with sedentary time in this study. Those who were non-Hispanic White were less sedentary, which is inconsistent with finding of other study.[51] This inconsistency may be due to the fact that our sample was mainly Non-Hispanic White and other races have been combined because of small sample size. Lower education and being unemployed were positively associated with sedentary time. Lower education is often associated with jobs that require physical labor, but this was not the case in our study because only 14% of the COPD people in the sample were working. Perhaps this finding

indicates that educated people value the benefits of physical activity for health. Being occupationally active may have a protective effect against sedentary lifestyles.[52] Ford et al[53] has emphasized that levels of physical activity and sedentary time should be examined separately. This is because two dimensions may have different determinants, which is supported by our finding. Overall, variables associated with level of physical activity were different from variables associated with sedentary time in our study. This finding suggests that different population should be targeted, depending on whether the intervention is developed to increase physical activity or to decrease sedentary time.

This study has strengths and limitations. Major strengths include the use of a nationally representative population and the objective measure of physical activity. Four limitations are noted. First, the accelerometer did not capture the full picture of sedentary time because participants wore the device only during waking hours; thus, we cannot estimate total sedentary time. Second, some physical activities cannot be captured by an accelerometer, such as swimming or showering, and accelerometers are not effective in capturing the static components of physical activity.[39] Third, the NHANES did not ask about depression during the period of 2003–2006, a comorbidity that could have affected the level of physical activity. Fourth, because the NHANES dataset (2003–2006) contained no indicator for disease severity, we could not provide disease severity.

Conclusion

The findings of this study provide additional confirmation that people with COPD in the United States are extremely sedentary and have low levels of LPA and MVPA. This highlights the need to assess patients' physical activity level in clinical settings and further emphasizes the need to assess their sedentary time and to detail their patterns of physical activity, so that more individualized goals for physical activity could be set in people with COPD. Several demographic and clinical characteristics were associated with sedentary time and different levels of physical activity. Understanding those factors that are related to sedentary time and different levels of physical activity may help health care providers (1) to identify people with COPD whose lifestyles pose a risk to their health, (2) to identify appropriate PA targets and develop more effective programs to decrease sedentary time and improve physical activity in patients with COPD. Further study is required to confirm these findings in well-defined COPD populations. And, the relationship of sedentary time, independent of physical activity, and time spent in LPA to health-related outcomes should be examined.

Acknowledgments

This study is supported by T32 Post Doctoral Fellowship; Health Promotion/Risk Reduction Interventions with Vulnerable Populations Training Grant in University of Michigan, Ann Arbor.

References

1. Minino, AM.; Xu, JQ.; Kochanek, KD. National Vital Statistics Reports. Vol. 59. Hyattsville, MD: National Center for Health Statistics; 2010. Deaths: Preliminary Data for 2008.
2. Murray CJ, Lopez AD. Alternative projections of mortality and disability by cause 1990–2020: Global Burden of Disease Study. Lancet. 1997; 349(9064):1498–1504. [PubMed: 9167458]

3. Arne M, Janson C, Janson S, et al. Physical activity and quality of life in subjects with chronic disease: chronic obstructive pulmonary disease compare with rheumatoid arthritis and diabetes mellitus. Scan J Prim Health Care. 2009; 27(3):141–147.
4. Pitta F, Troosters T, Spruit MA, Probst VS, Decramer M, Gosselink R. Characteristics of physical activities in daily life in chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 2005; 171(9):972–977. [PubMed: 15665324]
5. Benzo RP, Chang CC, Farrell MH, et al. Physical activity, health status and risk of hospitalization in patients with severe chronic obstructive pulmonary disease. Respiration. 2010; 80(1):10–18. [PubMed: 20234126]
6. Katz P, Chen H, Omachi TA, et al. The role of physical inactivity in increasing disability among older adults with obstructive airway disease. J Cardiopulm Rehabil Prev. 2011; 31(3):193–197. [PubMed: 21124233]
7. Garcia-Aymerich J, Lange P, Serra I, Schnohr P, Antó JM. Time-dependent confounding in the study of the effects of regular physical activity in chronic obstructive pulmonary disease: an application of the marginal structural model. Ann Epidemiol. 2008; 18(10):775–783. [PubMed: 18708291]
8. Garcia-Aymerich J, Lange P, Benet M, Schnohr P, Anto JM. Regular physical activity reduces hospital admissions and mortality in chronic obstructive pulmonary disease: a population based cohort study. Thorax. 2006; 61(9):772–778. [PubMed: 16738033]
9. Seidel D, Cheung A, Suh ES, Raste Y, Atakhorrami M, Spruit MA. Physical inactivity and risk of hospitalisation for chronic obstructive pulmonary disease. Int J Tuberc Lung Dis. 2012; 16(8):1015–1019. [PubMed: 22668830]
10. Global Initiatives for Chronic Obstructive Lung Disease. [Accessed 20.04.13] Global Strategy for Diagnosis, Management, and Prevention of COPD. Available at: http://www.goldcopd.org/guidelines-global-strategy-for-diagnosis-management.html
11. Hernandes NA, de Teixeira DC, Probst VS, Brunetto AF, Ramos EM, Pitta F. Profile of the level of physical activity in the daily lives of patients with COPD in Brazil. J Bras Pneumol. 2009; 35(10):949–956. [PubMed: 19918626]
12. Garcia-Aymerich J, Lange P, Benet M, Schnohr P, Anto JM. Regular physical activity modifies smoking-related lung function decline and reduces risk of chronic obstructive pulmonary disease: a population-based cohort study. Am J Respir Crit Care Med. 2007; 175(5):458–463. [PubMed: 17158282]
13. Healy GN, Dunstan DW, Salmon J, et al. Objectively measured light-intensity physical activity is independently associated with 2-h plasma glucose. Diabetes Care. 2007; 30(6):1384–1389. [PubMed: 17473059]
14. Lynch BM, Dunstan DW, Healy GN, Winkler E, Eakin E, Owen N. Objectively measured physical activity and sedentary time of breast cancer survivors, and associations with adiposity: findings from NHANES (2003–2006). Cancer Causes Control. 2010; 21:283–288. [PubMed: 19882359]
15. Lynch BM, Friedenreich CM, Winkler EAH, et al. Associations of objectively assessed physical activity and sedentary time with biomarkers of breast cancer risk in postmenopausal women: findings from NHANES (2003–2006). Breast Cancer Res Treat. 2011; 130(1):183–194. [PubMed: 21553294]
16. Healy GN, Wijndaele K, Dunstan DW, et al. Objectively measured sedentary time, physical activity, and metabolic risk. Diabetes Care. 2008; 31:369–371. [PubMed: 18000181]
17. Healy GN, Matthews CE, Dunstan DW, Winkler EAH, Owen N. Sedentary time and cardio-metabolic biomarkers in US adults: NHANES 2003–06. Eur Heart J. 2011; 32(5):590–597. [PubMed: 21224291]
18. Watz H, Waschki B, Kirsten A, et al. The metabolic syndrome in patients with chronic bronchitis and COPD. Chest. 2009; 136:1039–1046. [PubMed: 19542257]
19. Pitta F, Breyer MK, Hernandes NA, et al. Comparison of daily physical activity between COPD patients from Central Europe and South America. Respir Med. 2009; 103(3):421–426. [PubMed: 19006659]
20. Troosters T, Sciurba F, Battaglia S, et al. Physical inactivity in patients with COPD, a controlled multi-center pilot-study. Respir Med. 2010; 104(7):1005–1011. [PubMed: 20167463]

21. Garcia-Aymerich J, Serra I, Gómez FP, et al. Physical activity and clinical and functional status in COPD. Chest. 2009; 136:62–70. [PubMed: 19255291]
22. Eliason G, Zakrisson AB, Piehl-Aulin K, Hurtig-Wennlöf A. Physical activity patterns in patients in different stages of chronic obstructive pulmonary disease. COPD. 2011; 8(5):369–374. [PubMed: 21895516]
23. Vorrink SN, Kort HS, Troosters T, Lammers JW. Level of daily physical activity in individuals with COPD compared with healthy controls. Respir Res. 2011; 12:33. [PubMed: 21426563]
24. Garcia-Aymerich J, Felez MA, Escarrabill J, et al. Physical activity and its determinants in severe chronic obstructive pulmonary disease. Med Sci Sports Exerc. 2004; 36(10):1667–1673. [PubMed: 15595285]
25. Esteban C, Quintana JM, Aburto M, et al. Impact of changes in physical activity on health-related quality of life among patients with chronic obstructive pulmonary disease. Eur Respir J. 2010; 36(2):292–300. [PubMed: 20075059]
26. Steele BG, Holt L, Belza B, Ferris S, Lakshminaryan S, Buchner DM. Quantitating physical activity in COPD using a triaxial accelerometer. Chest. 2000; 117(5):1359–1367. [PubMed: 10807823]
27. Owen N, Leslie E, Salmon J, Fotheringham MJ. Environmental determinants of physical activity and sedentary behavior. Exerc Sport Sci Rev. 2000; 28(4):153–158. [PubMed: 11064848]
28. Owen N, Bauman A, Brown W. Too much sitting: a novel and important predictor of chronic disease risk? Br J Sports Med. 2009; 43(2):81–83. [PubMed: 19050003]
29. Sugiyama T, Healy GN, Dunstan DW, Salmon J, Owen N. Joint associations of multiple leisure-time sedentary behaviours and physical activity with obesity in Australian adults. Int J Behav Nutr Phys Act. 2008; 5:35. [PubMed: 18590570]
30. Centers for Disease Control and Prevention. [Accessed 31.01.13] National Health and Nutrition Examination Survey; About the National Health and Nutrition Examination Survey (a). Available at: http://www.cdc.gov/nchs/nhanes/about_nhaes.htm
31. Centers for Disease Control and Prevention. [Accessed 31.01.13] National Health and Nutrition Examination Survey; Questionnaires, documents, and related documentation (b). Available at: http://www.cdc.gov/nchs/data/nhanes/nhanes_05-06/BM.pdf
32. Centers for Disease Control and Prevention. [Accessed 31.01.13] National Health and Nutrition Examination Survey (c). Available at: http://www.cdc.gov/nchs/data/nhanes/nhanes_05_06/meccomp_d.pdf
33. Hawkins MS, Storti KL, Richardson CR, et al. Objectively measured physical activity of USA adults by sex, age, and racial/ethnic groups: a cross-sectional study. Int J Behav Nutr Phys Act. 2009; 6:31. [PubMed: 19493347]
34. Hawkins MS, Sevick MA, Richardson CR, Fried LF, Arena VC, Kriska AM. Association between physical activity and kidney function: National Health and Nutrition Examination Survey. Med Sci Sports Exerc. 2011; 43(8):1457–1464. [PubMed: 21200336]
35. Trost SG, McIver KL, Pate RR. Conducting accelerometer-based activity assessments in field-based research. Med Sci Sports Exerc. 2005; 37(11 Suppl):S531–S543. [PubMed: 16294116]
36. Buman MP, Hekler EB, Haskell KL, et al. Objective light-intensity physical activity associations with rated health in older adults. Am J Epidemiol. 2010; 172(10):1155–1165. [PubMed: 20843864]
37. Freedson PS, Melanson E, Sirard J. Calibration of the computer science and applications, Inc. accelerometer. Med Sci Sports Exerc. 1998; 30(5):777–781. [PubMed: 9588623]
38. Welk, GJ. Use of accelerometer-Based activity monitors to assess physical activity. In: Welk, GJ., editor. Physical Activity Measurement for Health Related Research. Champaign: Human Kinetics; 2002. p. 125-141.
39. Matthew CE. Calibration of accelerometer output for adults. Med Sci Sports Exerc. 2005; 37(11 Suppl):S512–S522. [PubMed: 16294114]
40. McClain JJ, Sisson SB, Tudor-Locke C. Actigraph accelerometer interinstrument reliability during free-living in adults. Med Sci Sports Exerc. 2007; 39(9):1509–1514. [PubMed: 17805082]
41. Macfarlane DJ, Lee CC, Ho EY, Chan KL, Chan D. Convergent validity of six methods to assess physical activity in daily life. J Appl Physiol. 2006; 101(5):1328–1334. [PubMed: 16825525]

42. Heeringa, G.; West, B.; Berglund, PA. Applied Survey Data Analysis. Boca Raton, FL: CRC Press; 2010.
43. Haskell WL, Lee IM, Pate RR, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Med Sci Sports Exerc. 2007; 39(8):1423–1434. [PubMed: 17762377]
44. Pate RR, Pratt M, Blair SN, et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. JAMA. 1995; 273(5):402–407. [PubMed: 7823386]
45. Hartman JE, Boezen HM, de Greef MHG, Bossenbroek L, ten Hacken NHT. Consequences of physical inactivity in chronic obstructive pulmonary disease. Expert Rev Respir Med. 2010; 4(6): 735–745. [PubMed: 21128749]
46. Ransdell LB, Wells CL. Physical activity in urban white, African-American, and Mexican-American women. Med Sci Sports Exerc. 1998; 30(11):1608–1615. [PubMed: 9813874]
47. He XZ, Baker DW. Differences in leisure-time, household, and work-related physical activity by race, ethnicity, and education. J Gen Intern Med. 2005; 20(3):259–266. [PubMed: 15836530]
48. McGlone S, Venn A, Walters EH, Wood-Baker R. Physical activity, spirometry and quality-of-life in chronic obstructive pulmonary disease. COPD. 2006; 3(2):83–88. [PubMed: 17175670]
49. Moy ML, Matthess K, Stolzmann K, Reilly J, Garshick E. Free-living physical activity in COPD: assessment with accelerometer and activity checklist. J Rehabil Res Dev. 2009; 46(2):277–286. [PubMed: 19533541]
50. Killian KJ, Leblanc P, Martin DH, Summers E, Jones NL, Campbell EJ. Exercise capacity and ventilatory, circulatory, and symptom limitation in patients with chronic airflow limitation. Am Rev Respir Dis. 1992; 146(4):935–940. [PubMed: 1416421]
51. Matthews CE, Chen KY, Freedson PS, et al. Amount of time spent in sedentary behaviors in the United States, 2003–2004. Am J Epidemiol. 2008; 167(7):875–881. [PubMed: 18303006]
52. Marshall SJ, Jones DA, Ainsworth BE, Reis JP, Levy SS, Macera CA. Race/ethnicity, social class, and leisure-time physical inactivity. Med Sci Sports Exerc. 2007; 39(1):44–51. [PubMed: 17218883]
53. Ford ES, Li C. Physical activity or fitness and the metabolic syndrome. Expert Rev Cardiovasc Ther. 2006; 4(6):897–915. [PubMed: 17173504]

Table 1

Sample characteristics for people with COPD and the comparison group.

	COPD (*n* = 224)	Comparison group (*n* = 1386)
	Mean ± SD	Mean ± SD
	n (%)	*n* (%)
Age	70.05 ± 8.66	69.21 ± 8.67
Gender (male)*	114 (50.9%)	891 (64.3%)
Race		
Others, including Hispanic, Mexican-American, Non-Hispanic Black	63 (28.1%)	551 (39.8%)
Non-Hispanic White	161 (71.9%)	835 (60.3%)
Education		
High school or less	132 (59.2%)	841 (60.9%)
More than high school	91 (40.8%)	541 (39.2%)
Income		
<$25,000	110 (51.6%)	499 (38.5%)
$25,000–$55,000	68 (31.9%)	470 (36.3%)
>$55,000	35 (16.4%)	327 (25.2%)
Currently working*	32 (14.3%)	453 (32.7%)
Marital status*		
Living with someone, married	166 (51.8%)	871 (62.8%)
Separated, widowed, divorced	108 (48.2%)	515 (37.2%)
Number of people in household		
1	65 (29.0%)	336 (24.2%)
2–7	159 (71.0%)	1050 (75.8%)
Self-reported health*		
Excellent, very good, and good	112 (51.9%)	980 (73.5%)
Fair and poor	104 (48.2%)	354 (26.5%)
Pack years of smoking*	56.43 ± 44.75	39.91 ± 37.66
Shortness of breath*	168 (75.0%)	552 (40.0%)
Coughing*	82 (36.6%)	137 (9.9%)
Sputum*	75 (33.6%)	146 (10.6%)
Wheezing*	115 (51.3%)	150 (10.8%)
Number of Co-morbidities*	3.26 ± 2.10	2.15 ± 1.71
Body Mass Index, kg/m^2	28.74 ± 7.24	28.24 ± 5.39

* $p < 0.05$ comparison of data between COPD and comparison group.

Table 2

Comparison of sedentary time and physical activity measured by accelerometer between people with COPD and comparison group.

	COPD (*n* = 224)	Comparison group (*n* = 1386)
	Mean ± SD	**Mean ± SD**
Days monitored	6.40 ± 0.90	6.57 ± 0.80
Wear time (minutes monitored daily)	931.67 ± 157.40	941.65 ± 145.45
Mean activity intensity[a]	146.93 ± 93.45	197.03 ± 111.38*
Sedentary time (minutes/day)	675.79 ± 169.74	641.37 ± 161.65
Sedentary % time	.72 ± 0.11	0.68 ± 0.11*
LPA (minutes/day)	249.52 ± 97.57	288.06 ± 101.53*
LPA % time	0.27 ± 0.10	0.31 ± 0.11*
MVPA (minutes/day)	6.36 ± 11.37	12.21 ± 16.23*
MVPA % time	0.007 ± 0.012	0.013 ± 0.017*

*$p < 0.05$ between COPD and comparison group.

LPA = light physical activity; MVPA = moderate to vigorous physical activity. Sedentary % time = time spent sedentary (minutes/day)/daily wear time for accelerometer. LPA % time = time spent in LPA (minutes/day)/daily wear time for accelerometer. MVPA % time = time spent in MVPA (minutes/day)/daily wear time for accelerometer.

[a]Mean activity intensity means mean total counts/total wear time (minute).

Table 3

Contributions of demographic and clinical variables to sedentary time and different levels of physical activity based on multiple regression analysis in people with COPD (n = 224).

	R^2	Unstandardized beta	df	F	p
A) Dependent variable was mean activity intensity (log mean activity intensity[a])					
Overall model	33.3		9, 22	10.49	0.00001
Age		−0.03			0.0001
Race		0.16			0.08
Marital status		−0.06			0.39
Income level		−0.03			0.62
Working status		−0.21			0.12
Self-reported health		−0.43			0.001
Body mass index		−0.01			0.03
Shortness of breath		−0.17			0.08
Number of comorbidity		−0.05			0.89
B) Dependent variable was sedentary time (minutes/day)					
Overall model	21.7		7, 24	10.06	0.00001
Age		3.05			0.08
Race		−77.95			0.01
Marital status		12.37			0.52
Income level		30.71			0.11
Level of education		45.04			0.01
Working status		101.65			0.001
Shortness of breath		74.48			0.003
C) Dependent variable was time spent in light physical activity (minutes/day)					
Overall model	29.4		9, 22	5.63	0.001
Age		−2.14			0.01
Gender		38.76			0.002
Race		10.73			0.45
Marital status		−16.67			0.19
Working status		−31.74			0.23

	R^2	Unstandardized beta	df	F	p
Self-reported health		−71.15			0.001
Body mass index		−2.19			0.04
Shortness of breath		−10.40			0.60
Number of comorbidity		−4.82			0.20
D) Dependent variable was time spent in moderate to vigorous physical activity (log minutes/day)					
Overall model	30.5		9, 22	20.32	0.0001
Age		−0.06			0.0001
Gender		−0.32			0.03
Marital		−0.14			0.77
Level of education		0.13			0.38
Working status		−0.28			0.34
Self-reported health		−0.73			0.001
Shortness of breath		−0.42			0.05
Number of comorbidity		0.01			0.93

[a]Mean activity intensity means mean total counts/total wear time (minute).