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The Association of Self-Reported Aerobic Physical Activity, Muscle Strengthening Physical Activity, and Stretching Behavior with Presenteeism

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Abstract

Objective—Evaluate relations between aerobic physical activity (PA), muscle-strengthening PA, and stretching behavior and presenteeism in university employees.

Methods—A cross-sectional study used health assessment data from two employee respondent groups ($n_{2015}=10,791$ and $n_{2009}=10,165$). Multivariable zero-inflated negative binomial regression models assessed the association between self-reported PA types and presenteeism.

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Results—There was consistent evidence that employees who reported participating in sufficient aerobic PA had higher odds for no work limitations ($OR_{2015}=1.45$, $p<0.001$; $OR_{2009}=1.55$, $p<0.001$) and lower levels of work limitations ($IRR_{2015}=0.92$, $p<0.05$; $IRR_{2009}=0.83$, $p<0.001$) compared to employees who reported participating in no activity. There was some evidence of an inverse association between muscle-strengthening PA and work limitations, but no evidence between stretching behavior and work limitations.

Conclusions—Promoting PA among employees is a key health behavior to target for worksites concerned about presenteeism.

INTRODUCTION

Poor health of employees impacts employers by contributing to increased medical care expenses and lost productivity.¹ Lost productivity is one key consequence of absenteeism and presenteeism. Absenteeism refers to missed workdays due to illness, while presenteeism refers to decrements in health-related work role function while on-the-job.² Studies suggest costs from presenteeism exceed those of absenteeism.^{1,3} More specifically, presenteeism costs are estimated to account for 18–60% of total dollars lost due to select health conditions.⁴ Given the high cost of presenteeism, there is a need to better understand the potential impact of key health behaviors such as physical activity on reducing presenteeism.

Physical activity has been shown to improve cardiorespiratory, metabolic, musculoskeletal, functional, and mental health.⁵ Furthermore, evidence indicates people who are physically active are less likely to develop chronic conditions compared to people who are inactive, with the association following a dose-response pattern.⁵ Two likely mechanisms driving the potential relation between physical activity and presenteeism are chronic disease control and prevention. People who are more physically active develop fewer chronic conditions, or have better control of their conditions, potentially leading to lower levels of presenteeism.

Previous studies in this area have almost exclusively focused on the relation between aerobic physical activity and presenteeism. Past observational studies have reported significant inverse associations^{6–10}, an association with light aerobic physical activity only¹¹, or no association.^{12–14} Furthermore, only one known study included muscle-strengthening activity and stretching behavior, finding no association.¹⁵ There are many potential reasons for inconsistent results, including varying measures and means of operationalizing physical activity and presenteeism, and different control variables included in analyses. In addition, no studies have examined associations with presenteeism across multiple levels of aerobic, muscle-strengthening, and stretching activity. The purpose of this study was to determine the associations between aerobic physical activity, muscle-strengthening physical activity, and stretching behavior and presenteeism in a large population of university employees.

METHODS

Design

A cross-sectional study design examined aims using secondary de-identified data provided by the Office of Employee Benefits at a large university system. Two datasets were provided from annual health assessments (HA) to perform a replication analysis. One dataset was

from HAs administered and voluntarily returned during the 2009 plan year while the other was from HAs administered during the 2015 plan year. The University System changed the HA in 2013 so the respective datasets had some of the same questions (capturing the outcome) and some different questions (related to physical activity and control variables) used in analyses. Using datasets with different physical activity questions allowed for more than one operationalization of physical activity to improve construct validity by reducing mono-operation bias.¹⁶ The HA was offered by the university system to provide employees with feedback about their health behaviors and institutions with wellness trends. Employees received a \$25 gift card for completing the HA if they also attended a wellness or preventive exam visit. The University of Texas Health Science Center at Houston ethics review board approved this study.

Participants

Participants included benefits-eligible employees from any member institution who completed an HA during the 2009 or 2015 plan year. There were a total of 16 institutions within the System during the time of study: 9 academic, 6 medical, and 1 administrative. In total, there were about 75,000–85,000 employees who worked in the system at some point during each respective plan year. A range of 62–64% of employees worked at medical institutions, 35–37% at academic institutions, and 1% at the administrative institution. The System offered HAs to all benefits-eligible employees at member institutions who were at least 18 years of age. The Office of Employee Benefits advertised the HA on their website and employees were also contacted through email and directed to a website to complete the self-reported HA.

Measures

Presenteeism—Presenteeism was measured in both HAs using the 8-item Work Limitations Questionnaire (WLQ), which was designed to measure on-the-job impact of chronic conditions. Similar to the original 25-item WLQ¹⁷, the 8-item version has demonstrated good reliability and validity.¹⁸ The 8-item WLQ uses two root questions: 1) “In the past 2 weeks, how much time did your physical health or emotional problems make it difficult for you to...?” and 2) “In the past 2 weeks, how much time were you able to...?” The items are based on four job dimensions: time management, physical work, mental/interpersonal, and output tasks. Response options include: “all of the time (100%),” “most of the time,” “some of the time (about 50%),” “a slight bit of the time,” and “none of the time (0%).” There is also a response option: “does not apply to my job.” If less than 15% of responses to a question were “does not apply to my job,” then it was deemed relevant to the working population and the respective value was set to missing. The scale value was set to missing if an employee had more than two items missing. An index score was calculated by converting responses to percentages and averaging them together, resulting in values from 0–100. Items using the second root question were reverse coded for the scoring process. A score of 0 represented a respondent limited none of the time, whereas 100 represented a respondent limited all of the time.

Physical Activity—The 2015 HA included questions for aerobic physical activity, muscle-strengthening physical activity, and stretching behavior. Aerobic physical activity was

assessed by the following question: “How many days/week do you participate in at least 20–30 minutes of physical activity?” There were eight response options, which were used to create ordered groupings informed by the US Physical Activity Guidelines¹⁹: not active (no activity), insufficiently active (1–4 days of moderate exercise or 0–2 days of vigorous exercise), sufficiently active (5–6 days of moderate or 3–4 days of vigorous exercise), or highly active (7 days of moderate or > 4 days of vigorous exercise). The 2015 HA also included two separate questions capturing days/week respondents engaged in “strength training exercises” and “stretching exercises to improve the flexibility of your back, neck, and shoulders”. Responses to the muscle-strengthening question were used to create ordered groupings based on the US Physical Activity Guidelines¹⁹: 0, 1, or 2 days/week. Since there are no specific recommendations for stretching behavior, the original response options were used: 0, 1, 2, or 3 days/week.

The 2009 HA included questions about aerobic and muscle-strengthening activity only. To measure aerobic activity, respondents were asked to list the number of days/week and minutes/session they did cardiovascular exercise (including jogging, cardio machines, aerobics, brisk walking, swimming, or any other such exercise). An ordered grouping variable was created based on minutes/week: not active (0 minutes/week), insufficiently active (>0 and < 150 minutes/week), sufficiently active (150 and <300 minutes/week), and highly active (≥ 300 minutes/week). To measure muscle-strengthening activity, participants were asked to list the number of days/week and minutes/session they did strength-building exercise (including weightlifting, push-ups, sit-ups, yoga, pilates, or any other such exercise). An ordered grouping variable was created based on days/week: 0, 1, 2 days/week.

Control Variables—Control variables included age, gender, institution type (medical vs. non-medical), number of chronic conditions (0, 1–2, or 3), and number of risk factors (0, 1–2, or 3). There were minor differences between the two HAs for risk factor and chronic conditions assessment. The 2009 HA included the following risk factors: smoking (current smoker), chewing tobacco use (current user), frequency of fruit and vegetable consumption (< 3 servings per day), excessive alcohol consumption (>7/14 drinks/week for women/men), and stress (in the past year stress has affected my health or well-being). Number of chronic conditions for the 2009 HA was determined by the presence of allergies, arthritis, asthma, cancer, chronic back pain, chronic neck pain, chronic obstructive pulmonary disease (COPD), depression, diabetes, gastroesophageal reflux disease (GERD), heart disease, migraines, osteoporosis, hypertension, and stroke. The 2015 HA included the same risk factors, except stress was determined by difficulty coping with stress and sleep (<7 hours of sleep/night) was included as an additional risk factor. The chronic conditions were the same except neck pain, GERD, heart disease, and migraines were replaced with angina/congestive heart failure/heart attack, heartburn, headaches, and anxiety.

Statistical Methods

Descriptive statistics were evaluated for both the 2009 and 2015 samples. Zero-inflated negative binomial (ZINB) regression models (1 for each sample) were used to determine whether independent associations existed between the dependent variable of work

limitations and; 1) aerobic physical activity, 2) muscle-strengthening physical activity, and 3) stretching behavior. ZINB models were used because the distribution of work limitations in both datasets was positively skewed and contained an extremely large number of zeros.²⁰ The skewed distributions were likely due to study samples representing general employee populations, which would be healthier than patient populations where a more normal distribution would be expected. ZINB models assume zeros are generated by two separate processes, which lead to excess zeros in the data. For this analysis, it was impossible to know whether employees reported no work limitations because they had no health issues, or, if they had health issues but they were under control or not contributing to work limitations. ZINB models contain two parts: a binary component and a negative binomial count component to model relations while accounting for the excess zeros.²⁰ The Vuong statistic was used to compare model fit between a ZINB and a (non-inflated) negative binomial model, with a significant result supporting the use of the ZINB model.²⁰

Age, gender, institution type, number of risk factors, and number of chronic conditions were entered in all models to control for confounding. Predicted values of work limitations for respective physical activity groups (adjusted for control variables) were computed for each respective model to help illustrate practical significance. An alpha value of 0.05 was considered to be the level of statistical significance and all analyses were performed using Stata 13.0.²¹

RESULTS

Respondent Characteristics

Both 2015 and 2009 respondent groups were evaluated independently for a replication analysis. Sample sizes were similar with 10,791 respondents in 2015 and 10,165 respondents in 2009, with complete data across all study variables. There were 1,526 respondents who took the HA in both 2009 and 2015. Data set characteristics are presented in Table 1. In 2015, there was a higher percentage of female employees (80.8% versus 71.8%) and employees from a medical institution (75.3% versus 67.6%) than in 2009. The mean age for both respondent groups was similar with values of 41.7 and 42.2 years, respectively. A range of 25–26% of employees reported participating in sufficient or high levels of aerobic physical activity in both samples. However, a greater percentage of employees reported participating in sufficient muscle-strengthening activity in the 2009 versus the 2015 respondent group (41.0% vs. 28.4%). Stretching behavior was only available in the 2015 data, where 38.5% reported participating in 2 days of stretching. There was a greater percentage of respondents in 2009 with zero chronic conditions (36.4% vs. 25.0%) than in 2015, although the percentages were relatively similar for the risk factor groupings. The mean work limitations value was slightly higher in 2009 (11.4) than in 2015 (8.8). In addition, there was a smaller percentage of zero values in 2009 (35%) compared to 2015 (46%).

There were some differences in demographic variables when comparing HA respondent groups to the total enrolled employee populations for each respective plan year. Respondent groups had a higher percentage of female employees in 2009 (71.8%) and 2015 (80.8%) compared to the total employee population, which was about 60% female in both 2009 and

2015. There were also more respondents employed at a medical institution (67.6% in 2009 and 75.3% in 2015) compared to the total eligible working populations, which ranged from 62–64%. However, the average age of the respondent groups (about 42 for both years) was similar to the average age for the total population in both years (about 43 years).

2015 Regression Results

Results from the zero-inflated models for both respondent groups are presented in Table 2. Employees with sufficient and high levels of reported aerobic physical activity had higher adjusted odds (OR = 1.45; 95% CI = 1.23–1.17 and OR = 1.61; 95% CI = 1.27–2.05, respectively) for reporting no work limitations compared to employees with no reported aerobic physical activity. Employees with sufficient reported muscle-strengthening activity (≥ 2 days) had higher adjusted odds (OR = 1.22; 95% CI = 1.08–2.36) for reporting no work limitations compared to employees with no muscle-strengthening activity. Employees who reported participating in 1–2 days of stretching had lower adjusted odds (OR = 0.83; 95% CI = 0.74–0.94) for reporting no work limitations compared to employees with no stretching.

Negative binomial model results indicated only aerobic physical activity had a significant inverse relation with work limitations. Reported participation in sufficient or high levels of aerobic physical activity was associated with less expected work limitations (adjusted IRR = 0.92; 95% CI = 0.84–0.99 and adjusted IRR = 0.86; 95% CI = 0.75–0.98, respectively) compared to inactive employees. In contrast, reported participation in one day of muscle-strengthening physical activity was associated with a higher expected amount of work limitations (adjusted IRR = 1.07; 95% CI = 1.10–1.13) relative to no reported muscle-strengthening physical activity. There was no relation between reported stretching behavior and presenteeism. The Vuong test statistic supported the use of the zero-inflated model over a negative binomial regression model ($z = 61.92$, $p < 0.001$) for the 2015 data.

2009 Regression Results

Results from the 2009 respondent group revealed employees who reported sufficient and high levels of aerobic physical activity had higher adjusted odds for reporting no work limitations (OR = 1.55; 95% CI = 1.32–1.83 and OR = 1.59; 95% CI = 1.27–1.99, respectively) compared to employees with no reported aerobic physical activity (see Table 2). However, there was no significant relation between muscle-strengthening physical activity and the adjusted odds for no work limitations. Negative binomial results indicated reported participation in insufficient and sufficient levels of aerobic physical activity decreased the expected amount of work limitations (adjusted IRR = 0.87; 95% CI = 0.82–0.92 and adjusted IRR = 0.83; 95% CI = 0.78–0.89, respectively), compared to employees with no aerobic activity. However, the trend did not hold for employees with high aerobic physical activity. Furthermore, there was no significant relation between muscle-strengthening physical activity and the amount of work limitations. The Vuong test statistic supported the use of the zero-inflated model over a negative binomial regression model ($z = 77.95$, $p < 0.001$) for the 2009 data.

Predicted Work Limitation Levels

Predicted work limitation levels were compared between physical activity groups for each respective physical activity type and dataset (Figures 1a–1c). The 2009 respondent group had higher levels of work limitations compared to the 2015 respondent group across all respective physical activity categories. Figure 1a illustrates the inverse relation between aerobic physical activity and work limitations, with a dose response trend in the 2015 respondent group. Predicted work limitation levels for 2015 respondents revealed an excess of 2.1–3.0% of time inactive employees were unable to meet job demands compared to employees with sufficient or high levels of physical activity. Predicted work limitation levels for 2009 respondents revealed an excess of 2.0–3.6% of time inactive employees were unable to meet job demands compared to employees with insufficient or sufficient levels of physical activity. Figures 1b and 1c illustrate the lack of support for an inverse relation between muscle-strengthening physical activity and stretching behavior and work limitations.

DISCUSSION

The purpose of this study was to examine the relations among aerobic physical activity, muscle-strengthening physical activity, and stretching behavior and presenteeism. Results indicated reported aerobic physical activity was inversely related to presenteeism; meaning employees who were sufficiently active had higher odds for no work limitations and lower levels of work limitations compared to employees who were inactive. The relation between muscle-strengthening physical activity and presenteeism was less clear. Findings from the 2015 data suggested employees with 2 days of muscle-strengthening physical activity had higher odds for no work limitations; however, the association was not significant in the 2009 data. Furthermore, there was no support for an inverse relation between muscle-strengthening activity and the amount of work limitations in either data set. For stretching behavior, results suggested employees who participated in 1–2 days of stretching had lower odds for no work limitations.

Comparing findings between respondent groups revealed consistent evidence supporting the idea that participating in sufficient and high levels of aerobic physical activity contributed to better health for employees and thus greater odds for no work limitations. Among employees with work limitations, the 2015 data supported a dose response relation where higher levels of physical activity were associated with lower levels of work limitations. However, in the 2009 data, employees in the high aerobic activity group did not have significantly lower levels of work limitations compared to inactive employees. This finding could be due to the 2009 HA question emphasizing aerobic exercise rather than general physical activity. As a result, the 2009 data may have contained an isolated group of high exercisers more prone to musculoskeletal injuries impacting physical health²².

When comparing predicted work limitation levels between employee physical activity groups, results suggested a difference of up to 3.6% of time inactive employees were unable to meet job demands relative to employees with sufficient aerobic activity. Assuming a standard 40 hour work week for 50 weeks out of the year, this equates to 72 hours or up to 9 additional days lost for an entire year. These results demonstrate how the difference in work

limitations between aerobic physical activity groups can accumulate over time to have a meaningful impact. Stated differently, an employer could recapture 1–2 weeks of productive time per year if they were able to convert employees who participate in no aerobic physical activity to those who participate in sufficient levels of aerobic physical activity.

Past studies evaluating the relation between physical activity and presenteeism have focused on aerobic activity. Our results are consistent with these studies reporting a significant inverse association with small to moderate effect sizes.^{7–11} Previous studies have reported odds for presenteeism to be 1.4–2.3 times higher for inactive participants compared to aerobically active participants.^{7,10,11} Other studies treating presenteeism as a continuous variable also reported a significant inverse association with small effect sizes.^{8,9} Our study supports previous findings and improves on them in two ways. First, we used a model that accounted for the high number of zeros in the data while retaining information about the amount of work limitations. Second, our results clarify that employees meeting or exceeding recommended aerobic activity levels have higher odds for no work limitations; and, employees meeting recommended levels of aerobic activity have lower levels of work limitations than inactive employees. Therefore, our results show the amount of aerobic physical activity driving the association with presenteeism is consistent with guideline recommendations.¹⁹

One study that included muscle-strengthening activity and stretching behavior when evaluating the relation between physical activity and presenteeism reported no significant findings after controlling for aerobic activity and other health-related variables.¹⁵ Our results, in comparison, provided suggestive evidence for a significant relation between muscle-strengthening physical activity and no work limitations. Additionally, we found 1–2 days of stretching behavior was associated with lower odds for no work limitations. The stretching finding could be in part due to the cross-sectional nature of the data. Employees with worse health and more work limitations may participate in stretching behavior to compensate, which could explain how more reported stretching was associated with lower odds for no work limitations. In addition, the muscle-strengthening and stretching survey questions were based on days per week without accounting for time per session. Therefore, respondents may have reported very short bouts of muscle-strengthening activity or stretching behavior that would have a minimal health impact.

Similar to past studies^{15,23–25}, we also found chronic conditions and risk factors were positively related to work limitations; meaning those with more conditions or risk factors had a greater amount of work limitations or had lower odds of no work limitations. We used variables to capture health and risk profiles based on the number of conditions and risk factors rather than including each condition or risk factor as a separate variable in the model. Effect sizes for risk factors and chronic conditions were moderate-to-high, suggesting strong relations. Our results, while limited to a population of university employees, are similar to other working populations. Consequently, we consider our results generalizable to the general working population.

Limitations

All data were from voluntary HAs where the response rates were relatively low (13.5% in 2009 and 12.6% in 2015) for both respondent groups. There was a potential selection bias since there were more females and employees from medical institutions in respondent groups compared to the eligible employee population. Also, HAs were self-reported and, therefore, respondents may have over-reported physical activity levels, underreported risk factors, or chose not to disclose health information because of privacy concerns. Since data were collected from HAs, the measures for physical activity and control variables lacked validity and reliability testing. In addition, the 2015 HA's aerobic physical activity question emphasized frequency instead of volume. Guidelines for aerobic physical activity are based on volume (time and intensity/week) rather than frequency (number of days/week), which could have led to misclassifications in the exposure variable. Lastly, this study used a cross-sectional sample, limiting conclusions about causal inferences.

Strengths

Multiple study strengths add value and support to findings. First, this study examined all three types of physical activity while the existing literature has focused on aerobic physical activity only. Second, we used ordinal physical activity variables based on the US Physical Activity Guidelines to better determine meaningful levels associated with presenteeism. Third, the analysis controlled for confounding by including demographic, health-risk, and chronic condition variables in the model. Lastly, we performed a replication analysis by testing hypotheses in two different respondent groups. Results between respondent groups were relatively consistent despite differences between physical activity measures.

Conclusions

Our results indicate aerobic physical activity is an important health behavior to target for worksite health programs concerned about presenteeism. Additionally, worksite health professionals focusing on presenteeism should promote aerobic physical activity levels consistent with recommendations from the US Physical Activity Guidelines. Muscle-strengthening activity may have a positive impact on presenteeism; however more research is needed with improved measures to verify this finding. Results also suggest a comprehensive approach that targets multiple risk factors may have the greatest impact on presenteeism. Physical activity is clearly important, however employees with multiple risk factors have high levels of work limitations. Therefore, promoting physical activity and other healthy behaviors can have the greatest impact presenteeism. Future research should focus on using better measures of physical activity that capture information about the volume of aerobic activity and the specific types, intensity, and duration of muscle-strengthening activity and stretching behavior. In addition, future evaluations should examine the longitudinal relation to determine if increasing physical activity can lead to reductions in presenteeism.

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REFERENCES

1. Collins JJ, Baase CM, Sharda CE, et al. The assessment of chronic health conditions on work performance, absence, and total economic impact for employers. *J Occup Environ Med.* 2005; 47(6):547–557. [PubMed: 15951714]
2. Amick, B., III, Gimeno, D. Measuring work outcomes with a focus on health-related work productivity loss. In: Wittink, H., Carr, D., editors. *Evidence, Outcomes & Quality of Life in Pain Treatment: A Handbook for Pain Treatment Professionals*. London, UK: 2007. p. 329-343.
3. Chapman LS. Presenteeism and its role in worksite health promotion. *Am J Heal Promot.* 2005 Apr; 19:1–8.
4. Goetzel RZ, Long SR, Ozminkowski RJ, Hawkins K, Wang S, Lynch W. Health, absence, disability, and presenteeism cost estimates of certain physical and mental health conditions affecting U.S. employers. *J Occup Environ Med.* 2004; 46:398–412. [PubMed: 15076658]
5. Physical Activity Guidelines Advisory Committee. *Physical Activity Guidelines Advisory Committee Report*. Washington (DC): US Department of Health and Human Services; 2008.
6. Pronk NP, Martinson B, Kessler RC, Beck AL, Simon GE, Wang P. The association between work performance and physical activity, cardiorespiratory fitness, and obesity. *J Occup Environ Med.* 2004; 46(1):19–25. [PubMed: 14724474]
7. Burton WN, McCalister KT, Chen C-Y, Edington DW. The association of health status, worksite fitness center participation, and two measures of productivity. *J Occup Environ Med.* 2005; 47(4): 343–351. [PubMed: 15824625]
8. VanWormer JJ, Fyfe-Johnson AL, Boucher JL, et al. Stress and Workplace Productivity Loss in the Heart of New Ulm Project. *J Occup Environ Med.* 2011; 53(10):1106–1109. [PubMed: 21983810]
9. Williden M, Schofield G, Duncan S. Establishing Links Between Health and Productivity in the New Zealand Workforce. *J Occup Environ Med.* 2012; 54(5):545–550. [PubMed: 22547124]
10. Burton WN, Chen C-Y, Li X, Schultz AB, Abrahamsson H. The Association of Self-Reported Employee Physical Activity With Metabolic Syndrome, Health Care Costs, Absenteeism, and Presenteeism. *J Occup Environ Med.* 2014; 56(9):919–926. [PubMed: 25153302]
11. Elizabeth Brown H, Ryde GC, Gilson ND, Burton NW, Brown WJ. Objectively Measured Sedentary Behavior and Physical Activity in Office Employees. *J Occup Environ Med.* 2013; 55(8):945–953. [PubMed: 23887700]
12. Fonseca VR, Nobre MRC, Pronk NP, Santos LA. The association between physical activity, productivity, and health care utilization among employees in Brazil. *J Occup Environ Med.* 2010; 52(7):706–712. [PubMed: 20595919]
13. Cash SW, Beresford SAA, Henderson JA, et al. Dietary and physical activity behaviours related to obesity-specific quality of life and work productivity: baseline results from a worksite trial. *Br J Nutr.* 2012; 108(6):1134–1142. [PubMed: 22142517]
14. Guertler D, Vandelanotte C, Short C, Alley S, Schoeppe S, Duncan MJ. The Association Between Physical Activity, Sitting Time, Sleep Duration, and Sleep Quality as Correlates of Presenteeism. *J Occup Environ Med.* 2015; 57(3):321–328. [PubMed: 25742538]
15. Callen BL, Lindley LC, Niederhauser VP. Health risk factors associated with presenteeism in the workplace. *J Occup Environ Med.* 2013; 55(11):1312–1317. [PubMed: 24164759]
16. Shadish, WR., Cook, T., Campbell, D. *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. Belmont, CA: Wadsworth, Cengage Learning; 2002. p. 64-102.
17. Lerner D, Amick B III, Rogers W, Malspeis S, Bungay K, Cynn D. The Work Limitations Questionnaire. *Med Care.* 2001; 39(1):72–85. [PubMed: 11176545]
18. Walker TJ, Tullar JM, Diamond PM, Kohl HW III, Amick BC III. Validity and Reliability of the 8-item Work Limitations Questionnaire. *J Occup Rehabil.* 2016; 26(4):1–8. [PubMed: 26714830]

19. Centers for Disease Control and Prevention. US Department of Health and Human Services Physical activity guidelines for Americans. Atlanta, GA: Centers for Disease Control and Prevention (CDC), National Center for Chronic Disease Prevention and Health Promotion; 2008. p. 6-17.
20. Long, JS., Freese, J. Regression Models for Categorical Dependent Variables Using Stata. Third. College Station: Stata Press; 2006. p. 481-559.
21. StataCorp. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP; 2013.
22. Colbert LH, Hootman JM, Macera CA. Physical activity-related injuries in walkers and runners in the aerobics center longitudinal study. Clin J Sport Med. 2000; 10(4):259–263. [PubMed: 11086751]
23. Boles M, Pelletier B, Lynch W. The Relationship Between Health Risks and Work Productivity. J Occup Environ Med. 2004; 46(7):737–745. [PubMed: 15247814]
24. Burton WN, Chen C-Y, Conti DJ, Schultz AB, Pransky G, Edington DW. The association of health risks with on-the-job productivity. J Occup Environ Med. 2005; 47(8):769–777. [PubMed: 16093926]
25. Kowlessar NM, Goetzel RZ, Carls GS, Tabrizi MJ, Guindon A. The relationship between 11 health risks and medical and productivity costs for a large employer. J Occup Environ Med. 2011; 53(5): 468–477. [PubMed: 21562464]

Figure 1.

(A) Predicted percent time ($\pm$ 95% CI) an employee is unable to meet job demands by aerobic physical activity group and respondent group.

(B) Predicted percent time ($\pm$ 95% CI) an employee is unable to meet job demands by muscle-strengthening physical activity group and respondent group.

(C) Predicted percent time an employee is unable to meet job demands by stretching behavior for the 2015 respondent group (n=10,791). There was no stretching question in the 2009 health assessment. All models were adjusted for gender, institution type, age, risk factors, and chronic conditions.

Table 1

Comparison of Demographic, Physical Activity, Health Related and Work Limitations Variables between the 2015 and 2009 Health Assessment Respondent Groups

	2015 (n=10,791)	2009 (n=10,165)
Demographic Variables		
Gender (% women)	80.8	71.8
Age (M $\pm$ SD, years)	41.7 $\pm$ 11.1	42.2 $\pm$ 11.3
Institution Type (% employed at Medical Institution)	75.3	67.6
Physical Activity Variables		
Aerobic Physical Activity (%)		
None	12.7	16.4
Insufficient	61.4	58.2
Sufficient	21.4	19.8
High	4.5	5.6
Muscle Strengthening Physical Activity (%)		
None	52.8	43.2
Insufficient	18.8	15.8
Sufficient	28.4	41.0
Stretching Behavior (%)		
0 days	38.5	n/a
1 day	22.6	n/a
2 days	17.0	n/a
3 or more days	21.9	n/a
Health Related Variables		
Number of Chronic Conditions (%)		
0	25.0	36.4
1–2	49.6	44.3
3	25.0	19.3
Risk Factors (%)		
0	23.4	20.8
1–2	70.4	71.4
3	6.1	7.8
Dependent Variable		
Work Limitations Score (M $\pm$ SD)	8.85 (12.5)	11.37 (14.1)

Model Results from Zero-inflated Regression of Presenteeism on Physical Activity for the 2015 (n=10,791) and 2009 (n=10,165) Health Assessment Respondent Groups

Table 2

Variable	2015 Logit	2009 Logit	2015 Negative Binomial IRR (95% CI)	2009 Negative Binomial IRR (95% CI)
Aerobic Physical Activity				
None	1.00	1.00	1.00	1.00
Insufficient	1.15 (0.99–1.31)	1.11 (0.97–1.28)	0.96 (0.90–1.02)	0.87 (0.82–0.92)
Sufficient	1.45 (1.23–1.71)	1.55 (1.32–1.83)	0.92 (0.84–0.99)	0.83 (0.78–0.89)
High	1.61 (1.27–2.05)	1.59 (1.27–1.99)	0.86 (0.75–0.98)	0.93 (0.84–1.04)
Muscle Strengthening Physical Activity				
None	1.00	1.00	1.00	1.00
Insufficient	1.04 (0.93–1.17)	0.89 (0.77–1.02)	1.07 (1.01–1.13)	1.04 (0.98–1.10)
Sufficient	1.22 (1.08–1.36)	1.07 (0.96–1.19)	1.05 (0.99–1.12)	0.97 (0.93–1.02)
Stretching Behavior				
None	1.00	1.00	1.00	1.00
1 day	0.83 (0.74–0.94)	n/a	1.02 (0.96–1.08)	n/a
2 days	0.83 (0.73–0.94)	n/a	0.99 (0.93–1.06)	n/a
3 or more days	0.94 (0.82–1.06)	n/a	0.97 (0.90–1.03)	n/a
Female (ref. = male)	0.92 (0.83–1.02)	0.82 (0.74–0.91)	0.95 (0.90–1.00)	1.01 (0.97–1.06)
Medical Institution (ref. = non-medical)	1.20 (1.10–1.32)	0.97 (0.88–1.06)	1.05 (0.99–1.10)	1.06 (1.02–1.10)
Age	1.02 (1.01–1.02)	1.03 (1.02–1.03)	0.996 (0.994–0.998)	0.989 (0.987–0.992)
Number of Risk Factors				
None	1.00	1.00	1.00	1.00
1–2	0.67 (0.61–0.74)	0.54 (0.49–0.60)	1.16 (1.10–1.23)	1.36 (1.29–1.44)
3	0.20 (0.16–0.26)	0.25 (0.20–0.32)	1.54 (1.42–1.68)	1.55 (1.43–1.68)
Number of Conditions				
None	1.00	1.00	1.00	1.00
1–2	0.79 (0.72–0.87)	0.70 (0.63–0.77)	1.10 (1.04–1.16)	1.04 (0.996–1.09)
3	0.43 (0.38–0.48)	0.31 (0.27–0.36)	1.26 (1.18–1.34)	1.31 (1.24–1.39)

The Vuong test statistics for 2015 and 2009 models were significant ($z = 61.92$ and $z = 77.95$, $p < 0.001$, respectively) suggesting the zero-inflated model fit better than a negative binomial model. Bold values indicate statistical significance, $p < 0.05$.