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The Longitudinal Relation between Self-Reported Physical Activity and Presenteeism

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Abstract

This study evaluates the longitudinal relation between self-reported physical activity and health related work limitations (also known as presenteeism) among employees from a public university system. A retrospective longitudinal study design was used to examine research aims. Data were from self-reported health assessments collected from employees at a large University System in Texas during the 2013–2015 plan years (n=6,515). Work limitations were measured using the self-

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report 8-item work limitations questionnaire. Latent growth curve models were used to test whether: 1) baseline physical activity was associated with baseline work limitations; 2) changes in physical activity were related to changes in work limitations; and 3) baseline physical activity predicted changes in work limitations. Models were adjusted for demographic and health-related variables. The final adjusted growth curve model demonstrated excellent fit. Results revealed baseline physical activity was inversely associated with baseline work limitations ($\beta = -0.12$, $p < 0.001$). In addition, changes in physical activity were related to changes in work limitations ($\beta = -0.33$, $p = 0.02$). However, no relation was found between baseline physical activity and changes in work limitations ($\beta = -0.06$, $p = 0.42$). Results provide evidence that increasing physical activity among employees leads to decreases in health-related work limitations. Therefore, promoting physical activity among employee populations can help prevent and reduce presenteeism.

Keywords

Physical Activity; Presenteeism; Workplace

INTRODUCTION

Increased physical activity is a central component of worksite health promotion programs.¹ Physical activity prevents and controls chronic diseases², which can positively impact key worksite outcomes such as health-related work limitations (also known as presenteeism). Presenteeism is a key indicator of lost productivity while at work.^{3,4} Studies indicate presenteeism substantially contributes to indirect costs associated with poor health among employees.⁵⁻⁷

Multiple cross-sectional studies in worksites have reported an inverse association between physical activity and presenteeism.⁸⁻¹³ However, there are few longitudinal studies examining how changes in physical activity relate to presenteeism. Past longitudinal studies have reported decreases in health risks (e.g. physical inactivity, poor diet, high stress, tobacco use, etc.) were associated with improvements in presenteeism.¹⁴⁻¹⁸ However, when isolating changes in physical inactivity risk, results were inconsistent with some reports of no association^{14,15} and others with a significant inverse association.¹⁶⁻¹⁸ Physical inactivity risk has been inconsistently defined between studies (<1 day/week¹⁵, <3 days/week¹⁶, <5 days/week of activity^{14,18}, or <150 minutes of moderate intensity or 75 minutes of high intensity per week¹⁷), but is captured to represent people who need to increase activity to achieve additional health benefits. Given the small number of studies, inconsistent classifications of physical inactivity, a focus on transitions from being at risk for physical inactivity to not at risk, and differing results, an important research gap remains for longitudinal studies evaluating whether changes in physical activity relate to changes in presenteeism.

Many studies evaluating the relation between physical activity and presenteeism have relied on health assessment data.^{9,13-21} Health Assessments serve multiple purposes including informing employees about their health risks, providing information for a tailored action plan, and providing data for decision makers to offer and evaluate population health and

wellness services. Using health assessment data in research studies has disadvantages and advantages. A key disadvantage is health assessments often sacrifice specificity of measures to improve their broad range of coverage. As a result, there is little space for comprehensive measures that have been scientifically tested for reliability and validity. However, there are numerous advantages. Health assessments not only cover a wide range of health topics but employers commonly distribute health assessments to their entire employee population regularly (frequently annually). Therefore, large samples of longitudinal data to assess health behavior trends can become accessible. However, previous longitudinal studies have been limited by using two time points of data with a focus on changes in physical activity risk status over time.^{14–18} As a result, no known studies have used methods that incorporate more than two time points of data to more effectively model changes over time between physical activity and presenteeism.

The aim of this study was to use existing health assessment data with latent growth curve (LGC) modeling to evaluate the longitudinal relation between self-reported physical activity and presenteeism (measured by work limitations) in a large group of employees from a public university system. LGC models allow for simultaneous testing of multiple elements of the relation between physical activity and presenteeism including: 1) the relation between estimated baseline values of physical activity and work limitations; 2) how baseline physical activity values predict changes in work limitations; and 3) whether changes in physical activity over time relate to changes in work limitations. We hypothesize there will be a significant inverse relation between baseline values, that baseline physical activity will significantly predict changes in work limitations, and that changes in physical activity will be associated with changes in work limitations.

METHODS

Design

A retrospective longitudinal study design was used to examine research questions. The Office of Employee Benefits at a large university system provided secondary de-identified data collected from health assessment surveys. Health assessments were a feature of a system-wide wellness initiative used to inform individual employees about their health risk behaviors and institutions about health trends within their respective populations. The health assessments were administered to employees on an annual basis during the 2013–2015 plan years. Employees were allowed to complete one health assessment during each respective plan year. The institutional ethics review board approved all study procedures.

Participants

Benefits eligible employees (part- and full-time) from any member institution who completed at least two health assessments (during distinct plan years) were included in analyses. At the time of study, the university system consisted of 16 different institutions: 9 academic, 6 medical, and 1 administrative. Between 2013 and 2015, there were about 75,000–85,000 active employees within the system each respective year. About 62% worked at a medical institution, 37% at an academic institution, and 1% at the administrative institution. Employees at least 18 years of age and on the system's insurance plan were sent

emails directing them to a website to complete a voluntary, self-reported health assessment. In 2015, over 99% of employees were 18 years of age resulting in few employees ineligible to complete the health assessment due to age. Employees who completed the health assessment and also attended a wellness or preventive exam visit (during the same plan year) received a \$25 gift card. Participants were informed that health assessment data were collected by a third party and that individual-level data would not be shared with employers.

Measures

Health-Related Work Limitations—The 8-item Work Limitations Questionnaire (WLQ) was used to measure health-related work limitations. The 8-item WLQ, which is commonly used in health assessments²², is a reduced version of the 25-item WLQ that was developed to measure on-the-job impact of chronic conditions on an employee's ability to meet work demands²³. The 8-item WLQ includes questions from four domains captured by the original 25-item version: time management, physical work tasks, mental/interpersonal tasks, and output tasks. Extensive testing revealed the 8-item WLQ has good reliability and validity for capturing one factor for health-related work limitations.²⁴ The 8-item WLQ uses two root questions: 1) "How much time did physical health or emotional problems make it difficult for you to...?" and 2) "How much time were you able to...?" Both root questions use the same response options: "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" used to indicate relevance of questions to the employee population. If <15% of responses for the entire sample were "does not apply to my job" for a respective question, then the question was deemed relevant to the study population and it remained in the study with those values set to missing. However, if an employee answered "does not apply to my job" to 3 questions, then the scale score was set to missing and these employees were excluded from analyses since 3 questions were not relevant to their jobs. A total score for health-related work limitations was created by converting responses to percentages and taking an average. Items from the second root question were reverse coded for the scoring process. Zero represented an employee limited none of the time while a score of 100 represented an employee limited all of the time.

Physical Activity—Physical activity was assessed using the following question from the health assessment: "How many days per week do you participate in at least 20–30 minutes of physical activity?" There were eight response options that included: None," "1 day of moderate exercise," "2 days of moderate exercise," "3 days of moderate OR 1 day of vigorous exercise", "4 days of moderate OR 2 days of vigorous exercise," "5 days of moderate OR 3 days of vigorous exercise," "6 days of moderate OR 4 days of vigorous exercise," or "7 days of moderate OR more than 4 days of vigorous exercise." The physical activity variable was treated as a continuous variable with scores ranging from 0–7.

Control Variables—Age, gender, institution type (medical vs. non-medical), number of chronic conditions (related to physical health), presence of depression/anxiety (yes/no), and number of risk factors were included in models. Health assessments included questions asking respondents if they have, or have been told they have any of the following conditions: stroke, asthma, diabetes, arthritis, back pain, osteoporosis, cancer, high blood pressure,

chronic bronchitis, angina, heartburn, headaches, allergies, depression, and anxiety. Questions from the health assessment also covered the following health risks: smoking (current smoker), chewing tobacco (current user), frequency of fruit and vegetable consumption (<3 servings per day), excessive alcohol consumption (>7/14 drinks/week for women/men), trouble coping with stress, and sleep (<7 hours of sleep/night). Both risk factors and chronic conditions were treated as continuous variables. Since data were provided by the University System's Office of Employee Benefits and not each respective institution, some desirable control variables (collected by the institutions) could not be included in the analyses such as race, socioeconomic status, job type, and part- or full-time status.

Statistical Methods

Descriptive statistics were evaluated across all variables for study respondents. LGC models were used to test the longitudinal relation between physical activity and work limitations. In LGC models, intercepts and slopes are latent factors that have a direct effect on the observed variables (physical activity and work limitations) across time.²⁵ Intercepts represent the initial status at baseline for each respective variable while slopes represent the change over time. Estimated means for intercepts and slopes were generated from an initial, unadjusted model using physical activity and work limitations variables across the three time points to assess baseline values and changes in variables over time. To test hypotheses, an unadjusted model was evaluated with the following components: 1) the work limitations slope was regressed on the physical activity intercept to test whether baseline physical activity levels predicted changes in work limitations over time; 2) the work limitations slope was regressed on the physical activity slope to test whether changes in physical activity related to changes in work limitations; and 3) the work limitations intercept was regressed on the physical activity intercept to test the association between baseline physical activity and baseline work limitations. A second model was evaluated that regressed the intercept and slope variables on covariates to adjust for baseline values of gender, age, institution type, chronic conditions (physical and mental), and risk factors.

Full information maximum likelihood estimation with robust standard errors was used to account for missing data and the non-normality of continuous variables. Physical activity variables had an approximate normal distribution whereas work limitations had a positive skew. Model fit was assessed using the overall chi-square, comparative fit index (CFI), Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR)²⁶. Significant regression coefficients were determined using a p-value <0.05. Two sensitivity analyses were performed: one model that only included respondents who had three time points of data to determine whether there was a bias by including respondents with two time points of data; and two additional models stratified by gender to further assess the potential impact of gender on the differences in the relations between physical activity and work limitations. All modeling was performed using Mplus 7.31²⁷.

RESULTS

The final analytic sample consisted of 6,515 employees (Figure 1). All WLQ questions had <15% of responses in the “does not apply to my job” category suggesting items were relevant to the working population. The average time between assessments was about one year (369 days) with most respondents completing health assessments 9–15 months apart. Respondent characteristics are presented in Table 1. The respondent group contained a higher percentage of respondents who were female (83.2%) and employed at a medical institution (73.2%) compared to the total 2015 employee population (60%, and 64%, respectively). However, the mean age was similar to the total 2015 employee population (43.5 years). The mean physical activity level was 2.9 or about three days of 20 minutes of moderate intensity or one day of 20 minutes of vigorous intensity physical activity. Respondents had an average work limitations score of 8.1, representing 8.1% of time employees were unable to meet job demands.

Results from the unadjusted model demonstrated excellent fit ($\chi^2=24.5$, $df=8$, $p=0.002$ CFI=0.99, TLI=0.99, RMSEA=0.02, and SRMR=0.01). The estimated baseline physical activity value (intercept factor) was 2.81, which based on the physical activity question equates to about three days of moderate or 1 day of vigorous activity (20 minutes/day for each respective type). The physical activity slope was 0.20 indicating a small increase in physical activity levels over the three years of study. The estimated baseline mean for work limitations was 8.17 with a slope of -0.004 representing little to no change in work limitations over the three years of study. The intercepts were inversely related ($\beta = -0.25$, $p<0.001$) indicating higher physical activity levels were significantly associated with lower levels of work limitations at baseline. The physical activity slope was inversely related to the work limitations slope ($\beta = -0.32$, $p=0.017$) suggesting increases in physical activity predicted decreases in work limitations. The physical activity intercept was not significantly related to the work limitations slope ($\beta = 0.019$, $p=0.72$), indicating no relation between baseline physical activity levels and changes in work limitations.

When adding covariates, model fit remained excellent and results were consistent with the unadjusted model ($\chi^2=43.2$, $df=20$, $p=0.002$ CFI=0.99, TLI=0.99, RMSEA=0.01, and SRMR=0.01). The physical activity and work limitations intercepts were inversely related ($\beta = -0.12$, $p<0.001$) further supporting higher baseline levels of physical activity were associated with lower levels of baseline work limitations. The physical activity slope was inversely related to the work limitations slope ($\beta = -0.33$, $p=0.02$) suggesting changes in physical activity were inversely associated with changes in work limitations. However, there was no significant relation between the physical activity intercept and the work limitations slope ($\beta = -0.06$, $p=0.42$), suggesting no relation between baseline physical activity levels and changes in work limitations. Results from the multivariate LGC model are presented in Figure 2 while standardized coefficients for covariates are presented in Table 2.

There were 1,694 respondents who completed health assessments during all three time points. Results from the sensitivity analysis evaluating respondents with three time points of data were relatively consistent with previous findings. Model fit remained excellent ($\chi^2=39.9$, $df=20$, $p=0.005$ CFI=0.99, TLI=0.98, RMSEA=0.02, and SRMR=0.01). Similar

to the other models, physical activity and work limitations intercepts were inversely related ($\beta=-0.09$, $p=0.01$). In addition, physical activity and work limitations slopes had an inverse relation; however it did not reach statistical significance ($\beta=-0.12$, $p=0.17$). Furthermore, there was no relation observed between the work limitations slope with the physical activity intercept ($\beta=-0.07$, $p=0.34$). Results from models stratified by gender also indicated similar trends (Table 3). In both females and males, physical activity and work limitations intercepts were inversely related and statistically significant. Physical activity and work limitations slopes also had an inverse relation of similar magnitudes, but the relation did not achieve statistical significance for males. Lastly, there was no relation observed between work limitations slope with physical activity intercept for males or females.

DISCUSSION

This study examined the longitudinal relation between reported physical activity and presenteeism among employees from a large university system. Study results provide evidence suggesting changes in physical activity were inversely related to changes in work limitations; meaning respondents who increased their physical activity between measurement periods experienced a corresponding decrease in work limitations (and vice-versa). There was also evidence supporting the inverse relation between baseline physical activity levels and baseline work limitations. However, there was no evidence to support a relation between baseline physical activity levels and changes in work limitations. This finding is likely due to there being little to no change in work limitations across the respondent group during the time of study. Therefore, any changes in work limitations were not dependent on baseline physical activity levels.

Comparing results between the total respondent group and a subsample of employees with complete data on all three time points, revealed similar trends. Both analyses supported the inverse relation between baseline physical activity and work limitations, and, the non-significant relation between baseline physical activity and changes in work limitations. The magnitude of the relation between changes in physical activity and work limitations was slightly smaller ($\beta=-0.12$ versus $\beta=-0.33$) and non-significant in the subsample with three time points of data. The lack of statistical significance was likely due to a combination of the lower magnitude and a loss of power due to fewer respondents with complete data ($n=1,694$). Similar results were also found when comparing models between males and females. Despite a similar trend in the magnitude and direction, changes in physical activity were related to changes in work limitations in the female only model. However, there were fewer males in the dataset, which may have contributed to lack of statistical significance.

Similar to our results, previous observational studies have reported a significant inverse association between reported physical activity and presenteeism with small to moderate effect sizes.⁸⁻¹³ However, these studies were limited by cross-sectional designs and thus were unable to model changes over time. Results from past longitudinal studies evaluating how changes in physical inactivity risk were associated with changes in presenteeism reported mixed findings.¹⁴⁻¹⁸ Some studies have reported moving from high risk to low risk for physical inactivity were associated with decreases in presenteeism.¹⁶⁻¹⁸ Since these studies focused on risk factors, a dichotomous physical inactivity variable was used to

represent active versus inactive respondents. Therefore, only transitions from “at risk” for inactivity to “not at risk” were evaluated rather than changes in physical activity. Our study used an advanced statistical method to model data over time and variables that captured different levels of physical activity and presenteeism. Therefore, our study provides evidence that changes in physical activity (and not just physical inactivity risk) are associated with changes in presenteeism.

Limitations

A key study limitation was related to the physical activity measure. Physical activity was assessed by one question that emphasized frequency rather than volume and lacked validity and reliability testing. Health benefits of physical activity are primarily based on volume², which means some respondents may have been misclassified in terms of their activity levels. Additionally, the measure was not sensitive to change since it is possible respondents may have increased (or decreased) duration but not frequency of physical activity sessions. The question would not have detected such a change given the focus was on days per week of 20 or more minutes of activity rather than total minutes per week. Therefore, some changes in physical activity may have gone undetected, which would bias study results towards the null hypothesis. There is also a possibility of reverse causation that may influence findings. More specifically, people who have more work limitations may have limited ability to be physically active. This reverse causation could influence the relation observed between estimated baseline values. In addition, it is possible that people who experienced worsened health issues over time also experienced more work limitations. Worsened health issues could have resulted in decreases in physical activity levels, which could contribute to the reported inverse association.

Data are also from a voluntary, self-reported survey. As a result, the time interval between assessments was not always consistent. However, the average time between health assessments was about one year with the majority of respondents completing health assessments within 9–15 months of each other. In addition, respondents may not be representative of the entire employee population. There was a higher percentage of females and employees from a medical institution in the respondent group compared to the total employee population. Therefore, the sample may not be fully representative of the university employee population. Also, given the fact that employers promoted the health assessment, respondents may have withheld or misrepresented health information due to privacy concerns.

Strengths

Despite limitations primarily biasing results towards null hypotheses, the study had strengths. First, we had access to longitudinal data over the course of three years of study. As a result, we were able to use more advanced modeling methods to simultaneously test cross-sectional and longitudinal relations between physical activity and work limitations. Furthermore, we tested the relation across different levels of physical activity rather than focusing on changes in physical inactivity risk like past studies.^{14–18} The data also allowed for the inclusion of key covariates such as demographic and health-related variables. As a

result, we were able to account for the variance from these variables to better isolate the relation between physical activity and work limitations.

Conclusions

Study results provide evidence for a cross-sectional and longitudinal relation between physical activity and presenteeism. Study findings and past research support the idea that having a physically active workforce is associated with lower levels of work limitations. This study extends these findings by providing additional evidence that increasing physical activity can lead to decreases in work limitations. Therefore, promoting physical activity among active and inactive employees can help maintain and decrease work limitations. In addition, we found that more advanced modeling methods could be applied to health assessment data with awareness of limitations such as untested measures and the self-report nature of the data. Future research should continue to focus on evaluating the longitudinal relation with more refined measures for physical activity.

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Highlights

- Baseline physical activity was inversely related to baseline work limitations (79/85)
- Baseline physical activity levels do not predict changes in work limitations (79/85)
- Changes in physical activity were related to changes in work limitations (74/85)

Figure 1.
Reported numbers of individuals at each stage of the study

Figure 2. Adjusted Multivariate Latent Growth Curve Model Results with Standardized (β) Coefficients

*, $p < 0.05$; **, $p < 0.001$; Single-headed arrows represent standardized regression coefficients; Double-headed arrows represent correlations between variables. To facilitate interpretation, residual variances, disturbance terms, and covariates were omitted from the diagram. Coefficients for covariates are shown in Table 2. Study performed at a large university system in Texas from 2013–2016.

Table 1

Demographic, Health Related, Physical Activity, and Work Limitations Variables for Respondent Groups that completed 2 Health Assessments and 3 Health Assessments

	2 Time Points of Data (n=6,515)	3 Time Points of Data n=(1,694)
Demographic Variables		
Gender (% women)	83.2	85.9
Age (M $\pm$ SD, years)	42.6 $\pm$ 10.8	43.4 $\pm$ 10.7
Institution Type (% employed at Medical Institution)	73.2	71.5
Control Variables		
Number of Chronic Conditions (M $\pm$ SD, n) *	1.7 $\pm$ 1.5 (4,388)	1.8 $\pm$ 1.6 (1,694)
Number of Risk Factors (M $\pm$ SD, n) *	1.2 $\pm$ 0.9 (4,388)	1.1 $\pm$ 0.9 (1,694)
Presence of Depression/Anxiety (% yes) *	14.1	14.9
Predictor Variable		
Physical Activity (M $\pm$ SD, n) *	2.9 $\pm$ 1.9 (4,388)	3.0 $\pm$ 1.9 (1,694)
Outcome Variable		
Work Limitations Score (M $\pm$ SD, n) *	8.1 $\pm$ 11.9 (4,285)	8.0 $\pm$ 12.0 (1,694)

* Baseline values are based on employees with 2013 data only. Study performed at a large university system from 2013–2016.

Table 2

Standardized (β) Growth Curve Model Coefficients for Regression of Physical Activity and Work Limitations Intercepts and Slopes on Covariates at Baseline

Covariate	Intercept of PA	Slope of PA	Intercept of Work Limitations	Slope of Work Limitations
Gender	−0.13 **	−0.002	0.005	−0.06
Age	−0.004	0.05	−0.07 **	−0.10
Institution Type	0.07 **	−0.02	−0.02	0.004
Chronic Conditions	−0.20 **	0.11 *	0.11 **	−0.03
Risk Factors	−0.30 **	0.15 **	0.26 **	−0.20 *
Depression/Anxiety	−0.03	−0.02	0.20 **	0.001

*
p<0.05;

**
p<0.001;

PA, Physical Activity. Study performed at a large university system from 2013–2016.

Table 3

Comparison of Standardized (β) Coefficients for Adjusted Multivariate Latent Growth Models Stratified by Gender

Regression Path	Standardized (β) Coefficients and p-values	
	Female (n=5,420)	Male (n=1,095)
Work Limitations Intercept on Physical Activity Intercept	-0.11, p<0.001	-0.15, p<0.001
Work Limitations Slope on Physical Activity Slope	-0.38, p=0.003	-0.37, p=0.19
Work Limitations Slope on Physical Activity Intercept	-0.11, p=0.34	0.03, p=0.74

Models were adjusted for age, institution type, chronic conditions (related to physical health), risk factors, and depression/anxiety. Fit for both models was excellent (CFI=0.99, TLI 0.97, RMSEA 0.02, and SRMR 0.02).