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The Relation of Combined Aerobic and Muscle Strengthening Physical Activity with Presenteeism

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Abstract

Background—There is a need to understand physical activity types associated with health-related work limitations (also known as presenteeism). This study tests whether additive effects between physical activity types are associated with health-related work limitations among employees from a public university system.

Methods—A cross-sectional study using health assessment data ($n=10,791$) was used to examine aims. Analysis of covariance (ANCOVA) models tested differences in work limitations between physical activity groups based on combinations of stretching behavior, aerobic, and muscle strengthening physical activity. Planned contrasts compared differences between select groups.

Results—There were significant group differences ($p<0.001$) in reported work limitations after controlling for demographic, season, and health-related variables. Employees who reported participating in aerobic physical activity had significantly lower work limitations levels compared

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to inactive employees ($p=0.027$). Employees who reported participating in both aerobic and muscle strengthening physical activity had the lowest work limitations levels compared to all groups and significantly lower work limitations levels compared to employees who participated in aerobic physical activity only ($p=0.026$).

Conclusions—Results provide evidence of an additive effect where participating in a combination of aerobic and muscle strengthening physical activities may be most beneficial when targeting health-related work limitations.

Keywords

Exercise; Workplace; Resistance Training

INTRODUCTION

Given the economic impact of poor health among employees, employers are investing money and resources into worksite health promotion programs.¹ Physical activity is a primary focus of worksite health promotion due to the associated health benefits. Physical activity has been shown to prevent and control costly chronic diseases including cardiovascular disease, diabetes, and various cancers.^{2–5} Recent evidence also suggests physical activity is inversely associated with health-related work limitations (also referred to as presenteeism)^{6–8}, which is a key indicator of on-the-job lost productivity.⁹ Presenteeism has emerged as a major economic concern resulting from the high costs associated with lost work time.^{10,11} However, there is a lack of information about the potential association between combined physical activity types with presenteeism.

Observational studies evaluating the relation between physical activity and presenteeism have focused on aerobic physical activity.^{6,8,12–18} Many of these studies reported an existing inverse association.^{6,8,13,15,17} Although helpful, there are other dimensions of physical activity, most notably muscle strengthening activities that are also a key part of the physical activity guidelines.⁵ Only one known study has included muscle strengthening physical activity and stretching behavior as variables of interest, with results suggesting no significant association with presenteeism.¹⁹ However, no studies have evaluated the potential additive effect of combining different types of physical activity on presenteeism. For example, participating in both aerobic and muscle strengthening physical activity may have a greater impact on presenteeism than only performing one type of physical activity. This information may be helpful to better design physical activity components of worksite health promotion programs to help reduce presenteeism.

Muscle strengthening exercises can help maintain muscle and bone health as well as enhance functional status.⁵ Muscle strengthening activities have also been shown to improve body composition, reduce blood pressure, and improve glycemic control.^{20–22} There is little evidence that stretching behavior alone provides health benefits. However, stretching is a key component of physical fitness and exercises such as yoga, which can positively impact mental health.^{23–25}

Participating in a combination of physical activity types may lead to a better health profile than participating in a single type of activity. Therefore, the purpose of this study was to determine whether an additive effect of physical activity types is associated with health-related work limitations. Based on the known health benefits of physical activity, we hypothesize that reported participation in a singular physical activity type (stretching behavior, aerobic, or muscle strengthening physical activity only), will be associated with lower levels of work limitations compared to employees who are inactive. In addition, we hypothesize that reported combinations of stretching behavior, muscle strengthening, and aerobic physical activity will be associated with lower levels of work limitations compared to employees who participate in no activity and employees who participate in aerobic physical activity only.

METHODS

Study Design and Setting

A cross-sectional study design was used to examine the identified research questions. Secondary de-identified data were provided by the Office of Employee Benefits at a large university system in Texas. Data were collected from health assessment (HA) surveys administered during the 2015 plan year (September 1, 2014 to August 31, 2015) and analyzed in the spring of 2016. The HA was a feature of a system-wide wellness initiative to provide institutions with wellness trends and feedback to employees about their health behaviors. The institutional ethics review board approved study procedures.

Participants

Study participants included employees from any member institution who were eligible and completed a voluntary HA during the 2015 plan year. At the time of study, there were about 85,000 active employees from 16 different institutions within the University System: 9 academic (about 53,000 employees), 6 medical (about 31,400 employees), and 1 administrative (about 600 employees). Medical institutions provide training for health professions and services to patients, and therefore, employ people in clinical, research, administrative, among other types of positions. The academic institutions offer positions consistent with a traditional academic setting (e.g. faculty, staff, etc.). The System offered the HA to all benefits eligible employees who were 18 years of age and working at a member institution. Employees were contacted through email and directed to a website to complete the self-reported HA.

Measures

On-the-job impact of chronic conditions was assessed using the 8-item Work Limitations Questionnaire (WLQ), which, similar to the original 25-item version, has demonstrated good reliability and validity.^{26,27} The 8-item WLQ covers four job dimensions with two questions for each dimension: time management, physical work tasks, mental/interpersonal tasks, and output tasks. Question responses represent the percent of time an employee is unable to meet job demands while at work and 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,” which was used to determine the

relevance of questions for the population. If <15% of responses for a question were “does not apply to my job,” then the question was considered relevant and values were set to missing. If an employee had more than two questions missing, then the scale score was set to missing. A total score representing health-related work limitations (0–100%) was calculated by taking the average of responses. An index score of 0 represented someone limited none of the time, whereas 100 represented someone limited all of the time.

Physical activity was measured by three HA questions capturing stretching behavior, aerobic, and muscle strengthening physical activity. Aerobic physical activity was measured by the 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 determine whether respondents were meeting the US Physical Activity Guidelines for aerobic physical activity²⁸ and to categorize respondents into the following groups: 1) no aerobic activity; 2) insufficient aerobic activity (1–4 days of moderate exercise or 0–2 days of vigorous exercise); and sufficient aerobic activity (≥5 days of moderate OR ≥3 days of vigorous exercise). Two additional questions captured the days/week of “strength training exercises” and “stretching exercises to improve the flexibility of your back, neck, and shoulders”. Respondents were categorized into three groups for both the muscle strengthening activity and stretching behavior variables: 1) no activity; 2) 1 day of activity; 3) ≥2 days of activity.

A physical activity index variable was created using different combinations of all three reported physical activity types to form exclusive groups representing different profiles (Table 1). More specifically, there was a “no activity” group that participated in no type of physical activity. There was an “insufficient” activity group that participated in at least one type of physical activity but did not meet levels recommended by guidelines for any activity. There were also groups for each respective type of physical activity along with groups for those who participated in a combination of activity types.

The following variables were included as control variables: age, gender, institution type (employed at a medical versus non-medical institution), season (completed survey in a summer month), chronic conditions (having ≥1), presence of anxiety or depression, and risk factors (having ≥1). For the season variable, summer months were May–October, which were based on these months being in the top 50th percentile of average monthly temperatures for Texas reported by the National Climate Data Center.²⁹ The HA included questions about the presence of chronic conditions such as: stroke, asthma, diabetes, arthritis, back pain, osteoporosis, cancer, high blood pressure, chronic bronchitis, angina, heartburn, headaches, allergies, depression, and anxiety. Presence of depression or anxiety was included as a separate control variable to address mental health conditions separately. The HA also had questions about the following risk factors: 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).

Statistical Analysis

Descriptive statistics were evaluated for the study sample. Only respondents with complete data on all study variables were included in analyses. Analysis of covariance (ANCOVA)

models tested study aims. Levene's test was used to evaluate the homogeneity of variances assumption. A one-way ANOVA model was used to test differences in work limitations between physical activity groups without adjusting for control variables. Since there were nine different physical activity groups, a series of ANCOVA models were used to control for demographic, seasonality, and health-related variables to preserve cell sizes. The first ANCOVA model included gender, season, and institution type as fixed factors and age as a covariate. If variables were not significant, they were excluded from the final model to preserve degrees of freedom and cell sizes. All control variables were tested for interactions with the physical activity index variable.

Planned contrasts were performed on the final model to compare differences between select physical activity groups. The first set of contrasts tested whether each respective type of physical activity (in isolation) was associated with less percent time lost compared to those who were inactive. Thus, the no activity group was compared to employees who reported only participating in stretching behavior, or muscle-strengthening, or aerobic physical activity, respectively. A second set of planned contrasts tested whether the combination of physical activity types was associated with less percent time lost compared to those who were inactive. Lastly, a third set of planned contrasts tested whether the combination of physical activity types was associated with less percent time lost compared to those who participated in aerobic activity only. All analyses were performed using Stata 13 with a p-value of 0.05 as the level of significance.³⁰

RESULTS

Respondent Characteristics

A total of 11,910 employees completed the HA in plan year 2015. All questions from the WLQ had <15% of responses in the "does not apply to my job" category suggesting the items were relevant to the working population. Therefore, responses in the "does not apply to my job" category were treated as missing values. There were 1,119 (9%) respondents with missing data on more than two items from the WLQ. Thus, the analytic sample included 10,791 employees (characteristics are presented in Table 2). The majority of respondents were female (80.8%), completed the HA during a winter month (78.5%), and were employed at a medical institution (75.3%). Most employees reported at least one prevalent chronic condition (73.0%) or risk factor (76.6%), while 13.9% reported the presence depression or anxiety. The number of employees in each respective physical activity group varied with 347 respondents (3.2%) in the smallest represented group: those who reported participating in sufficient aerobic and muscle strengthening physical activity. The insufficient physical activity group contained the most respondents (35.9%) relative to the other physical activity groups. Furthermore, 10.9% of respondents reported participating in no activity and 13.9% reported participating in 2 days of stretching behavior only. Therefore, about 61% of the sample did not participate in sufficient levels of aerobic or muscle strengthening physical activity, suggesting most employees were not meeting guideline recommended levels of physical activity.

Model Results

Values of work limitations (percent time an employee was unable to meet job demands) ranged from 0–100. Preliminary data screening revealed a positively skewed (skewness=1.80) and leptokurtic (kurtosis=6.84) distribution. However, ANOVA is robust to the violation of normality assumption with large samples.^{31,32} Levene's test revealed significant differences in variances between physical activity groups: $F(8, 10,782) = 20.86$, $p < 0.001$. However, further testing using simulated ANOVA analyses to determine how unequal group sizes impact results revealed a slightly more conservative test (the proportion significant was really 0.032 rather than the expected 0.05). This finding was anticipated given the physical activity groups with fewer respondents had smaller variances. Therefore, the Type I error rate was not inflated by group differences in variances.³³

The overall F value for the one-way ANOVA model testing differences in work limitations between physical activity groups was statistically significant: $F(8, 10,782) = 18.77$, $p < 0.001$, corresponding with a small-to-moderate effect, $\eta^2 = 0.014$.³⁴ When gender, season, and institution type were included as fixed factors and age as a covariate, differences between physical activity groups remained significant ($F(8, 10,778) = 19.13$, $p < 0.001$). Age was significant ($F(1, 10,778) = 47.24$, $p < 0.001$) while gender ($F(1, 10,778) = 0.11$, $p = 0.735$), season ($F(1, 10,778) = 1.81$, $p = 0.178$), and institution type ($F(1, 10,778) = 2.47$, $p = 0.116$) were not. Because gender, season, and institution type were not significant, they were excluded from the final model that adjusted for age, chronic conditions, presence of depression or anxiety, and risk factors. In the final adjusted model, differences between physical activity groups remained significant: $F(8, 10,778) = 7.36$, $p < 0.001$, with an estimated effect size of $\eta^2 = 0.005$ (suggesting a small effect). Age, chronic conditions, presence of depression or anxiety, and risk factors were all significant. There were no significant interactions between the control variables and the physical activity variable in any of the models.

Planned Contrasts

Adjusted and unadjusted means for work limitations by physical activity group are shown in Table 3. Planned contrasts were conducted from the final model evaluating differences between physical activity groups (Table 4). Results indicated employees who participated in only stretching behavior ($p = 0.202$) or muscle strengthening physical activity ($p = 0.076$) did not have significantly lower values of work limitations compared to employees with no physical activity. In contrast, employees who participated in aerobic physical activity ($p = 0.027$) had lower values of work limitations compared to employees with no physical activity, where there was a mean difference of percent time an employee was unable to meet work demands of 1.28 (Figure 1). Results from testing the combination of physical activity types revealed aerobic with muscle strengthening physical activity had the greatest differences in percent time (3.05, $p < 0.001$) versus employees with no physical activity (Table 4). Furthermore, contrasts testing the additive effect of physical activity types revealed employees participating in muscle strengthening with aerobic physical activity had lower levels of work limitations compared to employees only participating in aerobic activity ($p = 0.026$). However, there was no significant difference when comparing employees who participated in stretching with aerobic activity to employees who participated in aerobic only ($p = 0.12$).

DISCUSSION

This study set out to determine whether a combination of physical activity types was associated with health-related work limitations. Results revealed that employees who participated in 5 days of aerobic physical activity had lower levels of reported work limitations compared to inactive employees, even after controlling for demographic and health-related variables. Additionally, employees who participated in both aerobic and muscle strengthening physical activity had lower levels of work limitations than employees who participated in aerobic activity alone. The greatest differences in work limitations were found between employees who participated in both aerobic and muscle strengthening physical activity versus inactive employees. These findings provide evidence of an additive effect where a combination of aerobic and muscle strengthening activity may be most beneficial when targeting presenteeism. This additive effect is likely due to unique health benefits gained from each respective physical activity type.⁵

The mean work limitations difference of 3.05 between inactive employees relative to employees who participated in both aerobic and muscle strengthening activity represents an additional 3.05% of time when a worker is unable to meet job demands. For employees who work a standard 40 hour week for 50 weeks out of the year, this equates to 1.22 additional hours lost/week or almost 8 days/year. Using the same standard work hours, employees who participated in only aerobic activity lost an additional 1.77% of time or about 4 additional workdays throughout the year compared to those who participated in both aerobic and muscle strengthening physical activity. Thus, even though physical activity group had a small effect size on work limitations, the additional time loss accumulated over a year for inactive employees can meaningfully impact organizations.

Past observational studies have reported significant differences in presenteeism ranging from 0.6–3.5% between people who participate in aerobic physical activity versus inactive participants.^{7,17,35,36} Our results were consistent with these studies, showing a significant difference of 1.28% when comparing aerobically active participants to inactive participants. However, the only type of physical activity evaluated in the abovementioned studies was aerobic activity. One known study evaluating the association between all three activity types (aerobic, muscle strengthening, and stretching) reported no significant associations with presenteeism.¹⁹ However, this study evaluated the independent effects of each activity type rather than testing an additive effect. Therefore, our findings extend the current literature by suggesting the combination of muscle strengthening and aerobic activity has the greatest impact on presenteeism.

The primary study limitations include a self-selected sample of employees and relying on self-reported HA measures. Employees willing to complete an HA may differ from the general employee population, impacting the generalizability of the study. Since HAs were self-reported, respondents may have overestimated physical activity levels and underestimated work limitations or other health risk behaviors because of privacy concerns. This issue could bias the study, reducing the effect observed between physical activity and work limitations. The aerobic physical activity question on the HA also emphasized frequency rather than volume of activity, which is used to determine guideline

recommendations. As a result, some respondents may have been misclassified in their respective physical activity group, which could also lead to smaller effects. Additionally, categorizing physical activity into adequate and inadequate groupings may lead to residual confounding since there is a loss of information when dichotomizing variables. Lastly, the distribution of work limitations deviated from normality, and there were differences in variances between physical activity groups. However, ANOVA is robust to violations of normality with large sample sizes and tests revealed that differences in variances did not inflate Type I error.^{31,32}

Study strengths included a large respondent group (>10,000 employees) and a novel approach of capturing different physical activity combinations. The large sample size allowed for testing many different combinations of physical activity types and made the analysis more robust to violating statistical assumptions. Also, given all respective groups contained 347 employees, variables could be added to the model to control for confounding. Furthermore, the nature of our physical activity variable allowed for testing unique study questions such as the importance of specific physical activity types and whether an additive effect exists.

CONCLUSIONS

Presenteeism can be a major economic burden to organizations. Promoting physical activity needs to remain a high priority for worksite health programs given the numerous health benefits and the association found with work limitations. Furthermore, our results suggest participating in adequate amounts of aerobic physical activity is associated with lower levels of work limitations. However, promoting the combination of muscle strengthening and aerobic physical activity may have the greatest effect on work limitations. These findings are consistent with the US Physical Activity Guidelines Committee Report, which recommends participating in both aerobic and muscle strengthening activity to achieve optimal health benefits from physical activity.⁵ Future research should use more comprehensive measures of physical activity and model relations over time to determine whether changes in physical activity relate to changes in presenteeism.

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Figure 1.

Table 1

Physical Activity Profiles for the Physical Activity Index Variable

Physical Activity Group	Aerobic (5 days)	Strength (2 days)	Stretching (2 days)
No Activity	No Activity	No Activity	No Activity
Insufficient Activity	No	No	No
Stretching only	No	No	Yes
Strength only	No	Yes	No
Strength + Stretching	No	Yes	Yes
Aerobic only	Yes	No	No
Aerobic + Stretching	Yes	No	Yes
Aerobic + Strength	Yes	Yes	No
Aerobic + Strength + Stretching	Yes	Yes	Yes

Table 2

Demographic, Health Related, Physical Activity, and Work Limitations Variables for Respondent Group
(n=10,791)

	%, n	Mean $\pm$ SD
Demographic Variables		
Gender (% women)	80.8 (8,715)	
Age (years)		41.7 $\pm$ 11.1
Institution Type (% Employed at a Medical Institution)	75.3 (8,124)	
Control Variables		
Completed Survey During Summer Month	21.5 (2,326)	
1 Chronic Condition	73.0 (7,875)	
Presence of Depression or Anxiety	13.9 (1,497)	
1 Risk Factor	76.6 (8,262)	
Physical Activity Variable		
No Activity	10.9 (1,177)	
Insufficient Activity	35.9 (3,876)	
Stretching only	13.9 (1,503)	
Strength only	4.6 (495)	
Strength + Stretching	8.8 (946)	
Aerobic only	6.5 (700)	
Aerobic + Stretching	4.3 (469)	
Aerobic + Strength	3.2 (347)	
Aerobic + Strength + Stretching	11.8 (1,278)	
Outcome Variable		
Work Limitations Score		8.85 $\pm$ 12.5

Table 3

Adjusted and Unadjusted mean Work Limitations scores by Physical Activity Group

Physical Activity Group	Unadjusted WLQ Mean	Adjusted WLQ Mean
No Activity	11.02	9.84
Insufficient Activity	9.74	9.39
Stretching only	9.05	9.24
Strength only	8.84	8.69
Strength + Stretching	8.58	9.00
Aerobic only	7.90	8.56
Aerobic + Stretching	6.63	7.44
Aerobic + Strength	6.44	6.79
Aerobic + Strength + Stretching	6.14	7.07

Results adjusted for age, chronic conditions, and risk factors

Table 4

Results of Planned Contrasts between Select Physical Activity Groups

Group Comparisons	Mean Difference	P-value
No Activity vs Stretching only	0.60	0.202
No Activity vs. Strength only	1.17	0.076
No Activity vs. Aerobic only	1.28	0.027
No Activity vs. Aerobic + Stretching	2.40	<0.001 *
No Activity vs. Aerobic + Strength	3.05	<0.001 *
No Activity vs. Aerobic + Strength + Stretching	2.77	<0.001 *
Aerobic vs. Aerobic + Stretching	1.12	0.119
Aerobic vs. Aerobic + Strength	1.77	0.026
Aerobic vs. Aerobic + Strength + Stretching	1.49	0.009

* Result remained significant even after using a Bonferroni adjusted p-value (<0.005)