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Is exercise used as medicine? Association of meeting strength training guidelines and functional limitations among older US adults

Jennifer L. Kraschnewski, MD, MPH^{a,b}, Christopher N. Sciamanna, MD, MPH^{a,b}, Joseph T. Ciccolo, PhD, CSCS^c, Liza S. Rovniak, Ph.D., MPH^{a,b}, Erik B. Lehman, MS^b, Carolina Candotti, MD^a, and Noel H. Ballentine, MD^a

Jennifer L. Kraschnewski: jkraschnewski@hmc.psu.edu; Christopher N. Sciamanna: csciamanna@hmc.psu.edu; Joseph T. Ciccolo: ciccolo@tc.columbia.edu; Liza S. Rovniak: lrovniak@hmc.psu.edu; Erik B. Lehman: elehman@phs.psu.edu; Carolina Candotti: ccandotti@hmc.psu.edu; Noel H. Ballentine: nballentine@hmc.psu.edu

^aDepartment of Medicine, Penn State Hershey Medical Center, 500 University Drive, Hershey, PA, 17033, United States

^bDepartment of Public Health Sciences, College of Medicine, The Pennsylvania State University, 500 University Drive, Hershey PA, 17033, United States

^cDepartment of Biobehavioral Sciences, Teachers College, Columbia University 525 West 120th St. New York, NY 10027, United States

Abstract

OBJECTIVE—To determine the association between meeting strength training (ST) guidelines (2 times per week) and the presence of functional limitations among older adults.

METHODS—This cross-sectional study used data from older adult participants (n=6,763) of the National Health Interview Survey conducted in 2011 in the United States.

RESULTS—Overall, 16.1% of older adults reported meeting ST guidelines. For each of nine functional limitations, those with the limitation were less likely to meet ST recommendations than those without the limitation. For example, 20.0% of those who reported no difficulty walking one-quarter mile met ST guidelines, versus only 10.1% of those who reported difficulty ($p<.001$). In sum, 21.7% of those with no limitations (33.7% of sample) met ST guidelines, versus only 15.9% of those reporting 1–4 limitations (38.5% of sample) and 9.8% of those reporting 5–9 limitations (27.8% of sample) ($p<.001$).

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Corresponding author: Christopher N. Sciamanna, MD MPH, Penn State Hershey Medical Center, Department of Medicine, Division of General Internal Medicine, Mail Code H034, 500 University Drive, Hershey, PA 17033-0850, Telephone: 717-531-8161, Fax: 717-531-7726, csciamanna@hmc.psu.edu.

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CONCLUSION—Strength training is uncommon among older adults and even less common among those who need it the most. The potential for ST to improve the public’s health is therefore substantial, as those who have the most to gain from ST participate the least.

Keywords

Aging; Public Health; Function; Lifestyle; Quality of Life; Muscle Strength; Exercise; Health Behavior; Physical Activity; Strength Training

INTRODUCTION

For many older adults, the loss of independence is often considered a fate worse than death. A 2007 survey of older US adults demonstrated that more seniors feared losing independence (26%) than feared dying (3%) (Prince Market Research 2007) and international studies have demonstrated similar results (Disabled Living Foundation 2009; Quine & Morrell 2007). It is not surprising, therefore, that the Healthy People 2020 goals for older adults focus not only on health, but also on “function and quality of life” (2011).

Unfortunately, functional limitations increase predictably with age due to loss of muscle mass and strength. Analysis of the National Health Interview Survey (NHIS) demonstrated that 17.3% of adults aged 55–64 had difficulty walking one-quarter mile, which increased to 56.1% of those aged 85 (Schoenborn & Heyman 2009). Many of these functional limitations, however, can be reversed or even prevented by strength training (ST) (Fiatarone et al. 1994; Nelson et al. 1994). For example, Gennuso and colleagues (2013) demonstrated that guideline-consistent ST interventions as short as 8 weeks can effectively shift older adults to a better overall functional classification. Given these benefits, the American College of Sports Medicine (ACSM) and American Heart Association (AHA) physical activity guidelines recommend that all adults participate in ST activities at least twice each week (Haskell et al. 2007). Further, these organizations launched the “Exercise is Medicine” initiative, in which physicians are encouraged to recommend physical activity to their patients as they would recommend any other effective treatment or preventive service (ACSM & AMA 2007). Despite these recommendations, only 21.7% of adults over 65 meet ST guidelines and physicians provide exercise counseling during a mere 11.3% of primary care visits (Centers for Disease and Prevention 2013; Kraschnewski 2013).

Although numerous studies have been conducted on ST behaviors and their benefits, it remains unknown if meeting ST guidelines is associated with the functional limitations of older adults. The aim of this investigation is to understand the association between meeting ST guidelines and the presence of functional limitations, to understand whether exercise is being used as a medicine (i.e. treatment for functional decline). We hypothesize that if ST were being used as a medicine, rates of use should be highest among those with the most functional limitations.

METHODS

This cross-sectional study analyzed data from the 2011 National Health Interview Survey (NHIS). Details of the survey sampling strategy and data collection procedures are described

elsewhere (Centers for Disease Control and Prevention 2012). Briefly, NHIS data are collected through personal household interviews by Census interviewers. Households were the basic unit of the NHIS, and all family members were selected to participate. The household respondent provided basic demographic and family relationship information about all household members. One adult per family (the ‘sample adult’) was randomly selected to answer the Sample Adult questionnaire, which was analyzed in this study. Given our interest in assessing older adults, the analysis was limited to those individuals age 65 years and older.

Frequency of ST was assessed using the following question: “How often do you do leisure-time physical activities specifically designed to strengthen your muscles such as lifting weights or doing calisthenics?” Participant responses included both the number of times ST was performed and the unit of time (i.e. “per week,” “per month”). These responses were categorized to signify whether the individual performed these activities at least twice each week, consistent with the ACSM/AHA Guidelines (Centers for Disease and Prevention 2006).

Functional limitations were assessed using 9 self-reported questions that asked whether the individual had difficulty performing a range of common activities. Each question had a common header (“By yourself, and without using any special equipment, how difficult is it for you to...”) with five response options: “not at all difficult”, “only a little difficult”, “somewhat difficult”, “very difficult” and “can’t do at all.” The 9 activities included: “walk a quarter of a mile - about 3 city blocks”, “walk up 10 steps without resting”, “stand or be on your feet for about 2 hours”, “sit for about 2 hours”, “stoop, bend, or kneel”, “reach up over your head”, “use your fingers to grasp or handle small objects”, “lift or carry something as heavy as 10 pounds such as a full bag of groceries” and “push or pull large objects like a living room chair.” Each response was then dichotomized to reflect whether a functional limitation was absent (i.e., “not at all difficult”) or present (i.e., all other responses), similar to the approach utilized by Hardy et al (2011). A composite variable (range: 0–9) was created by summing the number of functional limitations per individual, with 0 reflecting no difficulty performing any activity and 9 reflecting difficulty performing all activities. The composite functional limitations variable was then divided into tertiles, based on the distribution of the population, to understand the relationship between meeting ST guidelines and functional limitations.

Covariates included demographic variables: age (categorized into 5-year intervals), gender, race (Caucasian, Asian, African-American), ethnicity (Hispanic vs. non-Hispanic), education level (less than high school, high school, some college/associate’s degree, bachelor degree or higher), marital status (married vs. unmarried), and region of the country (Northeast, Midwest, South, West). Additional covariates included past medical history (hypertension, diabetes, heart disease, overweight and obesity), and health behaviors (smoking, alcohol intake, physical activity), consistent with variables shown to have associations in other studies (Carlson et al. 2010; Ciccolo et al. 2010). Body Mass Index (BMI) was re-categorized into normal, overweight and obese, based on the NIH Guidelines (1998). Physical activity was categorized according to the 2008 Physical Activity Guidelines for Americans: highly active (≥ 300 minutes per week of light- to moderate-intensity activity,

150 minutes per week of vigorous-intensity activity or in combination); sufficiently active (150–300 minutes per week of light- to moderate-intensity activity, 75–150 minutes per week of vigorous-intensity activity or in combination; insufficiently active (some activity but not enough to meet the more active definitions); and inactive (no light-to moderate-or vigorous-intensity activity of 10 minutes per session) (Carlson et al. 2010; Schoenborn & Adams 2010; U.S. Department of Health and Human Services 2008).

The analysis was conducted using SAS Version 9.3 (Cary, NC) to account for the stratified sampling frame using sampling weights provided in the original data. Limiting the analysis to adults at least 65 years of age who were Caucasian, African American, or Asian (including Hispanic ethnicity) resulted in 6,763 observations. A weighted logistic regression analysis was used to analyze the association between functional limitations as well as other variables (i.e., hypertension) and meeting or not meeting strength training (ST) guidelines (yes/no) as the dependent variable. The magnitude and direction of significant associations were quantified with odds ratios. To adjust the association of functional limitations with meeting/not meeting strength training guidelines for other variables, a multivariable analysis was conducted using weighted multiple logistic regression. The multivariable analysis was performed in a stepwise manner, first by adjusting for demographic covariates, second by adjusting for chronic health conditions (i.e., hypertension, obesity), and third by adjusting for other health behaviors (i.e., physical activity), to isolate the relationship between meeting ST guidelines and functional limitations. For the multivariable models, observations with missing values were excluded from the analysis. However, this accounted for only 5% or less of the total observations.

RESULTS

Overall, 16.1% of adults 65 and older reported doing ST activities at least twice per week, consistent with guidelines from the ACSM/AHA (Haskell et al. 2007). The bivariate relationships between meeting ST guidelines and demographic, behavioral and medical history variables are shown in Table 1. Meeting ST guidelines was more common among older adults who were younger, male, non-Hispanic, those with greater education, and those living in the West. Each health behavior was associated with meeting ST guidelines. Nonsmokers, moderate drinkers (v. nondrinkers) and those who met guidelines for vigorous intensity activity were more likely to meet ST guidelines. Individuals without chronic medical conditions were also more likely to meet ST guidelines.

The association between meeting ST guidelines and functional limitations can be seen in Table 2 and Figure 1. Overall, the most commonly reported functional limitations were stooping, bending or kneeling (50.6%), and difficulty with standing for 2 hours (42.8%). There was a negative association between meeting ST guidelines and each of the nine functional limitations; those who met the ST guidelines were less likely to have functional limitations. In sum, 21.7% of those without functional limitations (33.7% of sample) met ST guidelines, versus only 15.9% of those reporting 1–4 limitations (38.5% of sample) and 9.8% of those reporting 5–9 limitations (27.8% of sample) ($p < .001$).

As shown in Table 3, after adjusting for demographic covariates, the odds of meeting ST guidelines was 1.92 times (95% CI; 1.51, 2.41) and 1.39 times (95% CI; 1.08, 1.80) the odds for those without limitations and those with 1–4 limitations, respectively, compared to those reporting 5–9 limitations. This pattern remained when demographic and past medical history variables (i.e., body mass index, hypertension, diabetes, chronic heart disease) were added to the model. After adjusting for these covariates, the odds of meeting ST guidelines was 1.79 times (95% CI; 1.39, 2.29) and 1.35 times (95% CI; 1.04, 1.75) the odds for those without limitations and those with 1–4 limitations, respectively, versus those reporting 5–9 limitations. After adding health behaviors (i.e., smoking, alcohol intake, physical activity level) to the model, however, the point estimate of the relationship between meeting ST guidelines and functional limitations was in the same direction, but was associated with wide confidence interval and no longer statistically significant. In this multivariable adjusted model, the odds of meeting ST guidelines were 0.99 times (95% CI; 0.76, 1.30) and 0.85 times (95% CI; 0.64, 1.13) the odds for those without limitations and with 1–4 limitations, respectively, compared with those reporting 5–9 limitations.

DISCUSSION

This study sought to understand the relationship between meeting ST guidelines and functional limitations. The results showed a consistent and troubling pattern; those with functional limitations were less likely to meet ST guidelines. This pattern held for each functional limitation and when the limitations were summed; 21.7% of those with no functional limitations met ST guidelines versus 15.9% of those with 1–4 limitations and only 9.8% of those with 5–9 limitations. These patterns held, albeit less strongly, after adjusting for demographics and past medical history variables. Although the associations were no longer statistically significant after adjusting for other health behaviors, the point estimates continue to suggest that ST behaviors are associated with higher physical functioning.

To maximally improve the public's health and to properly implement "Exercise is Medicine," those with the greatest number of functional limitations should be performing ST the most. This expectation is similar to the observation that patients with the highest blood pressure should have the highest rates of antihypertensive medication use. Unfortunately, we found an opposite relationship; those with more functional limitations were consistently less likely to meet ST guidelines. This suggests the untapped potential of ST to improve the public's health by properly targeting older adults most in need. Though ST has the potential to help people reverse functional limitations, more than 80% of affected older adults are not doing enough ST to likely improve those limitations. Notably, functional limitations are not only concerning for loss of independence, but are associated with both increased health expenditures and risk of death (Hardy et al. 2011).

Clinicians may not be surprised by these findings. Older patients who have functional limitations often believe they would be physically unable to do activities such as strength training, rather than that they *need* strength training. Though older adults report that they do ST activities to "improve performance of tasks at home," our findings suggest that most individuals with functional limitations do not meet ST guidelines (Marzolini et al. 2010).

Further research is necessary to understand the barriers to ST in older adults, which may include a lack of understanding of the benefits of ST.

Consistent with other studies, meeting ST guidelines was strongly associated with younger age, among other demographic and health behavior variables (Carlson et al. 2010; Centers for Disease and Prevention 2006; Chevan 2008). Ciccolo and colleagues (2010), using a separate survey of 9,651 US adults, observed that 37.5% of adults aged 35–54 met ST guidelines versus only 21.7% of adults 55 and older. Furthermore, multiple investigators have observed a clustering of health behaviors, including meeting leisure-time physical activity guidelines, not smoking and eating healthy (Lippke et al 2012; Yusuf et al. 1996).

Given the potential benefits of ST for older adults, future research may need to better address barriers that prevent regular ST among older adults. First, older adults may be unaware that ST can improve functional limitations. Second, ST recommendations are more recent than aerobic exercise recommendations, which may explain why Abramson and colleagues (2000) observed that ST counseling by physicians was less common than counseling for aerobic activity (ACSM 1978; ACSM 1990). Third, functional limitations may cause older adults to believe that ST is an activity they cannot do. This is consistent with studies that suggest lower levels of self-efficacy predict lower physical activity participation levels among older adults (Jerome & McAuley 2013; McAuley et al. 2005).

Despite the observed relationship between functional limitations and meeting ST guidelines, there are several limitations to this study. First, the direction of the association is not clear, given the cross-sectional design. More longitudinal and experimental studies need to be conducted to clarify the direction of the relationship between strength training and functional limitations. Second, only ST participation was reported, not session quality, and participation was not verified with objective measurement. Although self-report measures remain widely-used for physical activity assessment, studies utilizing objective measurement observe that self-report measures overestimate activity levels (Troiano et al. 2008). Third, it is likely that some older adults were physically unable to perform ST activities, so these findings may not apply to all older adults. As a large body of research shows that adults over 80 years of age can safely participate in ST, we believe this percentage of older adults physically incapable of performing ST activities is small (Brill et al. 1998; Nelson et al. 1994). Fiatarone and colleagues (1994), for example, enrolled nursing home patients (average age = 87.1) in a high intensity ST program and observed attendance rates of 97% over 10 weeks.

These limitations, however, do not alter a key observation of this study: the vast majority of older adults with functional limitations are not meeting ST guidelines. This suggests that there is great potential for using ST to improve the public's health and that alternative strategies are needed to engage older adults, particularly those with functional limitations. A potential solution to better engage older adults is through the widespread dissemination of ST programs. One such ST program, Silver Sneakers from Healthways, is available at more than 14,000 fitness centers and is an included insurance benefit for more than 7.8 million older US adults (Nguyen et al. 2008a; Nguyen et al. 2008b). Even if programs were made

available, however, the results of this study suggest that those who would benefit most may not participate.

Physician screening for functional limitations and referral of patients to community programs may increase participation. In the United Kingdom, for example, physicians refer patients to exercise programs which are reimbursed by the National Health Service (Orrow et al. 2012). Murphy and colleagues (2012) observed in the UK that these exercise referrals are more effective for patients with conditions that can be improved by exercise (i.e., coronary heart disease). Further studies are necessary to determine if a similar approach could be used for ST in older adults, particularly those with functional limitations. Without more prompts and opportunities, ST is likely to continue being used *least* by those who need it *most*, threatening the best intentions of “Exercise is Medicine” (ACSM & AMA 2007; Braith & Stewart 2006).

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Highlights

- 16.1% of adults 65+ reported doing strength training (ST) at least twice per week.
- Adults with functional limitations are less likely to meet ST guidelines.
- Adults who have the most to gain from ST currently participate the least.

Figure 1.
Percentage of US Older Adults Meeting Strength Training Guidelines by Number of Functional Limitations.

Table 1

Association of demographic, medical history and risk behaviors of 2011 National Health Interview Survey participants with meeting strength training guidelines.

Characteristic	Category	Overall (N=6763)	Met Strength Training Guidelines (2 times/week)	
		N (%)	%	P-value ^a
Age	65–69	2059 (31.6)	20.1	<0.001
	70–74	1554 (23.5)	17.7	
	75–80	1487 (22.1)	13.3	
	Over 80	1663 (22.9)	11.6	
Gender	Male	2713 (44.0)	18.8	<0.001
	Female	4050 (56.0)	14.0	
Race	Caucasian	5538 (87.3)	16.7	<0.001
	Asian	324 (3.9)	14.9	
	African American	901 (8.8)	10.6	
Ethnicity	Hispanic	677 (7.1)	8.9	<0.001
	Non-Hispanic	6086 (92.9)	16.7	
Education	Less Than High School	1625 (21.1)	8.5	<0.001
	High School Grad/GED	2049 (31.6)	10.9	
	Some College/Associate's Degree	1587 (23.2)	18.8	
	Bachelor Degree or Higher	1438 (24.1)	27.6	
Marital Status	Married	2866 (56.2)	17.5	0.008
	Unmarried	3897 (43.8)	14.4	
Region	Northeast	1224 (19.8)	13.6	<0.001
	Midwest	1523 (22.3)	16.5	
	South	2445 (36.0)	13.7	
	West	1571 (21.9)	22.0	
Body Mass Index	Under 25 (Normal Weight)	2245 (33.1)	18.4	0.001
	25–30 (Overweight)	2324 (35.1)	16.4	
	30+ (Obese)	2194 (31.8)	13.4	
Hypertension	Yes	4309 (62.8)	14.9	0.004
	No	2441 (37.2)	18.3	
Diabetes	Yes	1376 (20.3)	12.8	0.002
	No	5375 (79.7)	17.0	
Chronic Heart Disease	Yes	1083 (16.6)	14.4	0.146
	No	5648 (83.4)	16.5	
Smoker	Yes	603 (7.9)	6.4	<0.001
	No	6131 (92.1)	17.0	
Alcohol Intake	Does not drink	3629 (51.4)	11.0	<0.001
	Moderate drinker	2818 (42.3)	21.6	

Characteristic	Category	Overall (N=6763)	Met Strength Training Guidelines (2 times/week)	
		N (%)	%	P-value ^a
	Heavy drinker	214 (3.4)	21.5	
Activity Level	Highly active	18.9	35.1	<0.001
	Sufficiently active	14.2	29.1	
	Insufficiently active	19.2	17.9	
	Inactive	47.7	4.0	

^a P-values from a weighted logistic regression taking into consideration the complex sampling stratification and clustering, all percentages are weighted percentages

Table 2

Association between meeting strength training guidelines and functional limitations of 2011 National Health Interview Survey participants.

Function	Limited	Overall (N=6763)	Met Strength Training Guidelines (2 times/week)	
		N (%)	%	P-value ^a
Lift or carry 10 pounds	Yes	1833 (24.7)	9.1	<0.001
	No	4930 (72.3)	18.4	
Walk up 10 steps	Yes	2254 (30.4)	9.3	<0.001
	No	4509 (69.6)	19.1	
Grasp small objects	Yes	1356 (19.1)	12.8	0.005
	No	5407 (80.9)	16.9	
Reach over head	Yes	1433 (19.8)	10.7	<0.001
	No	5330 (80.2)	17.5	
Stand for 2 hours	Yes	3054 (42.8)	11.6	<0.001
	No	3709 (57.2)	19.5	
Stoop or bend	Yes	3478 (50.6)	13.5	<0.001
	No	3285 (49.4)	18.8	
Walk ¼ mile	Yes	2790 (39.3)	10.1	<0.001
	No	3973 (60.7)	20.0	
Sit for 2 hours	Yes	1191 (16.3)	11.1	<0.001
	No	5572 (83.7)	17.1	
Push a large object	Yes	2258 (31.4)	10.0	<0.001
	No	4505 (68.6)	18.9	
Functional Limitations	0	2197 (33.7)	21.7	<0.001
	1–4	2525 (38.5)	15.9	
	5–9	2041 (27.8)	9.8	

^a P-values from a weighted logistic regression taking into consideration the complex sampling stratification and clustering, all percentages are weighted percentages

Table 3

Meeting strength training guidelines associated with functional limitations of 2011 National Health Interview Survey participants adjusted for other characteristics

	Functional Limitations	Meets strength training guidelines [OR (95% CI)] ^a
Model 1: Demographics (A) ^b	0	1.92 (1.51, 2.41)
	1–4	1.39 (1.08, 1.80)
	5–9	Reference
Model 2: Demographics (A) + Past Medical History (B) ^c	0	1.79 (1.39, 2.29)
	1–4	1.35 (1.04, 1.75)
	5–9	Reference
Model 3: Demographics (A) + Past Medical History (B) + Health Behaviors (C) ^d	0	0.99 (0.76, 1.30)
	1–4	0.85 (0.64, 1.13)
	5–9	Reference

^aOdds ratios and 95% CI's from a weighted multivariable logistic regression taking into consideration the complex sampling stratification and clustering

^bGroup A variables: Age, Gender, Race, Ethnicity, Education, Marital status, Region

^cGroup B variables: Body Mass Index, Hypertension, Diabetes, Chronic Heart Disease

^dGroup C variables: Smoking, Alcohol Intake, Activity Level