RESEARCH ARTICLE

Predictors of Upper-Extremity Physical Function in Older Adults

Hugo H. Hermanussen, BSc; Mariano E. Menendez, MD; Neal C. Chen, MD; David Ring, MD, PhD; Ana-Maria Vranceanu, PhD

Research performed at Massachusetts General Hospital, Boston, MA, USA

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Abstract

Background: Little is known about the influence of habitual participation in physical exercise and diet on upper-extremity physical function in older adults. To assess the relationship of general physical exercise and diet to upper-extremity physical function and pain intensity in older adults.

Methods: A cohort of 111 patients 50 or older completed a sociodemographic survey, the Rapid Assessment of Physical Activity (RAPA), an 11-point ordinal pain intensity scale, a Mediterranean diet questionnaire, and three Patient- Reported Outcomes Measurement Information System (PROMIS) based questionnaires: Pain Interference to measure inability to engage in activities due to pain, Upper-Extremity Physical Function, and Depression. Multivariable linear regression modeling was used to characterize the association of physical activity, diet, depression, and pain interference to pain intensity and upper-extremity function.

Results: Higher general physical activity was associated with higher PROMIS Upper-Extremity Physical Function and lower pain intensity in bivariate analyses. Adherence to the Mediterranean diet did not correlate with PROMIS Upper-Extremity Physical Function or pain intensity in bivariate analysis. In multivariable analyses factors associated with higher PROMIS Upper-Extremity Physical Function were male sex, non-traumatic diagnosis and PROMIS Pain Interference, with the latter accounting for most of the observed variability (37%). Factors associated with greater pain intensity in multivariable analyses included fewer years of education and higher PROMIS Pain Interference.

Conclusions: General physical activity and diet do not seem to be as strongly or directly associated with upper-extremity physical function as pain interference.

Keywords: Diet, Exercise, Pain intensity, Pain interference, Upper-extremity physical function

Introduction

Psychosocial factors and coping strategies like pain interference and depression influence how patients perceive and thus report physical function, but still a large proportion of variance in function remains unexplained (1-4). Diet and exercise are two of the most important self care factors associated with quality of life in older adults (5). Specifically, physical activity improves emotional health issues, reduces cognitive function decline and mortality, and improves general physical function and strength among older adults (6-13). Among various available diet plans, the Mediterranean diet has been associated with slower cognitive decline and decreased risk for Alzheimers Disease among older adults. Recent research has found an association between Mediterranean diet adherence and mobility performance, as well as with longevity and improved physical function in this population (14, 15). Little is known about the influence physical exercise and diet on upper-extremity physical function in older adults.

This study examined the crossectional association of general physical exercise, adherence to the Mediterranean diet, pain interference and depression to upper-extremity physical function in older patients with upper extremity illness. The primary null hypothesis was that there is no association between upper-extremity physical function and physical exercise and Mediterranean diet. Secondarily, we determined whether there was an association between pain intensity and physical exercise and diet.

Corresponding Author: David Ring, Department of Surgery and Perioperative Care, Dell Medical School, The University of Texas at Austin, Austin, Texas, USA
Email: dring@partners.org

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Materials and Methods

Study Design

After institutional review board approval, we invited 115 new and follow-up outpatients presenting to one of two orthopaedic hand surgeons to participate in this prospective cross-sectional study. Patients were enrolled one clinic day a week between March 2015 and July 2015. Patients were considered eligible if they were at least 50 years, able to communicate in English and give informed consent. Four patients declined participation, leaving 111 patients in the cohort.

A research fellow asked all consenting patients to complete a sociodemographic survey, three Patient-Reported Outcomes Measurement Information System (PROMIS) based computerized adaptive testing questionnaires (CAT) questionnaires, the Rapid Assessment of Physical Activity (RAPA) and the 14-item Mediterranean diet questionnaire. Social demographic variables included age, sex, race, years of education, insurance status, work status and marital status. The questionnaires were administered using Assessment Center, a secure web-based data collection tool (16, 17). All patient-identifiable information was collected separately on a computer spreadsheet. Comorbid conditions were retrieved from the medical records. Weight and height were self-reported. The BMI variable was obtained by the use of an online BMI calculator for imperial units (18).

Outcome Measures

The RAPA is a validated nine-item self-reported questionnaire to assess physical activity among adults older than 50 over the last year (19). The test consists of two parts (i.e. RAPA 1, 2), with the first part determining the level of physical activity and the second part providing an additional assessment of a patient's strength and flexibility. In the first part, RAPA 1, there are seven questions evaluating increasing levels of physical activity, the highest affirmative response to any of these questions determines the test score. An additional three points can be scored in RAPA 2. A score of one indicates no physical activity (sedentary lifestyle) while a score of 10 illustrates

Table 1. Characteristics of the Study Population (n=111)

Parameter	***P*-value**
†Total	111 (100)
Age* (years)	64±10 (50-90)
†Sex	
Female	67 (60)
Male	44 (40)
†Race/ethnicity	
White	97 (87)
Non-white	24 (13)
BMI (kg/m2)*	28±5.3 (19-48)
Education* (years)	16±4.4 (0-27)

Countinue Table 1.

†Insurance status	
Private	65 (59)
Medicaid	8 (7)
Medicare	35 (31)
Workers' compensation	2 (2)
Uninsured	1 (1)
†Working status	
Working	52 (47)
Retired	37 (33)
Unemployed	17 (15)
Workers' compensation	5 (5)
†Marital status	
Single	13 (12)
Married	64 (58)
Separated or divorced	26 (23)
Widowed	8 (7)
†Diagnosis	
Traumatic	42 (38)
Non-traumatic	69 (62)
†Other pain condition	
Yes	47 (42)
No	64 (57)
Pain intensity*	4.6±3.4 (0-10)
†Prior surgery	
Yes	40 (36)
No	71 (64)
†Smoking	
Yes	15 (14)
No	96 (86)
†Appointment type	
New patient	34 (31)
Follow-up	77 (69)
RAPA*	6.3±2.6 (1-10)
Mediterranean Diet*	6.2±2.4 (0-12)
PROMIS instruments*	
Upper Extremity Function	35±10 (15-56)
Pain Interference	57±9.1 (39-80)
Depression	50±9.9 (34-78)

PROMIS=Patient Reported Outcomes Measurement Information System
RAPA=Rapid Assessment of Physical Activity
*The values are given as the mean and the standard deviation, with the range in parentheses.
†The values are given as the number of patients, with the percentage in parentheses.

Table 2. Bivariate analysis

	PROMIS UE Physical function		Pain intensity	
Parameter	**mean ±SD**	***P* value**	**mean ±SD**	***P* value**
Sex				
Female	33±9.0	0.0049	4.8±3.3	0.6
Male	38±11		4.4±3.7	
Race/ethnicity				
White	35±10	0.93	4.4±3.5	0.052
Non-white	35±9.9		6.3±2.6	
Insurance status				
Private	36±11	0.78	4.2±3.1	0.3375
Medicaid	32±5.5		4.5±4.3	
Medicare	34±11		5.3±3.8	
Workers' compensation	37±10		4±2.8	
Uninsured	28		10	
Working status				
Working	36±11	0.17	4.2±3.3	0.2046
Retired	35±11		4.4±3.6	
Unemployed	32±4.9		5.9±3.2	
Workers' compensation	28±12		6.4±3.2	
Marital status				
Single	39±11	0.069	4±3.3	0.57
Married	36±10		4.4±3.4	
Separated or divorced	32±10		5.3±3.4	
Widowed	29±6.4		5.3±3.9	
Diagnosis				
Traumatic	32±11	0.021	3.9±3.2	0.097
Non-traumatic	37±9.6		5.0±3.5	
Other pain condition				
Yes	34±8.9	0.31	5.7±3.6	0.004
No	36±11		3.8±3.1	
Prior surgery†				
Yes	33±10	0.15	4.5±3.4	0.74
No	36±10		4.7±3.5	
Smoking				
Yes	30±7.0	0.033	6.9±2.9	0.0059
No	36±11		4.3±3.4	
Appointment type				
New patient	35±11	0.86	5.3±3.5	0.15
Follow-up	35±10		4.3±3.4	
Parameter	**Correlation (r)**	***P* value**	**Correlation (r)**	***P* value**
Age	-0.1	0.28	0.05	0.61
Education	0.38	<0.001	-0.45	<0.001

Countinue Table 2.				
BMI	-0.02	0.83	0.07	0.47
Mediterranean Diet	0.022	0.82	-0.018	0.85
RAPA	0.24	0.011	-0.21	0.025
PROMIS instruments				
Pain Interference	-0.71	<0.001	0.7	<0.001
Depression	-0.47	<0.001	0.24	0.011

*The values are given as the mean and the standard deviation, with the range in parentheses.

†The values are given as the number of patients, with the percentage in parentheses.

vigorous physical activity (20 minutes or more of vigorous activities a day for three or more days a week; Appendix I).

The PROMIS Upper Extremity Physical Function assesses a patient's reported degree of function of the upper extremity including shoulder, arm, and hand activities. Items consist of questions on activities including using buttons and zippers, reaching in a high cupboard, and opening containers (20, 21). The PROMIS Depression instrument measures self-reported negative mood (sadness, guilt), social cognition (interpersonal isolation, loneliness) and views of self (self-criticism, worthlessness) as well as decreased positive affect and engagement (meaning, purpose and loss of interest) (22). The PROMIS Pain Inference instrument assesses the consequences of pain on relevant aspects of a person's life. It may contain questions about the impact of pain on social, emotional, cognitive and physical aspects as well as recreational activities, sleep and enjoyment in life (23).

A validated 14-item Mediterranean diet tool was used to assess the adherence to a Mediterranean diet. This questionnaire tool was developed as part of a large randomized, cardiovascular nutritional prevention trial conducted in Spain (24). The questionnaire is scored 0-14 with 1 point assigned to each question. Higher scores indicate greater adherence to the Mediterranean diet.

Pain intensity at the time of enrollment was measured with an 11-point ordinal measure (0-10 numeric rating scale).

Patient Characteristics

The 111 patients comprising our sample consisted of 67 women (60%) and 44 men (40%), with a mean age of 64±10 years. Most patients were white (87%) and had private insurance (59%). The mean BMI was 28±5.3 kg/m2 (range 19-48). Three percent of the patients had less than a high school diploma and 35% had an advanced degree. A total of 47% of patients worked,

Table 3. Multivariable linear regression

PROMIS UE Function	Predictor	Coefficient	SE	95% CI Lower	95% CI Upper	Partial R^2	*P*	R^2
	Male sex (ref.: female sex)	2.9	1.3	0.27	5.6	0.044	0.031	
	Traumatic (ref: Non-traumatic)	-5.3	1.4	-8	-2.6	0.13	<0.001	
	Smoking (ref: Non-smoking)	-2.3	1.9	-6.09	1.5	0.014	0.23	
	Education	0.26	0.16	-0.057	0.59	0.025	0.11	0.62
	RAPA	0.092	0.26	-0.42	0.61	0.0012	0.72	
	PROMIS Pain Interference	-0.67	0.085	-0.84	-0.50	0.37	<0.001	
	PROMIS Depression	-0.094	0.076	-0.24	0.06	0.014	0.24	
Pain Intensity	**Predictor**	**Coefficient**	**SE**	**95% CI Lower**	**95% CI Upper**	**Partial R^2**	**P**	**R^2**
	Pain condition (ref: No pain condition)	0.72	0.49	-0.24	1.69	0.024	0.14	
	Smoking (ref: Non-smoking)	0.88	0.68	-0.47	2.24	0.014	0.2	
	Education	-0.14	0.058	-0.26	-0.025	0.046	0.018	
	RAPA	0.0037	0.095	-0.18	0.19	0.0005	0.97	0.55
	PROMIS Pain Interference	0.24	0.03	0.18	0.3	0.25	<0.001	
	PROMIS Depression	-0.033	0.026	-0.092	0.018	0.019	0.2	

33% of patients were retired, 15% was unemployed and 5% had workers' compensation. Eighty-six percent of patients were non-smokers and 64% reported no other pain condition. Most patients (64%) had no prior surgery on the affected side [Table 1].

Statistical analysis

An a priori power analysis indicated that a sample size of 111 patients would provide 90% statistical power (α=0.05) to detect a moderate effect size (f2=0.18) in a linear regression model of PROMIS Upper-Extremity Physical Function with seven predictors.

Continuous data were reported with the mean, SD, and range. Categorical data were presented in terms of frequencies and percentages.

In bivariate analysis, the correlations of continuous variables with PROMIS Upper-Extremity Physical Function and pain intensity were analyzed using Pearson correlations.

Associations with dichotomous and categorical variables were determined with the independent samples t-test and one-way analysis of variance, respectively.

All variables with $P<0.05$ in bivariate analysis were entered into a multiple linear regression model with the PROMIS Upper-Extremity Function score and pain intensity as response variables. The R-squared and partial R-squared were calculated to obtain the collective and the individual influence of the factors in the multivariable regression model in PROMIS Upper-Extremity Physical Function and pain intensity.

Results

General physical activity correlated with PROMIS Upper-Extremity Physical Function (r=0.24, $P=0.011$), and pain intensity (r=-0.21, $P=0.025$) in bivariate, but not multivariate analyses, [Table 2, 3]. Adherence to the Mediterranean diet did not correlate with PROMIS Upper-Extremity Physical Function, and pain intensity in bivariate analysis.

Male sex (t-value=-2.9, $P=0.0049$), non-traumatic diagnosis (t-value=2.3, $P=0.021$), smoking (t-value= 2.2, $P=0.033$), fewer years of education (r=0.38, $P<0.001$), higher PROMIS Pain interference (r=-0.71, $P<0.001$) and PROMIS Depression (r=-0.47, $P<0.001$) scores were associated with less upper-extremity physical function in bivariate analysis. Male Sex, non-traumatic diagnosis and higher PROMIS Pain Interference were associated with less upper-extremity physical function in multivariable analysis. Pain Interference was accountable for most of the observed variability (37%).

Having multiple pain conditions ($P=0.004$, t-value=-2.9), smoking ($P=0.0059$, t-value=-2.8), fewer years of education (r=-0.45, $P<0.001$), less general physical activity (r=-0.25, $P=0.0073$), higher PROMIS Pain interference (r=0.7, $P<0.001$) and PROMIS Depression (r=0.24 $P=0.011$) scores were associated with greater pain intensity in bivariate analysis. In multivariable analysis, only years of education and PROMIS Pain Interference were associated with pain intensity.

Discussion

The role of self care behaviors like general physical activity and diet in upper-extremity physical function is incompletely understood. This study sought to evaluate the relationship of general physical exercise and diet, to upper-extremity physical function, while accounting for important psychosocial variables previously depicted by research.

This study should be considered in light of its shortcomings. First, a key limitation of this study is that we assessed general rather than upper extremity specific physical activity. Upper extremity specific exercises like rowing or weight lifting may have a more direct effect on upper extremity pain intensity and function. Second, this study was performed at a single urban academic hospital in the Northeastern United States, which may limit generalizability to other settings and regions. Third, our study sample may not have been large enough to determine an association in multivariable analysis. A prior power analyses was calculated for moderate effect sizes. As such, the study is susceptible to type 2 error, whereby the effect of physical exercise and other variables may have been underestimated due to the small sample size. Fourth, although we used computer adaptive tests and shorter validated questionnaires to decrease the time to accomplish the tests, participants still had to complete five questionnaires and a sociodemographic survey, which might have affected the quality of the data. Lengthy questionnaires may cause respondents to become distracted and tired (25, 26). Fifth, cross-sectional study designs are limited by the fact that data are only collected at a specific point in time. In our study we asked questions about general physical activity at a point if time when patients may be temporary less active (i.e. due to trauma). However when administrating the RAPA to patients we emphasized that we tried to assess their general physical activity, not the current physical status.

Our finding that physical activity was associated with upper extremity function in older adults is consistent with results from prior research on general physical function (9-13). For instance, a cross-sectional study among 3075 older adults found that older adults who participate in 20 to 30 minutes of moderate-intensity exercise on most days of the week have better physical function than older persons who are inactive (9). That Pain Interference was the strongest predictor of physical function in multivariable analyses is consistent with prior research. For instance, PROMIS Pain Interference explained 51% of the variation in QuickDASH scores in a cohort of 213 patients with upper extremity illness (1). Similarly, Overbeek and colleagues recently reported that upper extremity disability is most strongly influenced by the degree to which pain interferes with achieving goals (2). That physical activity was not significantly associated with physical function in multivariable analyses may be a function of low power as depicted above. Further, it may be that physical activity indirectly impacts physical function through pain interference.

We want to emphasize that physical activity is important for patients, regardless the findings of this study. Participation in regular physical activity reduces the risk of weight gain, obesity, coronary heart disease, type 2 diabetes mellitus, Alzheimer's disease and dementia (27). It is important to realize that results are likely to be different for overall physical functioning. Our findings only provide information about the association between general physical exercise and upper-extremity specific function.

In conclusion, our data suggest that general physical activity and diet may not be as strongly or directly associated with upper extremity specific physical function as pain interference. Interventions to lower pain interference (e.g. cognitive behavioral therapy) hold potential to reduce musculoskeletal symptom intensity and improve upper-extremity physical function, and, perhaps indirectly increase physical activity (28).

Hugo H. Hermanussen BSc
Mariano E. Menendez MD
Neal C. Chen MD
Orthopaedic Hand and Upper Extremity Service
Massachusetts General Hospital, Boston, USA

David Ring MD PhD
Department of Surgery and Perioperative Care, Dell Medical School, The University of Texas at Austin, Austin, Texas, USA

Ana-Maria Vranceanu PhD
Massachusetts General Hospital, Behavioral Med Services, Boston, USA

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