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Walking and the 2-year risk of functional decline: An observational study of US adults with arthritis

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ABSTRACT

Recent studies of middle age and older adults with, or at risk for, arthritis demonstrate that engaging in physical activities like walking — even at levels below the current aerobic physical activity guideline of ≥150 min of moderate-intensity activity — can protect against onset of functional limitations. Using a large nationally representative sample of US adults ≥18 years with arthritis, we investigated whether, among those not meeting the aerobic activity guideline, walking ≥10 min/week vs. < 10 min/week reduced the risk of six outcomes (fair/poor health and five physical limitations) over 2 years.

We conducted a prospective cohort study among adults with arthritis in the 2010 National Health Interview Survey who participated in the 2011–2012 Medical Expenditure Panel Survey (n = 1426). Among adults not meeting the guideline, we examined the effect of walking on risk of developing each of six outcomes using hazard ratios (HRs) estimated from multivariable Cox regression models.

Among adults with arthritis not meeting the guideline, compared to walking < 10 min/week, walking ≥10 min/week was associated with a statistically significant decreased risk for all five limitations: walking three blocks (HR: 0.3 [95% CI = 0.2–0.6]), climbing 10 stairs (HR: 0.5 [95% CI = 0.3–0.8]), stooping/kneeling (HR: 0.4 [95% CI = 0.2–0.8]), reaching overhead (HR: 0.5[95% CI = 0.5–0.8]), and grasping (HR: 0.4 [95% CI = 0.2–0.7]). The decrease in risk was not significant for fair/poor health.

Even limited walking may prevent the onset of physical limitations among adults with arthritis of all ages not meeting the aerobic activity guideline.

Physical activity can improve the well-being of adults with arthritis. It reduces the risk of premature death and several chronic diseases (cardiovascular disease, ischemic stroke, type 2 diabetes, depression) and has multiple arthritis-specific benefits including reduced pain (Semanik et al., 2012; U.S. Department of Health and Human Services, 2008), anxiety (Kelley et al., 2017), and improved physical function (Semanik et al., 2012; U.S. Department of Health and Human Services, 2008; Dunlop et al., 2005). Despite this, 41% of adults with arthritis engage in < 10 min of aerobic physical activity each week (Murphy et al., 2017).

Promoting walking is an important public health strategy for increasing physical activity among the 54.4 million US adults with arthritis (Barbour et al., 2017) because it is low impact, inexpensive, and convenient (Lee and Buchner, 2008; Hootman et al., 2002). Controlled trials demonstrate that walking decreases pain and depression, and increases mobility and physical performance among adults with arthritis (Bruno et al., 2006; Callahan et al., 2011; Nyrop et al., 2011). Four reports from recent observational studies of middle age and older adults with, or at risk for, arthritis found that engaging in walking (White et al., 2014) — or in physical activities that may include walking (Dunlop et al., 2017; Dunlop et al., 2014; Feinglass et al., 2005) — at levels below the aerobic guideline of ≥150 min of moderate-intensity activity (U.S. Department of Health and Human Services, 2008), while not as beneficial as participating in recommended levels, protected against the onset of functional limitations. However, these studies were not generalizable to the entire US adult arthritis population, of which 47% are younger adults (18–44 years) (Barbour et al., 2017).

Our objective was to use nationally representative data for US adults with arthritis to test the hypothesis that among those not meeting the aerobic physical activity guideline, at least some walking reduced the risk of onset of limitations and decline in respondent-reported health status.

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1. Materials and methods

1.1. Study sample

The data sources for this study were the National Health Interview Survey (NHIS) and Medical Expenditure Panel Survey (MEPS). The NHIS is an ongoing, cross-sectional health survey that is representative of the national non-institutionalized civilian population. The Sample Adult Core is administered to one randomly-sampled adult in each NHIS household (National Center for Health Statistics). In 2010, the Cancer Control Supplement, which included questions concerning time spent walking, was administered to Sample Adult Core respondents. Final response rate for the 2010 Sample Adult Core was 60.8% (Centers for Disease Control and Prevention). The MEPS is a household panel survey, derived from the previous year's NHIS, which collects information on many characteristics including medical care utilization and expenditures and health status. Each year, approximately half of the previous year's NHIS households are sampled to create a new MEPS panel which is interviewed five times (rounds 1–5) over the next 2 years (Agency for Healthcare Research and Quality). The overall response rate over the five rounds for the panel starting in 2011 (Panel 16), which incorporates the 2010 NHIS response rate, was 53.5% (Agency for Healthcare Research and Quality, 2015).

Our analysis included both cross-sectional and longitudinal components. For the cross-sectional analysis, we identified adults with arthritis in the 2010 National Health Interview Survey (NHIS). For the longitudinal analysis (our primary analysis), adults with arthritis in the 2010 NHIS who also participated in the longitudinal panel of the 2011–2012 Medical Expenditure Panel Survey (MEPS) were followed over 2 years.

All NHIS and MEPS data were respondent-reported. Socio-demographic characteristics, health status, leisure-time physical activity, and minutes of walking/week were from the 2010 NHIS. Functional limitations and respondent-reported health data from the 2011–2012 MEPS were extracted for those NHIS participants comprising MEPS Panel 16.

1.2. Definition of arthritis, other conditions, and health status variables

We classified individuals answering “yes” to the NHIS question “Have you EVER been told by a doctor or other health professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?” as having arthritis (National Center for Health Statistics, 2011). In addition to arthritis, we also classified respondents as having each of eight other chronic physical conditions. We used similar NHIS questions to determine respondents' history of cancer, diabetes, heart disease, chronic liver conditions or hepatitis, pulmonary conditions, and stroke. Respondents were classified as having hypertension if a provider had mentioned it at ≥2 separate medical visits, and as having kidney disease if a provider mentioned that the respondent had weak or failing kidneys in the past year. We selected these eight conditions based on published recommendations for identification and reporting of chronic conditions (Goodman et al., 2013). We also included serious psychological distress (SPD), measured in the NHIS with the Kessler-6 which is a validated scale for assessing non-specific serious mental illness (Kessler et al., 2003), as a co-occurring condition. NHIS provided smoking status and body mass index (BMI) calculated from height and weight.

1.3. Measurement of physical activity and walking

NHIS measured usual duration and frequency of light-to-moderate-intensity (causing light sweating or a slight-to-moderate increase in breathing or heart rate) and vigorous-intensity (causing heavy sweating or large increases in breathing or heart rate) leisure-time aerobic physical activity lasting ≥10 min. Specifically, duration was recorded in minutes, and frequency was collected as the number of times per day, week, month, or year. Per the aerobic guideline, we defined meeting the guideline as participating in ≥150 min of moderate-intensity equivalent leisure aerobic activity/week. We multiplied vigorous-intensity activity minutes by two when combining light/moderate and vigorous intensity to calculate the total moderate-intensity equivalent minutes as specified by the guideline (U.S. Department of Health and Human Services, 2008). We classified participants as insufficiently active if they engaged in at least one 10-minute bout of moderate-intensity equivalent activity/week but did not meet the guideline, and as inactive if they reported no moderate-intensity equivalent activity that lasted at least 10 min in the past week.

The NHIS Cancer Control Supplement included questions on bouts of transportation or leisure-time walking lasting ≥10 min. Specifically, walking for transportation was prompted by, “During the past 7 days, did you walk to get some place that took you at least 10 minutes?” Walking for leisure was assessed with “Sometimes you may walk for fun, relaxation, exercise, or to walk the dog. During the past 7 days, did you walk for at least 10 minutes for any of these reasons? Please do not include walking for transportation.” Those who responded “yes” were asked: “In the past 7 days, how many times did you do that?” and “On average, how long did those walks take?”. It is not possible to determine whether participants included the time that they spent walking for leisure when they reported their leisure aerobic physical activity because, unlike the walking questions, the physical activity questions specify sweating or increased breathing or heart rate.

For both transportation and leisure walking, we included respondents who did not walk at all or reported only average bouts of activity < 10 min in the < 10 -minute category. We summed transportation and leisure-time minutes to derive total walking min/week and categorized responses into two levels: walked ≥10 min (i.e., walked ≥10 min/week for either leisure or transportation) and walked < 10 min. Then, we combined the aerobic activity and walking items to create a three-level hierarchical variable: 1) met the aerobic guideline, 2) did not meet the aerobic guideline, walked ≥10 min/week, and 3) did not meet the aerobic guideline, walked < 10 min/week. We included the first category, those who met aerobic guideline, when describing the US population with arthritis but, as discussed later, excluded them from most of the longitudinal analyses. Note that the second category includes individuals walking ≥150 min/week; it is possible to walk ≥150 min/week and not meet the aerobic guideline if that walking does not cause light sweating or a slight-to-moderate increase in breathing or heart rate.

1.4. Outcome measures

The first outcome was decline in respondent-rated general health status, asked in NHIS as, “Would you say your health in general is excellent, very good, good, fair, or poor?” We used a two-category measure because a test-retest reliability assessment of this question from 2005 to 2008 National Health and Nutrition Examination Survey data demonstrated low agreement for the 5-category variable but improved stability when dichotomized to excellent/very good/good vs. fair/poor (Zajacova and Dowd, 2011). MEPS assessed respondent-rated health status using during each of the five rounds. Text of this question in MEPS is presented in Appendix A.

The other outcomes, measured using similar questions in both surveys, were five specific functional limitations common among adults with arthritis: amount of difficulty walking three blocks; walking up 10 stairs; stooping, bending, or kneeling; reaching overhead; and grasping or handling small objects. MEPS measured these outcomes at rounds 1, 3, and 5; we dichotomized responses to no difficulty vs. any difficulty/unable to do the activity. Complete text and recoding of these measures are in Appendix A.

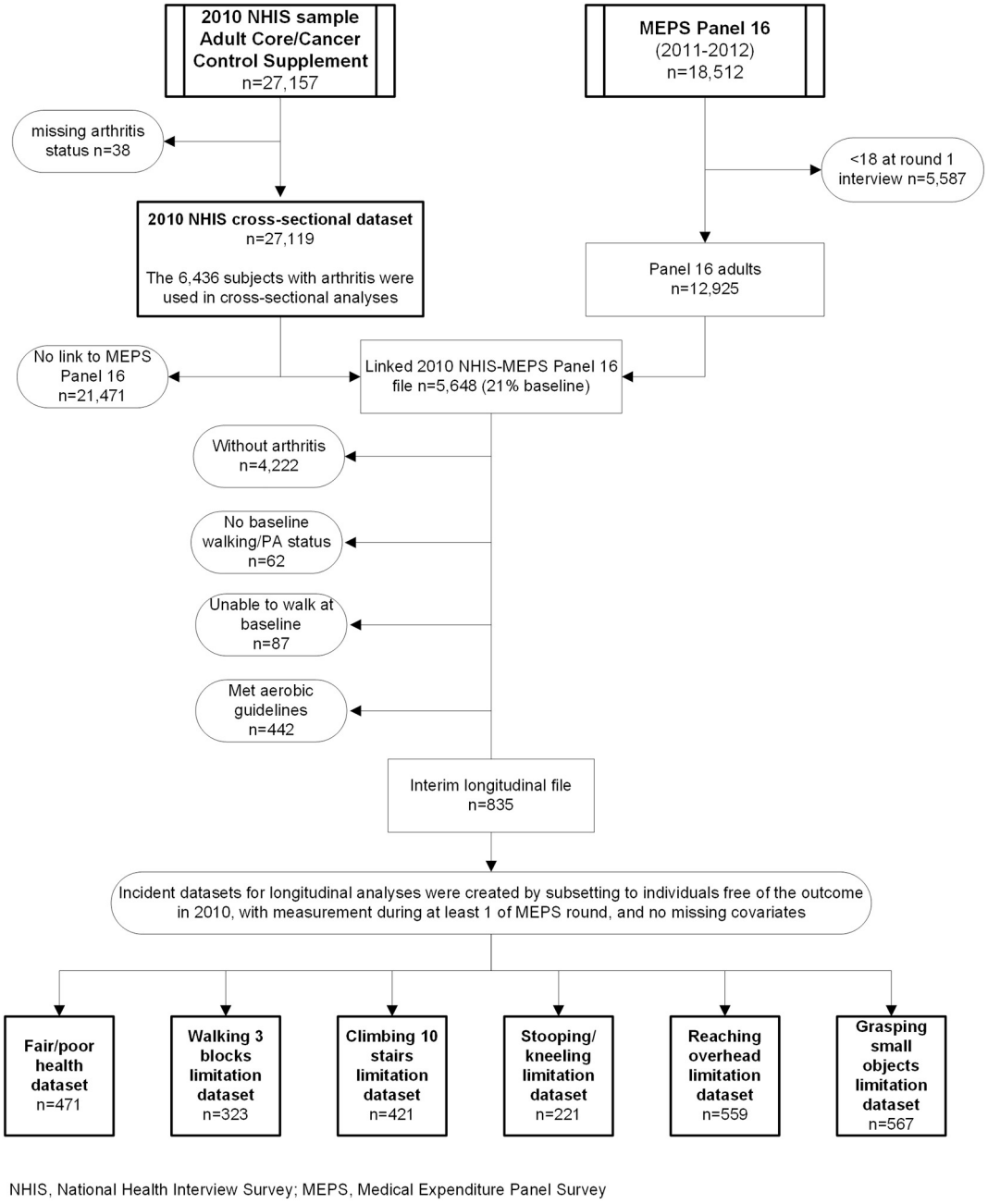


Fig. 1. Flow chart demonstrating the creation of analytic datasets from 2010 NHIS and MEPS Panel 16 files, US non-institutionalized civilian population.

1.5. Statistical analyses

Fig. 1 illustrates the steps followed to create the various analytic datasets (narrative description is in Appendix B). For our cross-sectional analyses, we examined socio-demographic characteristics, respondent-health and physical limitations reported in the 2010 NHIS survey stratified by three categories of combined aerobic activity and walking status (met aerobic guideline; did not meet aerobic guideline, walked ≥10 min per week; and did not meet aerobic guideline, walked < 10 min per week).

For our longitudinal analyses, we examined outcome onset of health and physical limitations among adults with arthritis who did not meet the aerobic guideline at baseline. Before longitudinal analysis, we generated Kaplan Meier curves to examine patterns in time to outcome onset between the two walking groups (< 10 min vs. ≥10 min/week) among those not meeting the aerobic guideline at baseline in 2010. Because the curves for the two baseline groups were roughly parallel for each outcome, we concluded that using proportional hazards (Cox regression) was appropriate to estimate risk of outcomes. We estimated the risk of each outcome using the associated incident dataset and multivariable proportional hazards regression models. We ran two models for each outcome where we estimated risk with adjusted hazard ratios (HR) and 95% confidence intervals (CIs). The HR represents the ratio of the hazard (in this study, the rate at which the outcome occurs during the two-year-period of MEPS) for one group of individuals divided by the hazard for another. HR > 1 indicates increased risk, and HR < 1 decreased risk, of the outcome for the group in the numerator compared with the group in the denominator (Allison and SAS Institute, 1995).

First, we analyzed weekly walking time as a binary variable: < 10 min (referent) vs. ≥10 min. Second, we examined potential dose-response patterns (i.e., whether risk of the outcome decreased with

Table 1
Characteristics of US adults age 18 + years with arthritis (n = 6436), overall and who do not meet aerobic activity guidelines (n = 4393), 2010 NHIS Cancer Control Supplement.

Characteristic	All adults with arthritis				Adults with arthritis not meeting aerobic physical activity guideline[a]			
	Weighted percent	(95% CI)			Weighted percent	(95% CI)		
Age group (years)								
18–44	15	(14	–	16)	12	(11	–	13)
45–64	47	(45	–	48)	45	(44	–	47)
≥65	38	(37	–	40)	43	(41	–	43)
Sex								
Men	41	(39	–	42)	37	(35	–	39)
Women	59	(58	–	61)	63	(61	–	65)
Race/ethnicity								
Hispanic	7	(7	–	8)	8	(8	–	9)
Non-Hispanic Black or African American	11	(10	–	12)	13	(12	–	14)
Non-Hispanic White	78	(77	–	80)	76	(74	–	77)
Non-Hispanic Asian	2	(2	–	3)	2	(2	–	3)
Non-Hispanic Other[b]	1	(1	–	1)	1	(1	–	2)
Highest education								
Less than high school	16	(15	–	17)	21	(20	–	22)
High school graduate	30	(29	–	32)	33	(32	–	35)
Some college/associate degree	31	(30	–	32)	30	(29	–	32)
College graduate	23	(21	–	24)	16	(14	–	17)
Body mass index (BMI) (kg/m^2)								
Under and normal weight (< 25)	26	(25	–	27)	25	(24	–	27)
Overweight (25– < 30)	35	(33	–	36)	31	(30	–	33)
Obese (≥30)	39	(38	–	41)	43	(42	–	45)
Smoking status								
Never	49	(47	–	50)	48	(46	–	50)
Former	33	(31	–	34)	32	(30	–	34)
Current	19	(18	–	20)	20	(19	–	22)
Co-occurring conditions (count)[c]								
None	26	(24	–	27)	21	(19	–	22)
1	31	(30	–	33)	30	(28	–	31)
2	22	(21	–	23)	24	(23	–	25)
3–9	21	(20	–	23)	26	(24	–	27)
Met minimum aerobic physical activity guideline[a]								
No	64	(62	–	66)	100			
Inactive[d]	42	(40	–	44)	66	(64	–	68)
Insufficiently active[e]	22	(21	–	23)	34	(32	–	36)
Yes	36	(34	–	38)				
Average total walking minutes/week[f]								
Unable to walk[g]	5	(4	–	6)	7	(6	–	8)
< 10 min	43	(42	–	45)	54	(52	–	55)
10– < 30 min	6	(6	–	7)	7	(6	–	8)
30– < 60 min	10	(9	–	11)	10	(9	–	11)
60– < 90 min	9	(8	–	10)	8	(7	–	9)
90– < 150 min	11	(10	–	12)	8	(7	–	9)
150 min and higher	16	(15	–	17)	7	(6	–	8)

NHIS, National Health Interview Survey.

[a] At least 150 min of moderate-intensity equivalent aerobic activity per week (i.e., 150 min of moderate-intensity aerobic physical activity, 75 min of vigorous-intensity aerobic activity, or an equivalent combination).

[b] Includes non-Hispanic American Indians and Alaska natives. There was insufficient sample size to report this race/ethnicity group separately.

[c] History of cancer (excluding non-melanoma skin), diabetes, heart disease, two or more mentions of hypertension at medical visit, chronic liver condition or hepatitis, pulmonary conditions, stroke, weak or failing kidneys in the past year, and current serious psychological distress.

[d] No moderate-intensity equivalent activity that lasted at least 10 min.

[e] At least one 10 min moderate-intensity equivalent activity bout, but < 150 min of moderate-intensity equivalent per week.

[f] Calculated by summing number of minutes walked/week in bouts of ≥10 min for leisure and transportation. Participants who were unable to walk were categorized as such. Those able to walk who reported average bouts < 10 min for both leisure and transportation or not walking at all were categorized as walking < 10 min.

[g] Among adults with arthritis, 345 participants were unable to walk.

increasing walking time) where ≥10 min walking time was categorized in five levels (10– < 30, 30– < 60, 60– < 90, 90– < 150, and ≥150 min). The multivariable models were adjusted for seven characteristics: age groups (18–44, 45–64, vs. ≥65 years); sex; count of nine co-occurring conditions described earlier (none, 1, 2, 3–9); race/ethnicity (Hispanic, non-Hispanic black, non-Hispanic other vs. non-Hispanic white); highest education level (< high school, high school graduate, some college or associate degree vs. college graduate); BMI category (kg/m^2) (< 25, 25– < 30 vs. ≥30); and smoking status (never, former, vs. current).

Table 2
General respondent-rated health and physical limitations among US adults with arthritis, by physical activity and walking status, NHIS 2010 Cancer Control Supplement, n = 6,436[a].

Characteristic	Met aerobic guideline (n = 2043)[b]				Did not meet aerobic guideline, walked ≥10 min (n = 1545)				Did not meet aerobic guideline, walked < 10 min (n = 2145)			
	%[c]	(95% CI)			%[c]	(95% CI)			%[c]	(95% CI)		
General respondent-rated health												
Good/very good/excellent	87	(85	–	88)	72	(69	–	74)	62	(59	–	64)
Fair/poor	14	(12	–	15)	28	(26	–	31)	39	(36	–	41)
Limitation walking 3 blocks												
No	77	(74	–	79)	57	(54	–	60)	35	(32	–	37)
Yes	22	(20	–	25)	40	(37	–	43)	59	(56	–	62)
Do not do	1	(1	–	2)	3	(2	–	4)	7	(5	–	8)
Limitation walking up 10 stairs												
No	84	(82	–	86)	68	(65	–	71)	50	(47	–	53)
Yes	15	(14	–	17)	30	(27	–	33)	47	(44	–	49)
Do not do	1	(0	–	1)	2	(1	–	2)	3	(3	–	4)
Limitation stooping, bending, or kneeling												
No	55	(53	–	58)	39	(36	–	42)	28	(26	–	30)
Yes	44	(42	–	47)	60	(57	–	63)	69	(67	–	71)
Do not do	1	(0	–	1)	1	(1	–	2)	3	(2	–	4)
Limitation reaching overhead												
No	86	(84	–	88)	78	(76	–	81)	68	(65	–	70)
Yes	14	(12	–	16)	21	(19	–	24)	32	(30	–	34)
Do not do	–[d]				–[d]				1	(0	–	1)
Limitation grasping or handling small objects												
No	83	(81	–	85)	77	(74	–	79)	70	(68	–	73)
Yes	17	(15	–	19)	23	(21	–	26)	30	(27	–	32)
Do not do	–[d]				–[d]				–[d]			

NHIS, National Health Interview Survey.
[a] Percentages are weighted. Sample size for the 3 strata add up to 5733 because n = 134 subjects were missing aerobic physical activity minutes, and an additional n = 327 were unable to walk and n = 242 were missing walking min walked/week.
[b] At least 150 min of moderate-intensity equivalent aerobic activity per week (i.e., 150 min of moderate-intensity aerobic physical activity, 75 min of vigorous-intensity aerobic activity, or an equivalent combination).
[c] Weighted percent.
[d] Estimate is too unstable to report (relative standard error > 0.3).

We also conducted sensitivity analyses to determine whether walking had the same effects on risk of outcome onset across each of the three aerobic activity groups. We used the same multivariable model described above but ran it separately for each of the three aerobic activity groups (inactive, insufficiently active, and met aerobic guideline).

We applied sampling weights to create nationally representative estimates. We used the NHIS-supplied adult sampling weights in cross-sectional analyses. We derived weights for the longitudinal analyses by dividing the MEPS-supplied Panel 16 longitudinal weights by the ratio of the adult-to-core NHIS sampling weights (Cohen, 2010). These weights adjusted for both selection and attrition in MEPS and the NHIS adult sampling section. We conducted all analyses using SAS 9.3 SURVEY procedures (SAS Institute, 2002–2011) with Taylor series linearization to account for the surveys' multi-stage sample designs.

2. Results

2.1. Cross-sectional analyses

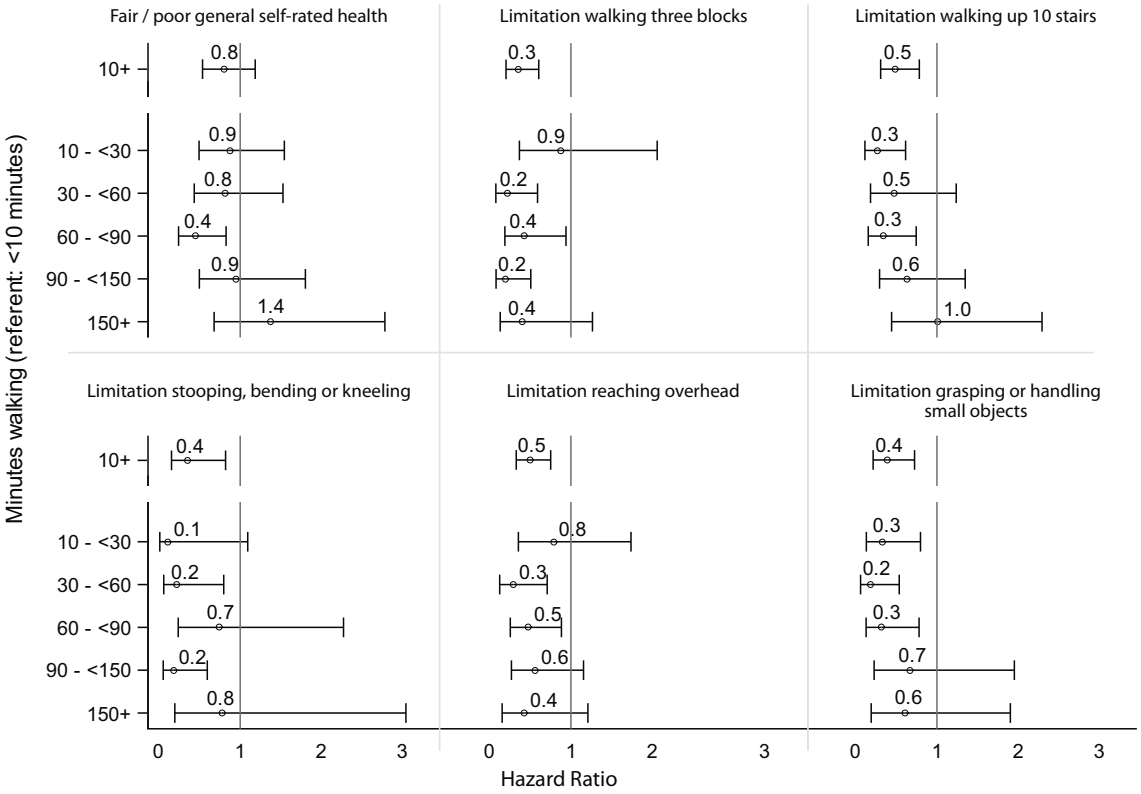
In 2010, 36% of adults with arthritis met the current aerobic guideline, 42% were inactive, and 22% were insufficiently active (Table 1). Five percent were unable to walk, 43% walked < 10 min/week, 36% walked 10– < 150 min/week, and 16% walked ≥150 min/week. Among those not meeting the aerobic guideline, 7% were unable to walk and 54% walked < 10 min/week.

Table 2 presents self-rated health and limitation information for US adults with arthritis in 2010 by physical activity and walking status. Across the three categories of combined aerobic activity and walking status, the 2010 prevalence of fair/poor health was lowest for those meeting the aerobic guideline (14%), followed by those not meeting the aerobic guideline and walking ≥10 min/week (28%), and highest among those not meeting the aerobic guideline and walking < 10 min/week (39%). Similarly, prevalence of the five functional limitations was lowest among those meeting the aerobic guideline and highest among those not meeting the aerobic guideline and walking < 10 min/week. Across the three categories, differences in fair/poor health and limitation estimates were statistically significant; CIs did not overlap among categories for any of the six measures.

2.2. Longitudinal analysis

For adults who did not meet the aerobic guideline in 2010 (baseline), there was a significantly lower risk of limitation onset for all five physical limitations among those walking ≥10 min compared with those walking < 10 min; HRs ranged from 0.3 to 0.5 (Fig. 2). HRs and CIs by limitation were walking three blocks (HR: 0.3 [95% CI = 0.2–0.6]), climbing 10 stairs (HR: 0.5 [95% CI = 0.3–0.8]), stooping/kneeling (HR: 0.4 [95% CI = 0.2–0.8]), reaching overhead (HR: 0.5 [95% CI = 0.5–0.8]), and grasping (HR: 0.4 [95% CI = 0.2–0.7]). Also, we did not find evidence of a dose-response relationship between the number of minutes walking and the risk of limitation onset. This may be partly due to the relatively small sample sizes of the more detailed walking time categories.

Results of the sensitivity analysis, examining the onset of the six outcomes in each of the three aerobic physical activity groups, appear in Appendix C. Among those meeting the aerobic guideline, none of the HRs were statistically significant; that is, there was no statistically significant protective effect against onset of limitations when



a Adjusted by age group, sex, race/ethnicity, highest education, count of nine co-occurring conditions (cancer, diabetes, heart disease, hypertension, chronic liver condition or hepatitis, pulmonary conditions, stroke, weak or failing kidneys, current serious psychological distress), BMI category, and smoking status.

b Events/sample sizes for analyses of each outcome are as follows: fair/poor general self-rated health (186/471); limitation walking three blocks (93/323); limitation walking up 10 stairs (126/421); limitation stooping, bending or kneeling (56/221); limitation reaching overhead (171/559); limitation grasping or handling small objects (108/567).

c Minutes walked for leisure or transportation in past week (NHIS 2010). Each panel of this figure presents results of two models, the first with minutes parameterized as ≥10 vs. <10 minutes, the second with five ordinal minute categories vs. <10 minutes.

d At least 150 minutes of moderate-intensity aerobic activity, 75 minutes of vigorous-intensity aerobic activity, or an equivalent combination/week.

e Analysis for each outcome excluded individuals who reported any of the following in the 2010 NHIS: being unable to walk, already having the outcome, or (for the five limitation variables) not engaging in the activity associated with the outcome.

MEPS, Medical Expenditure Panel Survey; NHIS, National Health Interview Survey; HR, Hazard Ratio; BMI, Body Mass Index

Fig. 2. Multivariable adjusted[a] HRs for onset of six outcomes (self-rated health and five functional limitations) [b] over 2 years (2011–2012 MEPS) among US adults with arthritis ≥18 years who did not meet the aerobic guideline [c] at baseline [d], by baseline walking status[e].

examining walking among adults with arthritis who met the aerobic guideline. Among those walking ≥10 min (referent: walking < 10 min), there was significantly lower risk of onset for limitation in walking three blocks and reaching overhead in the insufficiently active group. Also among those walking ≥10 min (referent: walking < 10 min), there was a significantly lower risk of limitation onset for walking up 10 stairs and grasping in the inactive group.

3. Discussion

Among adults with arthritis not meeting the aerobic guideline in 2010, those who walked ≥10 min vs. < 10 min/week had significant protective effects for all five physical limitation outcomes over 2 years. For adults with arthritis not meeting the aerobic guideline, walking may be an important strategy to prevent the onset of all five physical limitations examined.

These results are consistent with recent findings from four observational studies examining adults with or at risk of arthritis, including of osteoarthritis (OA). In these studies, modest amounts of moderate exercise or walking reduced the risk of incident physical limitation, even after adjusting for baseline characteristics. An analysis of 1992–1994 US Health and Retirement Study data demonstrated that adults with self-reported symptomatic arthritis who engaged in "insufficient" leisure-time physical activity were less likely (OR = 0.62; 95% CI: 0.48–0.79) than those who were inactive to experience functional decline (Feinglass et al., 2005). Another study of adults ≥50 years with or at risk of knee OA who were not functionally limited at baseline found that for each 1000 steps walked/day at baseline, there was a 16% to 18% reduction in the onset of functional limitations 2 years later (White et al., 2014). A 2014 study of adults ≥49 years with or at risk of knee OA in the US Osteoarthritis Initiative (OAI) demonstrated that light-intensity physical activity can reduce risk of OA onset for those at risk and delay onset or worsening of limitations for those with OA (Dunlop et al., 2014). The most recent report, also based on OAI data, concluded that, among adults ≥49 years with or at risk of knee OA, 45 min of moderate activity/week maintained or improved functioning over 2 years (Dunlop et al., 2017). Despite differences across studies, including differences in age (all four studies were limited

to middle age and older adults), arthritis definition (White et al., 2014; Dunlop et al., 2017), use of an accelerometer to measure activity (White et al., 2014; Dunlop et al., 2017), and outcomes examined, the consistency of our findings with these previous reports reinforces that low levels of physical activity, including walking, protect against onset of functional limitation and overall health decline.

The protective effects of walking ≥10 min against upper extremity function (i.e., reaching [(HR = 0.5] and grasping [HR = 0.4]) was unexpected. In a 1997 randomized trial, individuals with OA participating in a walking program performed significantly better on another upper extremity task (time to lift and carry 10 pounds) compared to those in a health education program (Ettinger Jr. et al., 1997). The authors hypothesized that improvements in upper extremity task functioning may result from the overall improvements in strength and fitness that walking confers.

Both NHIS and MEPS data have limitations. First, walking measures in NHIS — amount of time spent walking for leisure and transportation during the past 7 days, in bouts of ≥10 min — fail to capture smaller bouts of walking, and may not reflect participants' behavior over a longer period of time. Second, estimates were derived from respondent-reported aerobic physical activity and walking; therefore physical activity levels, including minutes of walking, may be inaccurate. Third, arthritis was based on respondent report which likely resulted in some misclassification of arthritis status. Fourth, because NHIS and MEPS questions were similar but not identical, changes in outcomes may be an artifact of wording differences. Fifth, because the physical activity questions include only leisure-time physical activity, some adults classified as not fulfilling the aerobic guideline may have actually done so through non-leisure activity such as walking or bike-riding for transportation.

The strength of this study is its use of nationally representative survey data for all adults with arthritis that measured a variety of characteristics and was sufficiently large for subgroup analysis. Results can be generalized to the entire US adult arthritis population, rather than middle age or older adults only as in previous studies; 47% of all adults with arthritis are younger adults (18–44 years) (Barbour et al., 2017). The linked NHIS and MEPS data allowed examination of the longitudinal benefits of walking over 2 years.

Our study provides additional evidence on the potential benefits of walking for adults with arthritis, namely, protection against disability even at levels below the current aerobic guideline. Our study also shows that 54% of adults with arthritis not meeting the current aerobic physical activity guideline do not walk even one weekly bout of ≥10 min; this group represents 58% of those who are not meeting aerobic guideline and are able to walk.

Promoting walking among adults who are not meeting the aerobic guideline may be an important strategy to prevent the onset of physical limitations. Walking may also be an easier way for these adults to start and maintain an active lifestyle. Community-based organizations can provide access to low-cost evidence-based walking programs, such as the Arthritis Program's Walk with Ease (Callahan et al., 2011). This program helps adults with arthritis overcome some of the barriers (e.g., fear of injury) to participating in physical activity, and have shown comparable effectiveness related to pain, stiffness, and fatigue outcomes for Hispanic, African American and non-Hispanic white participants (Wyatt et al., 2014; Callahan et al., 2016). Participation in programs such as these may prevent the onset of limitations and improve general health of the 54.4 million US adults with arthritis.

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