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Association of Physical Activity with Late-Life Mobility Limitation Among Women with Total Joint Replacement for Knee or Hip Osteoarthritis

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Abstract

Objective—To examine the association between leisure-time physical activity (PA) and survival to age 85 with mobility limitation or death before age 85 after total knee (TKR) or total hip (THR) replacement for osteoarthritis.

Methods—This was a prospective study among participants from the Women's Health Initiative (WHI), recruited during 1993–1998 (baseline age, 65–79 years) and followed through 2012. Medicare claims data were linked to WHI data to determine TKR (n=1,986) and THR (n=1,034). Self-reported PA was collected before total joint replacement (TJR).

Results—Women who were physically inactive before THR had the highest risk of mobility limitation at age 85 (odds ratio [OR]=2.36; 95% CI [CI]=1.30–4.26) compared with women who had the highest amount of PA (>17.42 MET-hours/week). Women who reported no moderate-to-vigorous PA (MVPA) before THR had the strongest risk of mobility limitation (OR=2.00; 95% CI=1.24–3.22) compared with women with the highest level of MPVA (≥15 MET-hours/week). Women who were physically inactive before TKR had the highest risk of mobility limitation (OR=1.68; 95% CI=1.15–2.45) compared with women who had the highest PA level. Women who reported no MVPA before TKR had the strongest risk of mobility limitation (OR=1.60; 95% CI=1.16–2.19) compared with women with the highest level of MPVA. There were significant dose-response associations of lower PA levels with increased risk of late-life mobility limitation and death.

Conclusion—Women with lower PA levels before TJR were more likely to experience mobility limitation in late life following TJR for hip or knee OA.

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Keywords

arthroplasty; osteoarthritis; functional outcomes; physical activity; knee; hip

INTRODUCTION

Osteoarthritis (OA) is a major cause of disability among older people, affecting one in eight adults (1,2). Total joint replacement (TJR) surgery, including total hip (THR) and total knee (TKR) replacements, may be considered in cases of severe OA (3,4). More than one million THRs and TKRs are performed annually in the United States (5). With the growth of the aging population and rising OA prevalence, utilization of THRs and TKRs will increase four-fold by 2030 (2,6). However, few studies have followed OA patients and TJR recipients prospectively into late life to understand patterns of functional changes and to define strategies to prevent mobility limitation among those who survive into very old age.

Physical activity (PA) has been recommended for the successful management of OA and may improve physical function among patients with severe OA (7–12). In a randomized controlled trial among older adults with knee OA, participation in an aerobic exercise program was associated with less physical disability, less knee pain, and better physical performance 18 months after the trial (10). Some studies have observed that PA may lead to better function before TJR (13–15). Men and women scheduled to undergo THR who participated in a 6-week exercise program showed greater improvements in physical function scores before surgery (15). However, little attention has been placed on the relationship between PA before TJR and long-term functional health after surgery (15–18). Previous studies yielded conflicting results on the potential impact of pre-surgery exercise programs on post-surgery functional outcomes among TJR patients. Two prior studies observed that pre-surgery PA did not improve functional outcomes a year after surgery (15,16), but a randomized controlled trial showed that an 8-week, tailored exercise program before THR resulted in better physical function six months after surgery (17).

Maintaining mobility in old age is a key component of successful aging and is an important public health goal for OA patients (1,19). Previous studies among the general population showed that regular PA is associated with better mobility and physical function later in life (20–24). However, to our knowledge, no study has determined whether pre-operative PA is associated with maintaining mobility in old age among a cohort of patients who underwent TJR for OA. A potential link would strengthen the evidence base supporting increase of PA levels before TJR among hip and knee OA patients.

Using prospective data from the Women's Health Initiative (WHI), we examined associations between leisure-time PA levels before TJR and survival to age 85 with mobility limitation or death before age 85 among women who underwent THR or TKR for OA.

MATERIALS AND METHODS

Study Population and Design

The WHI is a longitudinal study investigating determinants of chronic diseases in women. The study design has been previously described (25). Briefly, a cohort of 161,808 postmenopausal women aged 50 to 79 years was recruited from 40 United States clinical centers during 1993–1998. Women participated in one or more of three Clinical Trials (N=68,133), including one of two Hormone Therapy trials, or an Observational Study (N=93,676). In 2005, 77% of eligible women agreed to be followed through 2010 in the first Extension Study. In 2010, 87% of eligible women enrolled in an additional five years of follow-up in the second Extension Study. Our study was exclusive to women ages 65 years and older who were continuously enrolled in fee-for-service Medicare from baseline until the end of follow-up in 2012, and who underwent THR (N=1,034) or TKR (N=1,986) for OA at any time during follow-up (see Supplementary Methods and Supplementary Figures 1 and 2). Medicare claims data were used to identify THR and TKR. All participants provided written informed consent. This study complied with the Declaration of Helsinki and was approved by the Human Research Protections Program at the University of California, San Diego (Protocol No. 161486).

Physical Activity Assessment

At the baseline visit, women completed a questionnaire assessing usual participation in leisure-time PA. The questionnaire was completed on average 6.7 (standard deviation [SD] 3.7) years before TJR. The questionnaire has acceptable reliability, with high intraclass correlation coefficients for moderate-to-vigorous PA (MVPA) (r=0.77) and total PA (r=0.76) (26). Participants were asked how often they walk outside the home for more than 10 minutes without stopping, the duration of walking, and walking speed. Frequency categories were rarely or never, 1–3 times/month, 1 time/week, 2–3 times/week, 4–6 times/week, and ≥7 times/week. Duration categories for walking included <20 minutes, 20–39 minutes, 40–59 minutes, and ≥1 hour. Categories for walking speed included casual (slower than normal) strolling (<2 miles per hour [mph]), average or normal (2–3 mph), fairly fast (3–4 mph), and very fast (>4 mph). Participants reported how often and for how long at each session they participated in activities of light (e.g., slow dancing, bowling, and golf), moderate (e.g., biking outdoors, calisthenics, and easy swimming), and vigorous (i.e., that increased heart rate and produced sweating such as aerobics, aerobic dancing, and jogging) intensities. Frequency categories were none and 1, 2, 3, 4, or ≥5 days/week. Duration categories were <20 minutes, 20–39 minutes, 40–59 minutes, and ≥1 hour.

Midpoint values for ranges of frequency and duration of PA sessions were imputed, and the product of frequency and duration was used to create "hours/week (h/wk)" variables. Metabolic equivalent (MET) values were assigned for vigorous, moderate, and light activities as 7, 4, and 3 METs, respectively (27). MET values for walking were assigned as 5, 4, 3, and 2 for very fast, fast, average or normal, and casual, respectively. The MET level was then multiplied by h/wk to compute separate variables for walking, light, moderate, and vigorous activities in MET-h/wk. MVPA was computed as the sum of average or normal and fast walking, moderate activity, and vigorous activity. Total PA was computed by summing across all activities.

Total PA and walking were divided into four categories, including 0 MET-h/wk and tertiles for the remainder of the data. MVPA was categorized as 0, >0 to <7.5, 7.5 to <15, and ≥15 MET-h/wk according to current federal guidelines recommending ≥7.5 MET-h/wk of MVPA (28). Women with 0 MET-h/wk of total PA (i.e., who reported rarely or never walking and no light PA or MVPA) were defined as being "physically inactive."

Covariates

Participants reported demographic characteristics, lifestyle behaviors, and medical history at baseline via questionnaires. Demographic characteristics included race/ethnicity, education, income, and marital status. Lifestyle behaviors included smoking and alcohol consumption. Trained clinic staff measured height and weight at baseline. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared and categorized into established cutpoints: normal-weight (≤24.9 kg/m^2), overweight (25–29.9 kg/m^2), and obese (≥30 kg/m^2) (29). Additional baseline covariates were self-rated health, joint pain or stiffness, and hormone therapy use, which was defined according to self-reported use and participation in the hormone therapy trials. Depressive symptoms were measured using the Burnham scale [30]. The Medicare data file was used to collect information on age at TJR.

Information on chronic diseases associated with loss of mobility (31–33), including coronary heart disease, stroke, congestive heart failure, peripheral arterial disease, diabetes, cancer, and hip fracture, was self-reported at baseline. Incident diseases were identified during study follow-up through periodic clinic visits and mailed questionnaires administered biannually to Clinical Trial participants and annually to Observational Study and Extension Study participants. All diseases, except for diabetes, were adjudicated by physician review of medical records. Diabetes was defined as self-reported physician diagnosis of diabetes treated with either oral medication or insulin, which has been previously validated (34).

Outcomes

Women were classified as having survived to age 85 or died before this age. Deaths were verified by physician adjudication using hospital records, autopsy or coroner's reports, or death certificates. To ensure complete mortality follow-up, periodic linkage to the National Death Index was performed for all participants, including those lost to follow-up.

Late-life mobility status was assessed with the physical function subscale of the 36-item Short Form Health Survey (35), which participants completed annually after 2005. Among women who survived to age 85, mobility limitation was defined as reporting limitations in the ability to walk one block or climb one flight of stairs (31,32). The most recent measures with the least missing data that were collected within two years of the 85th birth year were used. Three possible aging outcomes were defined, similar to previous aging studies (36,37): survived to age 85 with mobility limitation; survived to age 85 with intact mobility (reference); or died before age 85. The age of 85 was selected because in US census reports, individuals ages 85 years and older comprise the "oldest-old" population, which is the fastest growing segment of the population ages 65 years and older (38).

Statistical Analysis

Baseline characteristics were compared across quartiles of total leisure-time PA using chi-square tests for categorical variables, and analysis of variance for normally distributed and Kruskal-Wallis tests for non-normally distributed continuous variables.

The analytic approach for this study was similar to that from previous prospective studies examining aging outcomes, in which the focus is not on associations with time-to–disability or -mortality, but rather mobility at advanced age or death before advanced age (36,37). Multinomial logistic regression models were used to examine associations between PA variables and the mobility outcome. Separate models were fit for total leisure-time PA, MVPA, walking, and walking speed as the primary exposures. Analyses were conducted separately for THR and TKR. Multivariable models were adjusted for age at first THR or TKR, race/ethnicity, study membership (Observational Study or Clinical Trial), education, baseline marital status, baseline alcohol consumption, baseline smoking, baseline BMI, hormone therapy use, number of chronic diseases, baseline depression, and occurrence of a second THR (or TKR). Models for THR were also adjusted for utilization of TKR and vice versa. Additional models were adjusted for baseline mobility to determine whether this factor mediated associations between PA variables and late-life mobility. To test for linear trend associations, continuous measures of PA variables were included in multivariable models. Interactions between PA variables and age at TJR and BMI were also tested.

In sensitivity analyses, to check for potential bias due to missing late-life functional data, women who survived to age 85 but had missing mobility data were assumed to have late-life mobility limitation in the models. A sensitivity analysis excluding women who received a TJR within two years of the baseline study visit was also conducted to determine if severe cases of hip or knee OA at the time of the baseline PA assessment biased findings. Finally, to determine if the timing of PA assessment biased findings, additional models were adjusted for number of years between the PA questionnaire and TJR.

P-values were two-sided and significant at $P<0.05$. Statistical analyses were conducted using SAS Version 9.3 (SAS Institute, Cary, NC).

RESULTS

The mean age at baseline was 69.5 (SD, 3.0; range, 65–79) years in the overall cohort. Women were followed for an average of 8.1 (SD, 3.5; range, 3–18) years after TJR. Furthermore, 94.9% were white, 3.0% were African American, and 2.2% were other racial/ethnic groups. In the THR cohort, 47.7% had mobility limitation at age 85, 35.3% had intact mobility at age 85, and 17.0% died before age 85. The mean age at first THR was 77.7 (SD 3.9; range, 67–84) years. In total, 20.6% had a second THR, 4.8% had a revision hip procedure, and 17.8% had TKR. In the TKR cohort, 48.7% had mobility limitation at age 85, 31.7% had intact mobility at age 85, and 19.6% died before age 85. The mean age at first TKR was 77.5 (SD 4.0; range, 67–84) years. Overall, 28.5% had a second TKR, 3.8% had a knee revision procedure, and 9.4% had THR.

At baseline, women with higher levels of total PA were more likely to be college graduates, have higher income, currently consume alcohol, and have excellent or very good self-rated health (Table 1). They were less likely to be obese, have depressive symptoms, have a history of chronic diseases, or report severe joint pain or stiffness at baseline. Women with lower PA levels were more likely to have mobility limitation at baseline. Half of women who reported not participating in any PA had baseline mobility limitation.

Relative to women with THR with the highest level of total PA (>17.42 MET-h/wk), physically inactive women (odds ratio [OR]=2.36; 95% confidence interval [CI]=1.30–4.26) had the highest odds of mobility limitation at age 85 (*p* for trend <0.001) in the multivariable model (Table 2). Compared with women with THR who reported ≥15 MET-h/wk of MVPA, the odds of mobility limitation were significantly higher for lower levels of MVPA and were highest in women with no MVPA (OR=2.00; 95% CI=1.24–3.22; *p* for trend <0.001). Relative to women with the highest amount of walking (>6.25 MET-h/wk), the odds of mobility limitation were strongest among women who did not engage in any walking (OR=1.81; 95% CI=1.20–2.72; *p* for trend=0.003). Furthermore, the odds of mobility limitation were approximately two-fold higher among women who reported casual (i.e., slower than normal) compared with fast walking speed (*p* for trend=0.02). There were significant dose-response associations of total PA, MVPA, walking, and walking speed with death before age 85. In models adjusting for baseline mobility, findings were no longer significant (data not shown).

Inactive women with TKR had the highest odds of mobility limitation at age 85 (OR=1.68; 95% CI=1.15–2.45) and dying before age 85 (OR=1.79; 95% CI=1.09–2.95) compared with women who were the most physically active before TKR (*p* for trend for mobility=0.007 and *p* for trend for death=0.02) (Table 3). Compared with women engaging in ≥15 MET-h/week of MVPA, those with lower levels of MVPA had significantly increased odds of mobility limitation (*p* for trend=0.002). Women with no MVPA had a two-fold increased risk of dying before 85 years (OR=2.24; 95% CI=1.47–3.42; *p* for trend=0.01). Women with casual relative to fast walking speed had increased odds of mobility limitation (*p* for trend=0.007) and death (*p* for trend<0.001). After adjusting for baseline mobility, PA variables were no longer significantly associated with late-life mobility or death (data not shown).

Findings did not vary by age at TJR or BMI. In sensitivity analyses, findings were not altered after excluding women who underwent a THR or TKR within two years of the baseline study visit. In sensitivity analyses assuming that women who survived to age 85 with missing data for mobility had late-life mobility limitation in the multivariable models, findings were similar. Adjustment for number of years between PA assessment and TJR did not alter the findings (data not shown).

DISCUSSION

In this prospective study, women who engaged in lower amounts of total PA and MVPA before TJR for hip or knee OA had increased risk of late-life mobility limitation as well as death. Risks for poor mobility and death were also significantly increased among women with slower walking speed. These findings were independent of demographic characteristics, lifestyle behaviors, BMI, and chronic conditions that may impair function. Our data underscore that a large proportion of women with hip or knee OA may reach old age with poor mobility despite TJR.

Among the general population, PA levels measured in midlife or early old age predicted mobility and physical functioning later in life (20–24). A community-based study among older men and women observed that regular PA (i.e., walking, gardening, or vigorous exercise) at least 3 times/week was associated with maintaining the ability to walk a half mile or up and down stairs without help four years later (24). Among men and women aged 70 to 89 years, a PA intervention compared with a health education program was associated with decreased risk of developing mobility disability, defined as the inability to walk 400 meters without help (22). Our findings build upon previous research by examining a cohort consisting exclusively of OA patients, an important consideration given that OA is a leading cause of disability among older adults (1).

Although there is some evidence that PA may improve physical function before TJR (14), it is unclear whether it optimizes long-term post-operative outcomes, because most studies have been limited by short post-surgery follow-up periods (15–17,39,40). A 6-week exercise intervention immediately before THR or TKR did not improve functional outcomes at six months after surgery (15). However, the long-term effectiveness of PA in minimizing disability among OA patients may depend on remaining physically active over time. For example, hip and knee OA patients who remained adherent to recommended home exercises for up to five years showed greater improvements in physical function (11). The dose-response associations of total PA, MVPA, and walking with mobility in old age and death in our study suggest that there may be long-term advantages in being physically active for women with hip or knee OA. Furthermore, the stronger associations of PA with mobility limitation among women with THR than TKR support future studies examining whether PA confers greater benefit for patients with hip or knee OA.

Some studies showed that patient PA levels do not change post-operatively, despite evidence that PA after TJR is associated with improved function (39,41–43). The research to date demonstrates that there may be advantages in PA both pre- and post-operatively. Accordingly, instilling behavioral change among TJR patients to participate in greater amounts of PA may be important for improvement of functional health in the long term.

We found that women with slower self-reported walking speed had increased risk of mobility limitation and death. Faster walking speed has been associated with decreased risk of knee OA (44). Among non-disabled older adults, walking speed is a predictor of future disability and mortality (45). Our results suggest that walking speed may also be a marker of future aging outcomes among OA patients with TJR.

The benefits of PA in the setting of OA include attenuation of joint loading, maintenance of joint stability, and assistance with joint motion and elasticity of periarticular tissues, all of which are important to maintaining function (1). Extended periods of inactivity due to OA increase risk of obesity, cardiovascular disease, and other conditions that may lead to poor function (1); however, our findings were independent of these diseases. All women who joined the WHI were ambulatory at baseline. Nonetheless, we observed that women who were less physically active were more likely to have difficulty walking one block or climbing one flight of stairs at baseline. Moreover, after controlling for baseline mobility, dose-response associations of PA with late-life mobility limitation and death were no longer significant. Because baseline PA and mobility were both assessed at the same study visit, we could not determine whether PA resulted in better mobility before TJR and consequently in late life. Notably, it was previously shown that OA patients with better pre-operative function achieved greater improvements in function after THR and TKR; however, factors such as PA that could result in better pre-operative function were not assessed (46).

Limitations of our study include self-reported PA and lack of information on strength, resistance, and flexibility exercises. Self-reported PA correlates weakly with objectively-measured PA, which may provide a better estimate of time spent in activities of varying intensity (47). Although we categorized PA levels resulting in loss of power, we also tested linear trend associations using continuous measures. We lacked information on specific types (e.g., household or work-related) of activity. Self-reported total energy expenditure from the WHI PA questionnaire correlates weakly with objectively-measured total energy expenditure, and thus may be prone to measurement error (48). PA was collected at baseline and several years before TJR. However, this approach is consistent with previous studies linking PA patterns in midlife and early old age to late-life disability (20–24). Our study consisted only of fee-for-service beneficiaries, thus findings may not be generalized to women enrolled in Medicare managed care plans. In the WHI, fee-for-service beneficiaries are more likely to be white and of a higher socioeconomic status. Because 95% of women in this sub-cohort of WHI women were white, we could not evaluate ethnic differences. Many women who survived to age 85 had missing information on late-life mobility. However, after fitting models assuming that these women had late-life mobility limitation, findings were similar, suggesting that our findings were not biased by missing outcome data. Our study was focused on examination of healthy aging outcomes in TJR recipients and did not address if PA levels were associated with increased risk of mortality among TJR survivors.

A strength of our study is the population-based sample of women followed for a long period of time after TJR, which provided the unique opportunity to assess late-life functional outcomes. The combination of WHI and Medicare data was a rich resource to examine the association of PA with late-life functional outcomes and death.

In conclusion, women with higher levels of total PA, MVPA, and walking, as well as faster walking speed, before TJR for hip or knee OA were more likely to have intact mobility in late life and have decreased risk of death. Additional studies are warranted to determine whether engaging in PA before TJR reduces risk of disability among patients with severe hip or knee OA.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Baseline Characteristics by Total Physical Activity Among Older Women with Total Joint Replacement for Osteoarthritis

	Total Physical Activity, MET-hours/week				*P*-value
	0 (N=371)	**>0 to 7 (N=789)**	**>7 to 17.42 (N=839)**	**>17.42 (N=819)**	
Age, years, mean (SD)	69.8 (3.1)	69.7 (2.9)	69.4 (2.9)	69.4 (2.9)	0.01
Race/ethnicity, no. (%)					
	(N=370)	(N=787)	(N=836)	(N=816)	
White	352 (95.1)	735 (93.4)	795 (95.1)	783 (96.0)	
African American	9 (2.4)	32 (4.1)	24 (2.9)	18 (2.2)	0.36
Other	9 (2.4)	20 (2.5)	17 (2.0)	15 (1.8)	
Education, no (%)					
	(N=370)	(N=786)	(N=836)	(N=816)	
Less than high school	14 (3.8)	31 (3.9)	21 (2.5)	19 (2.3)	
High school	85 (23.0)	153 (19.5)	114 (13.6)	103 (12.6)	
Some college	151 (40.8)	296 (37.7)	288 (34.5)	267 (32.7)	<0.001
College graduate	120 (32.4)	306 (38.9)	413 (49.4)	427 (52.3)	
Income, no (%)					
	(N=345)	(N=734)	(N=791)	(N=767)	
<$20,000	69 (20.0)	116 (15.8)	107 (13.5)	75 (9.8)	
$20,000–$50,000	174 (50.4)	391 (53.3)	401 (50.7)	370 (48.2)	<0.001
>$50,000	102 (29.6)	227 (30.9)	283 (35.8)	322 (42.0)	
Marital status, no. (%)					
	(N=370)	(N=787)	(N=837)	(N=818)	
Married/living as					
married	227 (61.4)	497 (63.2)	501 (59.9)	517 (63.2)	
Widowed	92 (24.9)	186 (23.6)	212 (25.3)	203 (24.8)	0.71
Divorced/separated	37 (10.0)	69 (8.8)	92 (11.0)	73 (8.9)	
Never married	14 (3.8)	35 (4.5)	32 (3.8)	25 (3.1)	
Alcohol consumption, no (%)					
	(N=367)	(N=783)	(N=839)	(N=816)	
Non-drinker	36 (9.8)	80 (10.2)	87 (10.4)	61 (7.5)	

	Total Physical Activity, MET-hours/week				*P*-value
	0 (N=371)	**>0 to 7 (N=789)**	**>7 to 17.42 (N=839)**	**>17.42 (N=819)**	
Past drinker	83 (22.6)	128 (16.4)	117 (14.0)	83 (10.2)	<0.001
Current drinker	248 (67.6)	575 (73.4)	635 (75.7)	672 (82.4)	
Smoking status, no. (%)					
	(N=362)	(N=783)	(N=830)	(N=816)	
Never smoked	190 (52.5)	421 (53.8)	440 (53.0)	385 (47.2)	
Past smoker	158 (43.7)	329 (42.0)	368 (44.3)	408 (50.0)	0.03
Current smoker	14 (3.9)	33 (4.2)	22 (2.7)	23 (2.8)	
Body mass index, kg/m^2, no (%)					
	(N=367)	(N=783)	(N=831)	(N=810)	
Normal weight	53 (14.4)	164 (21.0)	226 (27.2)	318 (39.3)	
Overweight	114 (31.1)	271 (34.6)	355 (42.7)	287 (35.4)	<0.001
Obese	200 (54.5)	348 (44.4)	250 (30.1)	205 (25.3)	
Hormone therapy use, no. (%)					
	(N=369)	(N=782)	(N=829)	(N=810)	
Never	132 (35.8)	305 (39.0)	280 (33.8)	294 (36.3)	
Past	96 (26.0)	209 (26.7)	221 (26.7)	194 (24.0)	0.19
Current	141 (38.2)	268 (34.3)	328 (39.6)	322 (39.8)	
Self-rated health, no. (%)					
	(N=369)	(N=784)	(N=832)	(N=811)	
Excellent	29 (7.9)	69 (8.8)	115 (13.8)	183 (22.6)	
Very good	119 (32.3)	314 (40.1)	364 (43.8)	358 (44.1)	<0.001
Good	162 (43.9)	339 (43.2)	291 (35.0)	241 (29.7)	
Fair/poor	59 (16.0)	62 (7.9)	62 (7.5)	29 (3.6)	
Burnham depression scale score ≥0.06, no. (%)	(N=361)	(N=773)	(N=823)	(N=794)	
	35 (9.7)	65 (8.4)	62 (7.5)	44 (5.5)	0.05
History of chronic diseases[a], no. (%)	(N=371)	(N=789)	(N=839)	(N=819)	
CHD	41 (11.1)	85 (10.8)	86 (10.3)	64 (7.8)	0.15
Stroke	32 (8.6)	66 (8.4)	55 (6.6)	60 (7.3)	0.46
CHF	30 (8.1)	39 (4.9)	37 (4.4)	21 (2.6)	<0.001

	Total Physical Activity, MET-hours/week				*P*-value
	0 (N=371)	**>0 to 7 (N=789)**	**>7 to 17.42 (N=839)**	**>17.42 (N=819)**	
PAD	22 (5.9)	30 (3.8)	32 (3.8)	27 (3.3)	0.18
Diabetes	75 (20.2)	137 (17.4)	102 (12.2)	118 (14.4)	<0.001
Cancer	110 (29.7)	199 (25.2)	236 (28.1)	233 (28.5)	0.33
Hip fracture	26 (7.0)	52 (6.6)	49 (5.8)	40 (4.9)	0.39
Any disease	226 (60.9)	436 (55.3)	431 (51.4)	420 (51.3)	0.006
Mobility limitation, no. (%)	(N=368)	(N=781)	(N=830)	(N=809)	
	185 (50.3)	243 (31.1)	200 (24.1)	127 (15.7)	<0.001
Joint pain, no. (%)					
	(N=369)	(N=782)	(N=835)	(N=812)	
None	32 (8.7)	92 (11.8)	104 (12.5)	139 (17.1)	
Mild	144 (39.0)	335 (42.8)	406 (48.6)	397 (48.9)	<0.001
Moderate	129 (35.0)	278 (35.6)	249 (29.8)	224 (27.6)	
Severe	64 (17.3)	77 (9.9)	76 (9.1)	52 (6.4)	

Note. Sample sizes for variables in each column do not sum to total due to missing data.

CHD = coronary heart disease; CHF = congestive heart failure; MET = metabolic equivalent of task; PAD = peripheral arterial disease.

[a]Includes baseline and incident chronic diseases.

Table 2

Multivariable Associations of Physical Activity with Mobility Among Women with Total Hip Replacement for Osteoarthritis[a]

	No. survived to 85 with mobility limitation/total (%)	Survived to 85 with mobility limitation[b] OR (95% CI)	No. died before 85/ total (%)	Died before 85[b] OR (95% CI)
Total physical activity, MET-hours/week[c]				
0	67/117 (57.3)	2.36 (1.30–4.26)	25/117 (21.4)	2.18 (0.98–4.84)
>0 to 7	149/286 (52.1)	1.74 (1.16–2.61)	59/286 (20.6)	2.36 (1.32–4.22)
>7 to 17.42	151/320 (47.2)	1.23 (0.85–1.78)	49/320 (15.3)	1.49 (0.85–2.62)
>17.42	126/311 (40.5)	1 [Ref]	43/311 (13.8)	1 [Ref]
Moderate-to-vigorous physical activity, MET-hours/week[d]				
0	107/198 (54.0)	2.00 (1.24–3.22)	41/198 (20.7)	2.03 (1.06–3.91)
>0 to <7.5	145/283 (51.2)	1.83 (1.23–2.71)	54/283 (19.1)	2.12 (1.20–3.74)
7.5 to <15	114/228 (50.0)	1.63 (1.09–2.43)	34/228 (14.9)	2.00 (1.09–2.43)
≥15	127/325 (39.1)	1 [Ref]	47/325 (14.5)	1 [Ref]
Walking[e]				
0	166/312 (53.2)	1.81 (1.20–2.72)	64/312 (20.5)	2.05 (1.13–3.72)
>0 to 2.5	102/211 (48.3)	1.58 (1.02–2.45)	47/211 (22.3)	2.65 (1.42–4.95)
>2.5 to 6.25	102/224 (45.5)	1.15 (0.77–1.72)	33/224 (14.7)	1.20 (0.64–2.27)
>6.25	123/287 (42.9)	1 [Ref]	32/287 (11.2)	1 [Ref]
Walking Speed[f]				
Casual (slower than normal)	103/210 (49.1)	1.90 (1.13–3.20)	54/210 (25.7)	2.08 (1.03–4.19)
Average or normal	227/468 (48.5)	1.24 (0.83–1.83)	59/468 (12.6)	0.91 (0.50–1.65)
Fast	79/196 (40.3)	1 [Ref]	27/196 (13.8)	1 [Ref]

CI = confidence interval; OR = odds ratio.

[a]Reference group is survived to age 85 with intact mobility.

[b]Adjusted for age at first total hip replacement, study membership, education, race/ethnicity, baseline marital status, baseline alcohol consumption, baseline smoking, baseline body mass index, total number of chronic diseases, hormone therapy use, baseline depression, second total hip replacement, and total knee replacement.

[c]N for multivariable analyses = 960. *P for trend* (mobility limitation) = <0.001; *P for trend* (death) = 0.02.

[d]N for multivariable analyses = 960. *P for trend* (mobility limitation) = <0.001; *P for trend* (death) = 0.03.

[e]N for multivariable analyses = 960. *P for trend* (mobility limitation) = 0.003; *P for trend* (death) = 0.01.

[f]N for multivariable analyses = 820. *P for trend* (mobility limitation) = 0.02; *P for trend* (death) = 0.03.

Table 3

Multivariable Associations of Physical Activity with Mobility Among Women with Total Knee Replacement for Osteoarthritis[a]

	No. survived to 85 with mobility limitation/total (%)	Survived to 85 with mobility limitation[b] OR (95% CI)	No. died before 85/ total (%)	Died before 85[b] OR (95% CI)
Total physical activity, MET-hours/week[c]				
0	144/275 (52.4)	1.68 (1.15–2.45)	69/275 (25.1)	1.79 (1.09–2.95)
>0 to 7	281/556 (50.5)	1.39 (1.04–1.85)	127/556 (22.8)	1.61 (1.09–2.38)
>7 to 17.42	289/580 (49.8)	1.24 (0.94–1.62)	100/580 (17.2)	1.11 (0.75–1.64)
>17.42	254/575 (44.2)	1 [Ref]	93/575 (16.2)	1 [Ref]
Moderate-to-vigorous physical activity, MET-hours/week[d]				
0	225/455 (49.5)	1.60 (1.16–2.19)	125/455 (27.5)	2.24 (1.47–3.42)
>0 to <7.5	261/500 (52.2)	1.39 (1.04–1.84)	94/500 (18.8)	1.44 (0.96–2.18)
7.5 to <15	219/436 (50.2)	1.39 (1.03–1.86)	82/436 (18.8)	1.49 (0.98–2.27)
≥15	263/595 (44.2)	1 [Ref]	88/595 (14.8)	1 [Ref]
Walking[e]				
0	334/660 (50.6)	1.52 (1.12–2.05)	161/660 (24.4)	1.35 (0.90–2.02)
>0 to 2.5	218/444 (49.1)	1.21 (0.89–1.67)	91/444 (20.5)	1.17 (0.76–1.80)
>2.5 to 6.25	225/437 (51.5)	1.20 (0.88–1.63)	57/437 (13.0)	0.66 (0.41–1.04)
>6.25	191/445 (42.9)	1 [Ref]	80/445 (18.0)	1 [Ref]
Walking Speed[f]				
Casual (slower than normal)	219/458 (47.8)	1.66 (1.16–2.38)	125/458 (27.3)	2.73 (1.62–4.59)
Average or normal	406/830 (48.9)	1.33 (0.99–1.80)	131/830 (15.8)	1.42 (0.88–2.29)
Fast	138/317 (43.5)	1 [Ref]	36/317 (11.4)	1 [Ref]

CI = confidence interval; OR = odds ratio.

[a]Reference group is survived to age 85 with intact mobility.

[b]Adjusted for age at first total knee replacement, study membership, education, race/ethnicity, baseline marital status, baseline alcohol consumption, baseline smoking, baseline body mass index, total number of chronic diseases, hormone therapy use, baseline depression, second total knee replacement, and total hip replacement.

[c]N for multivariable analyses = 1863. *P for trend* (mobility limitation) = 0.007; *P for trend* (death) = 0.02.

[d]N for multivariable analyses = 1863. *P for trend* (mobility limitation) = 0.002; *P for trend* (death) = 0.01.

[e]N for multivariable analyses = 1863. *P for trend* (mobility limitation) = 0.01; *P for trend* (death) = 0.25.

[f]N for multivariable analyses = 1510. *P for trend* (mobility limitation) = 0.007; *P for trend* (death) = <0.001.