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Relationship of Meeting Physical Activity Guidelines with Quality Adjusted Life Years

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Abstract

Objective—The Quality Adjusted Life Year (QALY) is a standard outcome measure used in cost-effectiveness analyses. This study investigates whether attainment of federal physical activity guidelines is associated with higher QALY estimates among adults with or at increased risk for knee osteoarthritis.

Methods—This is a prospective study of 1794 Osteoarthritis Initiative participants. Physical activity was measured using accelerometers at baseline. Participants were classified as 1) Meeting Guidelines (≥ 150 minutes of moderate-to-vigorous [MV] activity per week acquired in sessions 10 minutes), 2) Insufficiently Active (< 1 MV session[s]/week but below guideline), or 3) Inactive (zero MV sessions/week). A health-related utility score was derived from participant responses to the 12 item Short-Form Health Survey at baseline and two years later. QALY was calculated as the area under utility curve over two years. Relationship of physical activity level to median QALY adjusted for socioeconomic and health factors was estimated using quantile regression.

Results—Relative to the Inactive, median QALYs over two years were significantly higher for the Meeting Guidelines (0.112, 95% confidence interval [CI] 0.067–0.157) and Insufficiently Active (0.058, 95% CI 0.028–0.088) groups controlling for socioeconomic and health factors.

Conclusion—We found a significant graded relationship between greater physical activity level and higher QALYs. Using the more conservative estimate of 0.058, if an intervention could move someone out of the Inactive group and costs <\$2900 over two years, it would be considered cost

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effective. Our analysis supports interventions to promote physical activity even if recommended levels are not fully attained.

INTRODUCTION

Physical inactivity is an independent risk factor for developing chronic diseases including obesity, cardiovascular disease, diabetes, depression, and cancer (1). Conversely, regular physical activity improves health and reduces mortality (2–3). Furthermore, physical activity promotes arthritis-specific health benefits and is an integral part of treatment for osteoarthritis (OA) (4–7). Despite growing knowledge and public awareness, the majority of adults in the United States (US) do not attain recommended amounts of physical activity. Sedentary lifestyle is not only a public health problem but an economic burden due to costs associated with the treatment of inactivity-related diseases and injuries, lost productivity, and diminished quality of life (8). It is estimated that the annual cost directly attributable to inactivity in the US is \$24–76 billion, or 2.4–5% of national health care expenditure (8–10). Therefore, promoting physical activity is an important component in promoting overall health, addressing the epidemic of obesity and other chronic illnesses, and reducing healthcare costs in the long term.

Recognizing its importance, the US Department of Health and Human Services (DHHS) released physical activity guidelines in 2008 that recommend at least 150 minutes per week of moderate-to-vigorous (MV) activity done in sessions lasting at least 10 minutes (11) for all adults, including persons with arthritis. However, no study has used objectively measured physical activity to assess whether meeting guidelines translates into better quality of life among those with or at increased risk for OA, or whether interventions to increase physical activity would be cost-effective for this population. Cost-effectiveness analysis can be conducted using the Quality Adjusted Life Year (QALY), which is an outcome measure that captures multiple health benefits. This study investigated the relationship between QALY estimates and physical activity level among adults with or at increased risk for knee OA. Specifically we evaluated the differences in QALY estimates among three activity groups - inactive individuals who participated in no sessions of MV activity, insufficiently active individuals participating in MV activities but not meeting guidelines, and active individuals meeting federal guidelines.

METHODS

Study Sample

This study used prospective data from participants of the accelerometer ancillary study of the Osteoarthritis Initiative (OAI) conducted at baseline (OAI 48-month visit) with follow-up two years later (OAI 72-month visit). The OAI is a multi-center prospective study investigating risk factors and biomarkers for the progression and/or onset of knee OA (see <http://www.oai.ucsf.edu/datarelease/About.asp>). At enrollment, the OAI recruited 4796 men and women aged 45–79 with or at increased risk for developing symptomatic, radiographic knee OA (Figure 1). Knee OA risk factors included the following: knee symptoms in a native knee in the past 12 months; being overweight; knee injury causing difficulty walking for at least a week; history of any knee surgery; family history of a total knee replacement

for OA in a biological parent or sibling; Heberden's nodes; repetitive knee bending at work or outside of work; and age 70–79 years (12). The OAI excluded participants with rheumatoid or inflammatory arthritis, severe joint space narrowing in both knees or unilateral total knee replacement and severe joint space narrowing in the other knee, bilateral total knee replacement or plans to have bilateral knee replacement in the next 3 years, inability to undergo a 3.0T Magnetic Resonance Imaging (MRI) exam of the knee because of contraindications or inability to fit in the scanner or in the knee coil, positive pregnancy test, inability to provide a blood sample for any reason, use of ambulatory aides other than a single straight cane for more than 50% of the time in ambulation, comorbid conditions such as active cancer that might interfere with the ability to participate in a 4-year study, and current participation in a double-blind randomized trial. Knee radiographs were acquired annually using a “fixed-flexion” knee radiography protocol (13), including bilateral, standing, posteroanterior knee films with knees flexed to 20–30° and feet internally rotated 10° using a plexiglass positioning frame. Longitudinal radiographic changes were assessed by a single vendor (14).

Outcome Measure: Quality Adjusted Life Years (QALYs)

QALYs were calculated using health-related utility at baseline (OAI 48-month visit) and follow up two years later (OAI 72-month visit). Health related utility was measured by the Short Form 6D (SF-6D) utility score, a preference-based single index measure for health. Based on scoring algorithms developed by Brazier et al., the SF-6D utility was converted from the 12 item Short-Form Health Survey (SF-12) using the weights representing societal values of health states estimated from a random sample of the general adult population (15–16). More specifically, the SF-6D measures the following six health domains: physical functioning, role limitations, social functioning, pain, mental health, and vitality. For example, the pain domain varies from having no pain to having pain that severely interferes with work (both outside the home and housework). The SF-6D utility scores range from 0.0 (death, worst health state) to 1.0 (full health, best health state) with a minimally important difference of 0.033 (standard deviation 0.004) (17). An online program (<http://www.shef.ac.uk/scharr/sections/heds/mvh/sf-6d>) was used to convert SF-12 to SF-6D. QALY was calculated as the area under the health-related utility curve (i.e. the integral) over two years; for example, two years spent in perfect health would produce a QALY measure of 2.0, with any infirmities decreasing this value. Conceptually, an intervention that improves health-related utility will produce a gain in QALY over the 2 years period. QALY gained can then be incorporated with medical cost to arrive at cost effectiveness ratio (CER), which is expressed as additional cost per QALY gained. By convention, CER \$50,000 per QALY gained per person is considered cost effective.

Physical Activity Measures

Physical activity was measured at baseline (OAI 48-month visit) using GT1M ActiGraph accelerometer (ActiGraph; Pensacola, FL), a small uniaxial accelerometer that measures vertical acceleration and deceleration (18). The accuracy (19) and test-retest reliability (20) of ActiGraph accelerometers under field conditions have been established in many populations including persons with OA (21). Participants were instructed to wear the accelerometer on a belt at the natural waistline on the right hip in line with the right axilla

upon arising in the morning and continuously until retiring at night, except during water activities, for seven consecutive days. A daily log was maintained by the participants to record time spent in water and cycling activities to estimate the amount of physical activity not fully captured by accelerometers. Skipped days reported on the log were excluded from the analysis.

Accelerometer output is an activity count per minute, which is the sum of the number of accelerations weighted by the magnitude of each acceleration. Accelerometer data were analytically filtered using methodology validated in patients with rheumatic disease (22–23). Non-wear periods were defined as 90 minutes with zero activity counts, with allowance for up to two consecutive minutes of counts between 1–100 (23). A valid day of monitoring was identified by recording evidence of 10 or more wear hours per day (24). To provide reliable physical activity estimates, we restricted analyses to participants with 4–7 days of valid accelerometer monitoring (24).

Activity count cut point 2020 per minute was used as threshold for MV activity (24). Daily minutes of MV physical activity occurring in sessions lasting 10 or more consecutive minutes (with allowance for interruptions of up to 2 minutes below threshold) were calculated. Weekly totals were summed from the daily totals for persons with 7 valid days of monitoring or estimated as 7 times the average daily total for persons with 4 to 6 valid days of monitoring. Each person was classified into one of three physical activity groups according to the 2008 US DHHS physical activity guidelines: Meeting Guidelines (150 minutes of MV activity per week acquired in sessions 10 minutes), Insufficiently Active (< 1 MV activity session[s] per week but below guideline), or Inactive (zero MV activity sessions per week) (11). Accelerometer data were merged with the OAI public data containing information on participant characteristics.

Covariates

Socioeconomic factors measured at the OAI baseline included self-reported race/ethnicity, age, gender, education, living alone or not, and income. Health factors at OAI 48-month visit included body mass index (BMI), comorbid medical conditions, smoking status, presence of radiographic knee OA, chronic knee symptoms, and prior knee injury. BMI was calculated from measured height and weight (kg/m^2). Participants were classified as normal weight (BMI 18.5–24.9), overweight (BMI 25.0–29.9), or obese (BMI ≥ 30). Comorbidity score was estimated using the modified Charlson comorbidity index (25). A positive response to the question, “Did you have pain, aching, or stiffness on most days of a month during the past year?” was used to ascertain presence of chronic knee symptoms. Radiographic knee OA was defined by a Kellgren-Lawrence (KL) grade ≥ 2 in at least one knee. Prior knee injury severe enough to limit ability to walk for at least two days was based on self-report. Health factors missing at the 48-month visit were substituted with data from the most recent OAI annual visit.

Statistical Analysis

Descriptive analyses of characteristics were presented by physical activity level. Univariate analyses of baseline trend effects were evaluated by a Mantel Haenszel test for ordinal

categories, chi-square test for nominal variables, and analysis of variance for continuous variables.

In this sample, the distribution of QALY is left-skewed. We applied quantile regression analysis to estimate the association of physical activity levels with QALY scores. Quantile regression is robust to outliers and does not require assumptions regarding the underlining distribution of the outcome to obtain valid inference tests (26). Analyses controlled for socioeconomic and health factors. Stratified analyses were performed by gender and BMI.

Recognizing that systematic differences between persons included and excluded from the analysis sample could influence our findings, we performed weighted analyses recommended by Hogan (27) and Robins (28). Trends and statistical significance of weighted analyses mirrored the unweighted results. For simplicity, unweighted analyses are reported.

Analyses were performed using SAS (version 9.3) and Stata (version 10.0) software. Statistical testing was conducted at a nominal 5% alpha significance level.

RESULTS

Of the 2127 persons who consented to participate in accelerometer monitoring, 333 (15.7%) were excluded from the analysis (106 due to missing 2 year follow-up visit, 168 due to fewer than 4 valid days of physical activity monitoring, and 59 due to missing baseline or 2 year follow-up SF-12 utility scores), leaving 1794 persons available for analysis (Figure 1).

Table 1 presents baseline (OAI 48-month visit) characteristics for each physical activity group. Of the 1794 participants, only 13% met the DHHS physical activity guidelines; almost half (44%) were inactive, and the remainder (43%) were insufficiently active. Compared to the more active groups, the Inactive was more likely to be older, female, ethnically nonwhite, living alone, and have lower income and education level. The Inactive also tended to have more health problems including higher rates of obesity, higher mean comorbidity score, more frequent findings of smoking and chronic knee symptoms.

Better QALY measures were associated with higher physical activity levels. Figure 2 shows the cumulative frequency curves of QALYs stratified by activity level. Each point on the graph represents the proportion (vertical axis) of participants within that activity group with QALY measures equal to or higher than the value on the x-axis. Compared to the age-adjusted QALY (median=1.56) for the Inactive group, that of the Insufficiently Active group was 5.8% higher (median=1.65), and of the Meeting Guidelines group was 10.9% higher (median=1.73). Notably, the lines in Figure 2 are distinctly separated for a broad range of QALYs indicating a positive graded relationship between QALYs and physical activity level.

Figure 3 shows a step-wise rise in age-adjusted median QALY with increased physical activity level within the full cohort as well as gender and BMI status groups. A trend for more benefit of increasing physical activity among women was noted; however this gender effect was not statistically significant.

Table 2 presents the differences in QALY measures by physical activity level adjusting for socioeconomic and health factors. When compared to the Inactive, the median gains in QALYs after controlling for socioeconomic and health factors were 0.058 in the Insufficiently Active group and 0.110 in the Meeting Guidelines group. Similarly, subgroup analyses stratified by gender or BMI demonstrated a statistically significant positive graded relationship between physical activity level and median QALY score. When stratified by knee OA status, there was a trend towards improved QALY with increasing physical activity among those with chronic knee symptoms with or without radiographic knee OA, and that relationship was statistically significant in the subgroup without chronic knee symptoms. Sensitivity analyses tested if QALY differences were greater for the strata with chronic knee symptoms compared to the stratum with no knee symptoms by adding interactions between OA stratum with guideline status to the final model; interactions were not significant. Noteworthy from these stratified analyses is the consistent finding that the Inactive group had lower QALY than more active participants, including the Insufficiently Active group.

By design we eliminated participants who were deceased before the 2 year (OAI-72 month) follow-up visit, however these individuals potentially have the lowest QALY outcomes. A sensitivity analysis was conducted to determine the robustness of results if outcomes from 13 deceased participants were added to the sample and their utility set to zero at the time of death. The results remained unchanged. Sensitivity analyses also examined participants with knee OA compared to those without knee OA, and results were similar among the two categories.

DISCUSSION

We found a significant graded relationship between increasing levels of physical activity and better QALY measures among adults with or at increased risk for knee OA. Our findings held even after adjusting for potential confounders, demonstrating that this relationship is robust. After controlling for socioeconomic and health factors, the absolute increase in median QALY was 0.110 and 0.058 when comparing individuals in the Insufficiently Active and Meeting Guidelines groups to the Inactive group, respectively. These differences are clinically significant as they exceeded the minimally important difference of the SF-6D health utility of 0.033, which is the smallest incremental change that a patient can perceive as beneficial (17). Together, these differences represent an additional 10–20 days of perfect health in a year. These results indicate that increasing levels of physical activity, even below guideline levels, was associated with measurably better QALY outcomes for adults with or at increased risk for knee OA.

Similar findings held in analyses stratified by gender, BMI, and knee OA status. Although women tend to be more sedentary than men (8), both genders experienced significant QALY gain with higher physical activity. The trend is also evident among all BMI status subgroups. However, among those with BMI >30 kg/m², the trend in QALY gained with greater physical activity level did not achieve statistical significance after adjusting for health factors. This finding likely reflects the many obesity-related morbidities beyond physical activity level that confound QALY measures. As these obesity-related morbidities may be part of the causal pathway mediating the effect of physical activity on QALY,

adjusting for health factors may be an over adjustment. Among those with chronic knee symptoms with or without radiographic evidence of knee OA, greater QALYs were found among Meeting Guidelines and Insufficiently Active groups compared to the Inactive group, although those differences were not statistically significant after adjusting for covariates, likely due to smaller subgroup sample sizes. Among participants not reporting chronic knee symptoms, the Meeting Guidelines or Insufficiently Active groups each had significantly greater QALYs than the Inactive group.

The benefits of physical activity have been well documented in the literature. Studies (29–33) in the general population demonstrated a positive effect of physical activity on health status, physical fitness, and various metabolic measures. Randomized controlled trials (RCTs) (34–41) among adults with chronic conditions have shown a positive effect of interventions aimed to increase physical activity and incremental benefit in QALY outcomes. Change in QALY between intervention and control groups in these trials have been reported to range from 0.01 to 0.13 over 12 months. For purposes of comparison, assuming gain in QALY is linear over time, the incremental increase in average one-year age-adjusted QALY outcome (0.029–0.081) within the cohort of our study is consistent with the effect sizes reported in these RCTs.

While these RCTs demonstrate that physical activity interventions improve QALYs, they do not address the benefit of meeting current physical activity guidelines or use objective measures of physical activity. Compared to previous research, our study is distinct in several ways. First, many previous cost-utility trials do not quantify the differences in actual physical activity level between intervention and control groups. Therefore, even though higher QALY outcomes were shown with intervention, they were not directly related to any particular increase in activity level. By classifying participants into objectively measured physical activity groups, we were able to evaluate the association of higher physical activity level with QALY outcomes. This distinction is important as better self-reported health status from physical activity interventions has been found to be independent of change in physical activity level (30). Secondly, we used the federal physical activity guidelines as a benchmark for physical activity level. Several studies (8, 31, 38, 42–44) used similar guidelines to distinguish between those who are physically active and inactive. We also made the distinction between those who perform insufficient amount of MV activity below guideline level and those who were inactive, doing no sessions of MV activity at all. This allowed us to investigate whether activity below recommended guideline levels potentially convey health benefit. Thirdly, we used the accelerometer as an objective measure of physical activity whereas most other trials relied on self-reported measures using questionnaires. It has been shown that people tend to overestimate their level of physical activity (32), and therefore previous studies may have inaccurately estimated the benefit and cost effectiveness of higher physical activity levels. Lastly, our study population was comprised of those with or at increased risk for knee OA. This is an especially important target population because physical activity is an integral part of treatment for knee OA, yet knee OA often severely limits one's ability to pursue an active lifestyle. Our findings indicate physical activity is related to potential health benefits for all adults with or at increased risk for knee OA even if recommended levels are not achieved.

There are several public health implications from our findings. First, our results strengthen the case for the effectiveness and cost-effectiveness of physical activity. Cost-utility analyses generally show physical activity interventions to be fiscally viable and cost-effective (8, 42–43, 45). Using the most conservative estimate from our study, a QALY difference of 0.058 over 2 years between the Insufficiently Active and Inactive groups, an intervention that can move an individual out of the inactive group and costs less than \$2900 over the two year period, it will fall below the widely used benchmark of \$50,000 per QALY (46). Secondly, we have shown a graded relationship between physical activity and QALY outcomes. This study provides additional support for efforts to promote physical activity among those with or at increased risk for knee OA. Even though their disease may be physically limiting, increasing activity level, even when guidelines are not met, may translate to considerable benefit over time. Lastly, consistent with other studies (47), women in our sample tended to be more inactive and therefore should receive more attention for targeted intervention.

Strengths of our study include the large sample size, objective measurement of physical activity by accelerometer monitoring, and analysis by physical activity group using the benchmark DHHS physical activity guidelines. However, several limitations should be considered. First, longitudinal follow-up is limited to two years; therefore long term effects of physical activity cannot be implicated from this study. However, studies modeling lifelong effects of physical activity have suggested that longer periods of evaluation are associated with more favorable cost-effectiveness ratio as the benefit of increasing physical activity compounds over a life time (8, 42, 45). Secondly, this is a longitudinal cohort study, and these associations do not necessarily imply causation. Thirdly, it is recognized that accelerometers lack information on context of physical activity, and the accelerometer used could not capture water activities and may underestimate activities with minimal vertical movement such as cycling. However, diary information indicated that the underestimate was negligible. Fourthly, participants within the OAI or this accelerometer ancillary study are not chosen from a probability sample, and excluded persons with comorbidities limiting their study participation thus our findings may not be generalizable to all with or at increased risk for knee OA. However, the OAI recruited from multiple sites and across age, ethnicity, and gender categories to minimize selection bias. Lastly, strength and resistance training were not assessed in this study.

CONCLUSION

We showed a strong graded relationship between greater physical activity and better QALY outcomes. Our results support efforts to increase physical activity levels even when recommended physical activity levels are not fully attained. Future intervention studies should assess physical activity outcomes with objective monitoring, which is not subject to the recall bias associated with self-reported measures. Future studies should also focus on the sustainability of interventions that can result in meaningful change in physical activity at a reasonable cost.

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Figure 1.
Flow chart of analytical sample.

Figure 2.
Age-adjusted quality adjusted life years (QALYs) distribution by physical activity groups (n=1794).

Figure 3.

Age-adjusted median 2-year quality adjusted life years (QALYs) among physical activity groups stratified by gender and BMI.

Table 1

Characteristics of adults (n=1794) participating in accelerometer monitoring by physical activity level.

		Meeting Guidelines ^d (n=235) %	Insufficiently Active (n=763) %	Inactive (n=796) %	p-value ^b
Socioeconomic Factors					
Age in years:	<49–55	18.7	17.3	9.8	<0.001
	55–64	44.3	40.5	27.3	
	65 or older	37.0	42.2	62.9	
Gender:	Female	38.7	50.3	63.8	<0.001
	Male	61.3	49.7	36.2	
Race/Ethnicity:	White	96.6	84.9	80.9	<0.001
	African American	2.6	13.6	16.7	
	Other	0.9	1.4	2.4	
Education:	High school or less	6.4	9.2	17.8	<0.001
	College	93.6	90.8	82.2	
Income:	\$50,000	80.0	71.6	53.4	<0.001
	< \$50,000	20.0	28.4	46.6	
Living alone:	Yes	14.0	18.4	24.9	<0.001
	No/unknown	86.0	81.7	75.1	
Health Factors					
Body Mass Index:	<25	40.4	26.7	20.4	<0.001
	25–29.9	43.0	41.3	36.2	
	30	16.6	32.0	43.5	
Comorbidity Score:	Mean	0.3	0.4	0.6	<0.001
	(SD)	(0.8)	(0.9)	(1.1)	
Current Smoker		1.3	3.3	4.8	0.009
Knee OA status:	Chronic Knee Symptoms ^c with Radiographic Knee OA	15.3	26.6	29.5	<0.001
	Chronic Knee Symptoms ^c without Radiographic Knee OA	11.9	13.5	12.8	
	No chronic knee symptoms reported ^d	72.8	59.9	57.7	
Prior Knee Injury		58.7	53.9	45.9	<0.001

^aUS Department of Health and Human Services 2008 physical activity guidelines

^bMantel-Haenszel chi-square test for trend (1 d.f.) except for race and gender comparisons, which used chi-square test for overall differences

^cChronic knee symptoms based on report of pain, aching, or stiffness most days of the month during the past year

^dParticipants with or without radiographic knee OA but not reporting chronic knee symptoms

Table 2

Differences in median 2-year quality adjusted life years (QALYs) among physical activity groups stratified by gender, BMI, and knee OA status.

Sample	Adjustment Factors ^a	Difference Meeting Guideline vs. Inactive QALYs (95% CI)	Difference Insufficiently Active vs. Inactive QALYs (95% CI)	p-value for trend
Full Cohort (n=1794)	Age-adjusted Difference	0.162 (0.108, 0.216)	0.081 (0.044, 0.118)	<0.001
	SES factors ^b	0.154 (0.104, 0.204)	0.083 (0.049, 0.117)	<0.001
	SES+ Health factors ^c	0.112 (0.067, 0.157)	0.058 (0.028, 0.088)	<0.001
Stratified by Gender				
Female (n=983)	Age-adjusted Difference	0.203 (0.127, 0.279)	0.084 (0.039, 0.129)	<0.001
	SES factors ^b	0.199 (0.117, 0.281)	0.091 (0.042, 0.140)	<0.001
	SES+ Health factors ^c	0.154 (0.080, 0.228)	0.068 (0.025, 0.112)	<0.001
Male (n=811)	Age-adjusted Difference	0.111 (0.045, 0.177)	0.042 (−0.009, 0.093)	<0.001
	SES factors ^b	0.081 (0.022, 0.140)	0.046 (0.001, 0.091)	0.002
	SES+ Health factors ^c	0.074 (0.013, 0.134)	0.042 (−0.003, 0.088)	0.019
Stratified by BMI Status				
BMI <25 (n=461)	Age-adjusted Difference	0.214 (0.132, 0.296)	0.136 (0.070, 0.202)	<0.001
	SES factors ^b	0.168 (0.091, 0.245)	0.091 (0.030, 0.152)	<0.001
	SES+ Health factors ^c	0.122 (0.042, 0.202)	0.086 (0.023, 0.150)	0.006
BMI 25–29.9 (n=704)	Age-adjusted Difference	0.164 (0.094, 0.234)	0.109 (0.059, 0.159)	<0.001
	SES factors ^b	0.142 (0.066, 0.218)	0.088 (0.035, 0.140)	<0.001
	SES+ Health factors ^c	0.102 (0.035, 0.170)	0.068 (0.021, 0.115)	<0.001
BMI ≥30 (n=629)	Age-adjusted Difference	0.157 (0.031, 0.283)	0.028 (−0.035, 0.091)	0.034
	SES factors ^b	0.129 (0.015, 0.243)	0.040 (−0.018, 0.100)	0.013
	SES+ Health factors ^c	0.071 (−0.039, 0.181)	0.021 (−0.034, 0.076)	0.124
Stratified by Knee OA status				
Chronic Knee Symptoms ^d with Radiographic Knee OA (n=474)	Age-adjusted Difference	0.095 (−0.019, 0.209)	0.091 (0.030, 0.152)	0.011
	SES factors ^b	0.065 (−0.054, 0.185)	0.061 (−0.003, 0.125)	0.081
	SES+ Health factors ^c	0.081 (−0.042, 0.204)	0.037 (−0.030, 0.103)	0.130
Chronic Knee Symptoms ^d without Radiographic Knee OA (n=233)	Age-adjusted Difference	0.105 (−0.066, 0.276)	0.119 (0.006, 0.232)	0.008
	SES factors ^b	0.024 (−0.119, 0.167)	0.055 (−0.041, 0.150)	0.353
	SES+ Health factors ^c	0.027 (−0.110, 0.164)	0.070 (−0.021, 0.161)	0.262
No chronic knee symptoms reported ^e (n=1087)	Age-adjusted Difference	0.154 (0.108, 0.200)	0.091 (0.057, 0.125)	<0.001
	SES factors ^b	0.147 (0.093, 0.201)	0.084 (0.045, 0.123)	<0.001
	SES+ Health factors ^c	0.132 (0.081, 0.183)	0.069 (0.031, 0.107)	<0.001

^a Difference in median QALYs compared to inactive group from quantile regression.

^b Socioeconomic (SES) factors: age, race/ethnicity, living arrangement, income, and education.

^c Health factors: medical comorbidities, smoking, BMI, KL grade, knee symptoms, and prior knee injury

^d Chronic knee symptoms based on report of pain, aching, or stiffness most days of the month during the past year

^e Participants with or without radiographic knee OA but not reporting chronic knee symptoms