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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 an 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 [$\geq$150 min of moderate-to-vigorous (MV) activity per week acquired in sessions $\geq$10 min], (2) Insufficiently Active ($\geq$1 MV session[s]/week but below the 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 2 years later. The QALY was calculated as the area under utility curve over 2 years. The relationship of physical activity level to median QALY adjusted for socioeconomic and health factors was estimated using quantile regression.

Results: Relative to the Inactive group, median QALYs over 2 years were significantly higher for the Meeting Guidelines (0.112, 95% 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 2 years, it would be considered cost effective. Our analysis supports interventions to promote physical activity even if recommended levels are not fully attained.

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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 also 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 the 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 health care 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 min per week of moderate-to-vigorous

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(MV) activity done in sessions lasting at least 10 min [11] for all adults, including persons with arthritis. However, no study has used objectively measured physical activity to assess whether meeting the guidelines translates into better quality of life among those with or at an 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 an 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 the 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 2 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 (http://www.oai.ucsf.edu/datarelease/About.asp). At enrollment, the OAI recruited 4796 men and women aged 45–79 years with or at an increased risk for developing symptomatic, radiographic knee OA (Fig. 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 3.0-T 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, and 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].

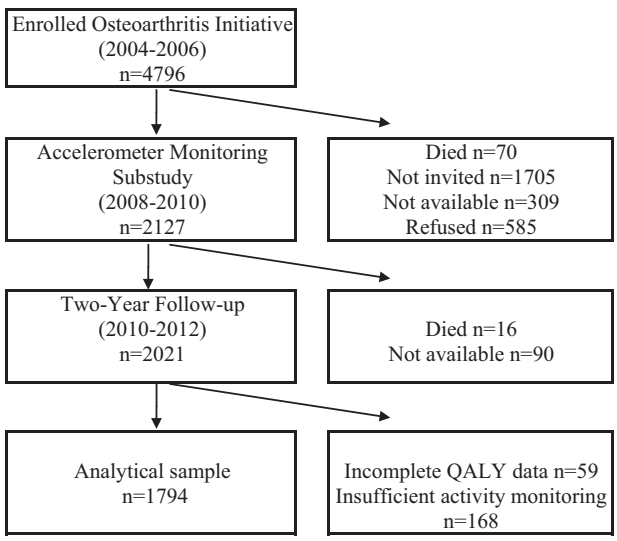

Fig. 1. A flow chart of an analytical sample.

Outcome measure: Quality-adjusted life-years (QALYs)

QALYs were calculated using health-related utility at baseline (OAI 48-month visit) and follow-up 2 years later (OAI 72-month visit). Health-related utility was measured by the Short-Form 6D (SF-6D) utility score, which is a preference-based single index measure for health. Based on scoring algorithms developed by Brazier et al. [15,16], 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. 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. The QALY was calculated as the area under the health-related utility curve (i.e., the integral) over 2 years, for example, 2 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-year period. The QALY gained can then be incorporated with medical cost to arrive at the cost-effectiveness ratio (CER), which is expressed as additional cost per QALY gained. By convention, CER $\leq$ \$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), which is 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 7 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 that was 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 that is validated in patients with rheumatic disease [22,23]. Non-wear periods were defined as $\geq$90 min with zero activity counts, with allowance for up to 2 consecutive minutes of counts between 1 and 100 [23]. A valid day

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