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Title

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Obesity and Other Modifiable Factors for Physical Inactivity Measured by Accelerometer in Adults with Knee Osteoarthritis: Data from the Osteoarthritis Initiative (OAI)

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Abstract

Objective—To investigate the public health impact of obesity and other modifiable risk factors related to physical inactivity in adults with knee osteoarthritis (OA).

Methods—The frequency of inactivity as defined by the United States Department of Health and Human Services was assessed from objective accelerometer monitoring of 1089 participants with radiographic knee OA aged 49 to 84 years during the OAI 48 month visit (2008–2010). The relationship between modifiable factors (weight status, dietary fat, fiber, smoking, depressive symptoms, knee function, knee pain, knee confidence) with inactivity was assessed using odds ratios (OR) and attributable fractions (AF) controlling for descriptive factors (age, gender, race, education, live alone, employment, frequent knee symptoms, comorbidity).

Results—Almost half (48.9%) of participants with knee OA were inactive. Being overweight (OR=1.8, CI: 1.2, 2.5) or obese (OR=3.9, CI: 2.6, 5.7), inadequate dietary fiber intake (OR =1.6, 95% CI: 1.2, 2.2), severe knee dysfunction (OR=1.9, 95% CI: 1.3, 2.8), and severe pain (OR=1.7, 95% CI: 1.1, 2.5) were significantly related to inactivity, controlling for descriptive factors. Modifiable factors with significant average AFs were being overweight or obese (AF=23.8%, 95% CI: 10.5%, 38.6%) and inadequate dietary fiber (AF=12.1%, 95% CI: 0.1%, 24.5%) controlling for all factors.

Conclusion—Being obese or overweight, the quality of the diet, severe pain, and severe dysfunction are significantly associated with physical inactivity in adults with knee OA. All

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components should be considered in designing physical activity interventions that target arthritis populations with low activity levels.

Arthritis is a growing public health problem in the United States affecting almost 50 million adults.[1] The prevalence of activity limitations attributable to arthritis is over 21 million. OA affecting the knee is currently a leading cause of disability in adults.[2–4] It is widely recognized that physical activity offers important benefits to persons with arthritis including knee OA. Physical activity programs can reduce pain, improve physical performance, reduce depressive symptoms, and prevent or delay disability in knee OA.[5–8] In addition to disease-specific benefits, randomized clinical trials show that physical activity can improve muscle strength and increase aerobic capacity, flexibility, and strength.[9–11] Recent federal guidelines now include people with arthritis in the physical activity recommendations to promote these benefits.[12]

Despite important health benefits from being physically active, persons with arthritis are particularly inactive and are at risk for poor health outcomes.[13,14] In a national US survey 44% of persons with arthritis were classified as inactive (i.e. reporting no sustained 10 minute periods of moderate-to-vigorous physical activity in a week) compared to 36% of adults without arthritis.[15] Physical inactivity may account for an estimated 21% of activity limitations attributed to arthritis.[16] Furthermore, physical inactivity threatens full participation in both employment opportunities and independent community living, and leads to increased healthcare costs.[17]

Identifying predictors of inactivity is important to develop public health interventions aimed at reducing inactivity. Therefore, this study simultaneously investigated risk factors that are modifiable and related to inactivity to identify strategic targets for public health intervention For example, knee pain and function are commonly viewed as barriers to being physically active for adults with knee OA and significant associations between inactivity were reported in the National Health Interview Survey (NHIS)[15] and Canadian National Population Health Survey (CNHS)[18] studies. Similarly being overweight, depressive symptoms, and smoking are associated with inactivity[7,19,20] and knee confidence is implicated by its strong association with physical function.[21] Literature from the general population shows that low fiber intake has been associated with low physical activity levels.[22,23]

There are limited reports on objectively measured physical activity that examine characteristics of inactivity. The purpose of this study was to identify modifiable risk factors that may increase the frequency of physical inactivity among adults with knee OA and to calculate the attributable fraction of modifiable risk factors that account for the excess physical inactivity in this sample.

MATERIALS AND METHODS

Study Population

This physical activity study evaluated a subcohort from the Osteoarthritis Initiative (OAI), a prospective study investigating risk factors and biomarkers associated with the development and progression of knee OA in adults aged 45–79 years at enrollment, with or at high risk to develop knee OA. Annual OAI evaluations began in 2004 at four clinical sites (Baltimore, Maryland, Columbus, Ohio, Pittsburgh, Pennsylvania, and Pawtucket, Rhode Island) and are currently ongoing (see http://www.oai.ucsf.edu/datarelease/About.asp). IRB approval was obtained at each of the participating sites. Each participant provided written informed consent. The OAI excluded individuals with rheumatoid or inflammatory arthritis; severe joint space narrowing in both knees on the baseline knee radiograph, 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; positive pregnancy test; inability to provide a blood sample; use of ambulatory aides other than a single straight cane for more than 50% of the time during ambulation; comorbid conditions that might interfere with the ability to participate in a 4 year study; current participation in a double-blind randomized trial. All OAI participants underwent knee radiography at baseline. The radiographic acquisition protocol may be found at http://www.oai.ucsf.edu/datarelease/OperationsManuals.asp. Baseline films were assessed by clinic readers for OARSI atlas[24] grades of tibiofemoral osteophytes and joint space narrowing. The baseline visit identified 2679 participants with radiographic evidence of knee OA (i.e., definite, or OARSI-atlas grade 1, osteophytes) in one or both knees from the total OAI enrollment of n=4796 persons in 2004–2005.

Accelerometer monitoring of physical activity study was offered to a subcohort of OAI participants at the 48 month follow-up visit between 2008 and 2010. A total of n=2127 persons consented to participate in accelerometer monitoring representing 78.4% of the 2712 eligible subcohort participants. (Another 1543 OAI participants had visits that preceded the accelerometer study start date and 541 were deceased/withdrew from the OAI study or/did not return for the 48 month visit). This report included only the 1223 participants with baseline radiographic knee OA as shown in Figure 1. Accelerometer and 48 month visit data were merged with OAI public data[25] containing information on participant characteristics.

Outcome---Physical Activity Measures

Physical activity was measured using a GT1M Actigraph accelerometer, a small uniaxial accelerometer that measures vertical accelerations.[26] Uniaxial accelerometer validation studies against whole-body indirect calorimetry showed high correlation with metabolic equivalent (r=0.93) and total energy expenditure (r=0.93).[27] The accuracy[28] and test-retest reliability[29] of Actigraph accelerometers under field conditions are established in many populations including persons with OA.[30] Accelerometers output an activity count, which is the weighted sum of the number of accelerations measured over 1 minute periods, where the weights are proportional to the magnitude of measured acceleration.

Trained research personnel gave participants uniform scripted instructions to wear the unit 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. Participants maintained a daily log to record time spent in water and cycling activities, which may not be fully captured by accelerometers.

Accelerometer data were analytically filtered using methodology validated in adults with rheumatic disease.[31–33] Non-wear periods were defined as 90 minutes with zero activity counts (allowing for two interrupted minutes with counts<100).[32] Accelerometer data included at least 4 or more valid days for each participant. A valid day of monitoring was defined as 10 wear hours in a 24 hour period.[31] Total daily minutes of moderate-to-vigorous (MV) physical activity was calculated using methodology from the National Institute of Health (counts 2020/minute occurring in bouts lasting 10 minutes, with allowance for interruptions of 1 or 2 min below the MV threshold).[31] Each person was classified according to the US Department of Health and Human Services (DHHS) physical activity guidelines[27]: Meet Recommendations (150 minutes of MV activity bouts/week in bouts lasting at least 10 minutes), Low Active (10–149 minutes of MV bouts/week) or Inactive (zero minutes of MV activity bouts/week).[12]

Modifiable Risk Factors

Modifiable general health factors included body mass index (BMI) and depressive symptoms. BMI was calculated from measured height and weight [weight (kg)/height (m)^2]. Persons were classified as normal weight (BMI=18.5–24.9), overweight (BMI=25.0–29.9), or obese (BMI   30). High depressive symptoms were assessed by a score   16 from the Center for Epidemiological Studies Depression scale.[34] Knee specific factors included knee function, knee pain, and knee confidence. Self-reported current knee function and pain in the past 7 days were obtained from the WOMAC (Western Ontario and McMaster University OA Index, Likert version 3.1, modified in the OAI).[35] Person-level scores used the maximum WOMAC value of the two knees. For the purpose of analysis, we classified WOMAC knee function symptoms based on tertiles as no dysfunction (bottom tertile): 0; moderate: 0.1–11.2; severe dysfunction (top tertile): 11.3–68. Similarly, WOMAC knee pain was classified using tertiles as no pain (bottom tertile): 0, moderate: 0.1–3.9; severe pain (top tertile): 4–20. Knee confidence was assessed using the Knee injury and Osteoarthritis Outcome Score (KOOS)[36] question "How much are you troubled with lack of confidence in your knees?" with possible responses of not at all, mildly, moderately, severely, and extremely.

Modifiable behavior factors included smoking status and dietary intake. Smoking status was dichotomized: current smoking versus not current smoking or missing. Dietary intake was assessed at baseline using the BLOCK 2000 systematic nutrition assessment.[37,38] For dietary intake variables, we focused on fat intake and dietary fiber intake as they represent the two extremes of low and high calorie dense food. Dietary factors were dichotomized: high (35% of daily calories) versus adequate/low fat and inadequate (<20g/day) versus adequate fiber.[39,40] Additional nutritional factors measured by the BLOCK 2000 were only weakly associated with inactivity status and therefore were not considered relevant as modifiable factors. The questionnaires can be obtained from the publically available OAI website (http://www.oai.ucsf.edu/datarelease/OperationsManuals.asp).

Descriptive Factors

Covariates were measured at the OAI 48 month visit except where noted. Descriptive covariates included sociodemographics and prior health factors. Sociodemographic baseline factors included race, age, gender, living status, education, and employment (at 24 month visit). Descriptive prior health factors included frequent knee symptoms, comorbidity, and the report of a total knee replacement prior to enrollment. Frequent knee symptoms were ascertained from a positive response to "During the past 12 months, have you had pain, aching, or stiffness in or around your right/left knee on most days for at least one month?" Comorbidities were assessed by the modified Charlson comorbidity index[41] at the 24 month visit.

Statistical analysis

Univariate analyses of baseline trend effects across physical activity levels were evaluated by a Mantel Haenszel test for ordinal categories. A chi-square test for overall differences was applied to nominal variables. Modifiable factors associated with physical inactivity were evaluated by logistic regression controlling for all descriptive and modifiable factors; an associated 95% confidence interval that falls above 1 indicates a significant association. Further analyses added interaction terms between gender and each modifiable factor to logistic regression models.

The attributable fraction (AF) related to inactivity was estimated for each modifiable risk factor.[42] The sample AF estimates "excess" inactivity based on the risk factor frequency and its association with inactivity. The term "excess" conceptually refers to the reduction in the

outcome that would occur if the risk factor were removed from the population. In a cross sectional sample, the AF is the potential reduction in the outcome (e.g., inactivity) if the risk factor was totally absent (e.g., no obesity),[43,44] but it does not imply cause and effect. An average AF (AAF) accounts for individuals with multiple factors, estimating the excess proportion of the outcome that can be attributed to any of the designated risk factors.[45] The AAF is usually lower than the sum of individual AFs because an outcome is typically attributable to more than one risk factor. The AF estimates were assessed using Poisson regression with robust error variance and the sample prevalence of the modifiable risk factors employing SAS version 9.2 with SAS macro in 2010–2011.[46,47]

RESULTS

A total of 1223 persons aged 49–84 years with radiographic knee OA participated in physical activity measurement using accelerometers at the 48 month OAI visit. At the baseline OAI visit, 67.1% of these had definite joint space narrowing equivalent of Kellgren-Lawrence grade 3 or 4.[48] Participants in this study had similar baseline age (62.0 versus 62.8 years), BMI (29.2 versus 29.8 kg/m^2) compared to the non-participating OAI radiographic knee OA cohort, but were more frequently male (44.9% vs. 38.9%), White (81.0% versus 75.3%), with slightly less pain (mean WOMAC pain 3.5 versus 4.6). Of the participants, 1111 (90.8%) had at least 4 valid days of accelerometer monitoring data; 1089 (all but 2%) had complete covariate data.

These 1089 adults with knee OA had mean age of 66.1 years, were primarily female (54.8%), white (83.7%), working (53.9%), did not live alone (78.3%), and had post high school education (84.9%). Few smoked (5.7%), or had high depressive symptoms (11.5%), but substantial portions reported high fat intake (46.3%), inadequate dietary fiber (79.2%), some limitations in knee function (69.1%), knee pain (68.6%), some trouble with lack of knee confidence (53.2%) and were overweight/obese (79.0%). In regard to physical activity, 48.9% (39.8% of men and 56.3% of women) were inactive, demonstrating no 10 minute bouts of moderate-to-vigorous activity during the week of monitoring. Only 10.2% attained recommended activity levels.

Descriptive and modifiable characteristics of this sample by physical activity characteristics are shown in Table 1. All descriptive factors were significantly associated with physical activity levels. Among modifiable factors, greater levels of physical inactivity were significantly associated with greater prevalence of overweight/obesity, inadequate dietary fiber intake, greater WOMAC knee dysfunction, and greater WOMAC knee pain.

The association of modifiable factors with inactivity quantified as odds ratios (OR) is summarized in Table 2. Modifiable factors significantly related to inactivity were being overweight (OR=1.8, 95% CI=1.2, 2.5) or obese (OR=3.9, 95% CI=2.6, 5.7), inadequate dietary fiber intake (OR=1.6, 95% CI=1.2, 2.2), severe dysfunction (OR=1.9, CI=1.3, 2.8), and severe pain (OR=1.7, 95% CI=1.1, 2.5), after controlling for descriptive factors. Being overweight (OR=1.8, CI: 1.2, 2.5) or obese (OR=3.7, CI: 2.5, 5.4) and inadequate dietary fiber intake (OR =1.5, 95% CI: 1.1, 2.1) were significantly related to inactivity, when controlling for all descriptive and modifiable factors.

The influence of modifiable factors on inactivity is further examined from a public health perspective. Figure 2 presents the modifiable factor AAFs adjusted for descriptive and other modifiable factors. The AAF accounts for the fact that some individuals have multiple modifiable risk factors. For example, among overweight/obese adults in this study, 80.2% had low fiber diets and 70.8% had knee pain. AAF model includes the significant modifiable factors based on the bivariate relationship between inactivity using logistic regression:

dietary fiber intake, weight status, knee function, knee pain. Being overweight/obese had a statistically significant 23.8% (95% CI =10.5%, 38.6%) relationship to excess inactivity. Inadequate dietary fiber was significantly related to another 12.1% (95% CI=0.1%, 24.5%). Together, being obese/overweight and having a low fiber diet accounted for 35.9% of excess inactivity in these adults with knee OA. Remaining modifiable factors were related to less than 7% excess inactivity and were not significant.

DISCUSSION

This study contributes to public health efforts to improve health outcomes of persons with arthritis by examining the association of potentially modifiable risk factors associated with physical inactivity in a large cohort of adults with radiographic evidence of knee OA. An important strength of this study is the objective assessment of physical inactivity. Only one of ten adults with knee OA had recommended physical activity levels. Notably, over one-third of men and half the women were completely inactive, doing no sustained moderate-to-vigorous activity that lasted 10 minutes in a week. Modifiable factors significantly associated with inactivity were being overweight/obese and consuming a diet with inadequate fiber, the report of severe knee limitations, and severe knee pain. Over 23.8% of excess inactivity was related to being overweight/obese, and another 12.1% was related to inadequate dietary fiber consumption, after accounting for other descriptive and modifiable factors.

A low level of physical activity among adults with arthritis is a recognized public health concern. However, assessing the magnitude of the problem has been a challenge due to differing methods for assessing physical activity. Earlier studies that relied on self-reported physical activity levels estimate that 23.8–57.8% adults with arthritis in the Unites States are inactive.[13,15,16,18–20] Imbedded into these estimates are differences related to the self-report of physical activity and how inactivity was defined. Inactivity was defined by no reported leisure time activity[19,49], less than 10 minutes/week MV leisure activities;[13] less than 3 sessions/month lasting 15 minutes of activities associated with moderate intensity energy expenditure,[16,18] and no reported activities lasting 10 minutes.[15] In this study, definition of physical inactivity is anchored on the federal DHHS definition and is assessed by objective accelerometer monitoring.

Modifiable factors were evaluated from two perspectives. The first perspective identifies factors associated with physical inactivity at the level of the individual. Modifiable factors significantly associated with inactivity based on adjusted ORs were obesity, knee pain, knee dysfunction, and dietary fiber intake. Earlier studies on adults reporting an arthritis diagnosis[18,19] found a significant relationship between inactivity and being overweight, but a 2002 NHIS study did not find a significant association.[15] These reports evaluate broader arthritis populations than the current study and rely on self-report to assess inactivity and weight status. Self-report is related to underreporting of weight[51] and over reporting of physical activity amount/intensity.[51] It is not known how reporting accuracy may influence the apparent association between inactivity and weight status, but measurement issues may contribute to the mixed findings across earlier studies.

Significant associations between inactivity and self-reported knee dysfunction (OR=1.9) and pain (OR=1.7), were in line with findings from the NHIS[15] and CNHS[18] studies. We also found a significant association between inactivity and inadequate fiber intake (OR=1.6). In the general adult population, low fiber intake has been associated with low physical activity levels.[22,23] This association may partially reflect the association of a low fiber diet, representing low intake of fruits, vegetables, whole grains and high consumption of refined carbohydrate/sugar related to snacking and a sedentary lifestyle.[52,53] Thus, a low fiber diet

may be a marker for unhealthy behaviors that include inactivity and high-fat/high-sugar snacking.

A second public health perspective examined the influence of each modifiable factor on inactivity by estimating the AAF for the sample. The sample AAF has public health relevance because the metric incorporates population criteria related to the risk factor prevalence plus its association with the outcome. Recognizing that many individuals had multiple modifiable risk factors (e.g., 80.2% of overweight/obese adults had low fiber diets and 70.8% reported pain), we examined the simultaneous effect of all modifiable risk factors on inactivity. While pain (AAF=6.2%) and dysfunction (AAF=2.6%) are associated with lower levels of inactivity, being obese/overweight (AAF=23.8%) and inadequate dietary fiber (AAF=12.1%) explain a significant and larger proportion of inactivity. The results reinforce the contribution of excess weight and poor diet.

Pain and poor function are commonly viewed as barriers to being physically active for adults with knee OA.[15,18,54] These findings indicate that being overweight/obese and an unhealthy diet are also important to consider. There is evidence that higher BMI is related to greater knee pain and poor function in adults with knee OA.[55–58] In turn, high levels of pain are associated with binge eating.[59] If obesity due to poor dietary patterns contributes to knee pain and resulting poor function through mechanical stress due to excess weight on the joint, then obesity supported by poor dietary choices may contribute to the relationship between knee pain and inactivity. However, randomized controlled trials show that exercise is safe and effective for overweight/obese adults with OA[58]. Taken together, these results support incorporating weight loss and diet modification into interventions designed to promote health benefits from physical activity.

There are limitations to acknowledge in the present study. Accelerometers do not provide information on the type of the physical activity (e.g., household, transportation), information which may be helpful in targeting interventions. The accelerometer used in this study cannot capture water activities and may underestimate upper body movement or activities such as cycling. Diary information showed a median of 0 minutes/day spent in water and cycling activities, so the potential underestimate of inactivity is negligible. Radiographic data on knee joint damage and dietary information were only available from baseline, 4 years prior to the current study. Because joint damage does not improve over time and people with subsequent knee replacements were excluded, radiographic verification remains valid. Dietary fiber intake tends to remain stable or decrease slightly over a three to four year period, as demonstrated by control groups from large nutritional trials;[60,61] a potential underestimate of inadequate fiber intake would likely understate the strength of its relationship with inactivity found in our analyses. Self-reported data are commonly subject to social desirability bias and recall bias. However, to minimize biases we have used validated questionnaires such as BLOCK 2000 for dietary variables, CES-D for depressive symptoms, WOMAC for knee function and pain, and KOOS for knee confidence. Our results will be strengthened if participants over-reported dietary fiber intake as we would have under-estimated the effects of dietary fiber. Finally, causality cannot be inferred from these cross-sectional data. These limitations must be balanced against the substantial strengths of this study which include the large sample size, clinical measures of height and weight as opposed to self-reports, radiographic verification of knee OA, and the age and gender diversity of this OA cohort. An important strength of this study is that federal DHHS definition of inactivity[27] based on objective accelerometer monitoring was used.

Despite substantial health benefits related to physical activity, adults with radiographic knee OA were particularly inactive. A substantial 48.9% of adults with knee OA were classified as inactive, demonstrating no 10 minute episodes of moderate-to-vigorous activity in a

week. There is a critical need to intensify public health efforts to reduce physical inactivity among adults with knee OA. Being obese/overweight, the quality of the diet, severe pain, severe dysfunction, and levels of physical activity are inter-related in adults with knee OA. One cannot hope to improve physical activity patterns in adults with knee OA without consideration for weight management, diet, and OA pain and disability, as all may affect successful achievement of activity goals. All components should be considered in developing physical activity interventions that target arthritis populations with low activity levels.

Acknowledgments

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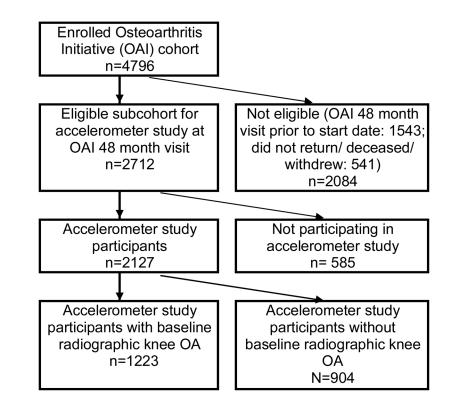
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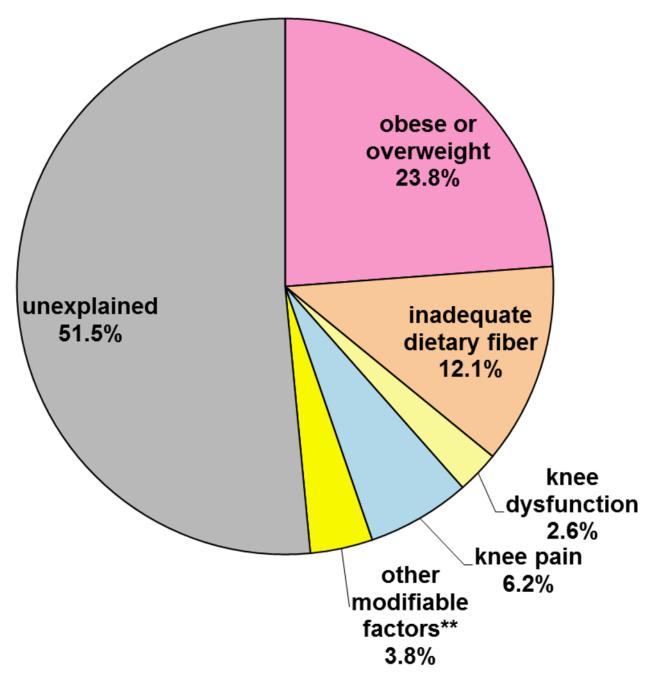
Significance and Innovations

- We investigated the potential public health impact of modifiable factors including being obese/overweight, low fiber diet, inadequate dietary fat, smoking status, depressive symptoms, severe knee pain, and severe knee dysfunction related to physical inactivity in adults with knee osteoarthritis.

- The public health importance of each modifiable risk factor on physical inactivity was estimated using the attributable fraction.

- Modifiable factors significantly associated with physical inactivity (being obese/ overweight, the quality of the diet, severe knee pain, and severe knee dysfunction) should be considered in developing physical activity interventions that target arthritis populations with low activity levels.

Figure 1.
Flow chart of analytical sample OAI participants in accelerometer study

Figure 2. Adjusted* average attributable fraction of inactivity for modifiable factors
*Adjusted for descriptive factors (age, gender, race, living status, education, employment, chronic knee pain, total knee replacement, comorbidities) and all modifiable factors (obese/overweight, inadequate dietary fiber, knee dysfunction, knee pain, a high fat diet, smoking, high depressive symptoms, or being troubled by knee confidence).
**Aggregated contribution of remaining modifiable risk factors (high fat diet, smoking, high depressive symptoms, or being troubled by knee confidence)

Table 1

Physical activity distribution of adults with radiographic knee OA (n=1089)

DESCRIPTIVE FACTORS	N	Inactive (%)	Low Active (%)	Met Recommendations (%)	Trend test p-value[*]
Overall	1089	48.9	41.0	10.2	-
Age in years:					
49–59	300	33.7	54.3	12.0	<.0001
60–69	374	42.8	45.7	11.5	
70–79	415	65.3	27.0	7.7	
Gender:					
Male	492	39.8	47.2	13.0	<.0001
Female	597	56.3	35.9	7.9	
Race/Ethnicity:					
White	911	46.9	41.3	11.9	<.0001
Non-White	178	59.0	39.3	1.7	
Live Alone					
Yes	236	58.1	33.1	8.9	0.0061
No	853	46.3	43.1	10.6	
Education					
Post high school	925	45.5	43.4	11.1	<.0001
High school or less	164	67.7	27.4	4.9	
Employed					
Working	587	40.6	47.4	12.1	<.0001
Not working	464	58.6	33.0	8.4	
Missing/Other	38	57.9	39.5	2.6	
Chronic Knee pain					
No	576	46.9	40.1	13.0	0.0114
Yes	513	51.1	41.9	7.0	
Total knee replacement prior to enrollment					
No	1020	68.1	27.5	4.4	0.0012
Yes	69	47.6	41.9	10.6	
Comorbidity					

DESCRIPTIVE FACTORS	N	Inactive (%)	Low Active (%)	Met Recommendations (%)	Trend test p-value[*]
Score 0	782	44.1	44.3	11.6	<.0001
1–2	262	61.1	32.4	6.5	
3 or more	45	60.0	33.3	6.7	
MODIFIABLE FACTORS					
General Health Factors					
BMI Normal[†]	229	35.8	46.3	17.9	<.0001
Overweight[††]	441	44.0	43.5	12.5	
Obese[†††]	419	61.1	35.3	3.6	
Depressive symptoms					
Not High	964	48.2	41.0	10.8	0.0948
High (CESD 16)	125	53.6	40.8	5.6	
Health Behaviors					
Fat Intake					
Adequate/Low	585	47.4	41.2	11.5	0.1394
High	504	50.6	40.7	8.7	
Dietary Fiber Intake					
Adequate	227	40.5	45.4	14.1	0.0018
Low	862	51.0	37.8	9.2	
Smoker					
No	1027	48.7	41.2	10.1	0.8391
Yes/Missing	62	51.6	37.1	11.3	
Knee-specific Health Factors					
WOMAC dysfunction[‡]					
None	337	42.1	43.9	14.0	<.0001
Moderate (Middle tertile)	378	46.0	41.5	12.4	
Severe (Top tertile)	374	57.8	37.7	4.6	
WOMAC knee pain[‡‡]					
None	342	43.3	42.7	14.0	<.0001
Moderate (Middle tertile)	364	47.5	40.7	11.8	
Severe (Top tertile)	383	55.1	39.7	5.2	

DESCRIPTIVE FACTORS	N	Inactive (%)	Low Active (%)	Met Recommendations (%)	Trend test p-value [*]
Knee Confidence					
Not troubled	510	48.8	39.6	11.6	0.2006
Mild/Moderately Troubled	530	47.6	43.2	9.3	
Severely/extremely Troubled	49	63.3	30.6	6.1	

[*]
Mantel-Haenszel chi-square test for trend (1 d.f.) except for race, gender, and living arrangement comparisons, which used chi-square test for overall differences;

[†]
Normal includes 1 person with BMI below the range 18.5–24.9;

[††]
Overweight BMI 25.0–29.9;

[†††]
Obese BM 30;

[‡]
WOMAC function tertiles based on maximum of left and right knees: low 0.0, middle 1.0–11.2; top tertile 11.3;

[‡‡]
WOMAC pain tertiles based on maximum of left and right knees: none, 0<middle<4.0; top (most pain) tertile 4.0

Table 2

Modifiable health factor odds ratios for physical inactivity in adults with radiographic knee OA (n=1089)

Modifiable Health Factors	N	Percent Inactive	Unadjusted Odds Ratio (95% CI)	Odds Ratio Adjusted for Descriptive Factors[#] (95% CI)	Odds Ratio Adjusted for Descriptive Factors and Other Modifiable Factors[##] (95% CI)
Health Behaviors					
Fat Intake					
Adequate/Low	585	47.4	Reference	Reference	Reference
High	504	50.6	1.1 (0.9, 1.4)	1.3 (0.9, 1.6)	1.0 (0.8, 1.3)
Dietary Fiber Intake					
Adequate	227	40.5	Reference	Reference	Reference
Inadequate	862	51.0	**1.5 (1.1, 2.1)**	**1.6 (1.2, 2.2)**	**1.5 (1.1, 2.1)**
Smoker					
No	1027	48.7	Reference	Reference	Reference
Yes/Missing	62	51.6	1.1 (0.7, 1.9)	1.4 (0.8, 2.5)	1.4 (0.8, 2.5)
General Health Factors					
Weight status Normal[†]	229	35.8	Reference	Reference	Reference
Overweight[††]	441	44.0	**1.4 (1.0, 2.0)**	**1.8 (1.2, 2.5)**	**1.8 (1.2, 2.5)**
Obese[†††]	419	61.1	**2.8 (2.0, 3.9)**	**3.9 (2.6, 5.7)**	**3.7 (2.5, 5.4)**
Depressive symptoms					
Not high	964	48.2	Reference	Reference	Reference
High	125	53.6	1.2 (0.9, 1.8)	1.2 (0.8, 1.8)	1.0 (0.7, 1.6)
Knee Specific Factors					
WOMAC function[‡]					
No dysfunction	337	42.1	Reference	Reference	Reference
Moderate (middle tertile)	378	46.0	1.2 (0.9, 1.6)	1.3 (0.9, 1.8)	1.1 (0.7, 1.7)
Severe (top tertile)	374	57.8	**1.9 (1.4, 2.5)**	**1.9 (1.3, 2.8)**	1.7 (0.9, 3.1)
WOMAC knee pain[‡‡]					
No pain	342	43.3	Reference		Reference

Modifiable Health Factors	N	Percent Inactive	Unadjusted Odds Ratio (95% CI)	Odds Ratio Adjusted for Descriptive Factors[#] (95% CI)	Odds Ratio Adjusted for Descriptive Factors and Other Modifiable Factors[##] (95% CI)
Moderate (middle tertile)	364	47.5	1.2 (0.9, 1.6)	1.4 (0.9, 1.9)	1.3 (0.8, 2.0)
Severe (top tertile)	383	55.1	**1.6 (1.2, 2.2)**	**1.7 (1.1, 2.5)**	1.1 (0.6, 2.0)
Knee Confidence					
Not troubled	510	48.8	Reference	Reference	Reference
Mildly/Moderately troubled	530	47.6	1.0 (0.7, 1.2)	1.0 (0.7, 1.3)	0.8 (0.6, 1.1)
Severely/extremely troubled	49	63.3	1.8 (1.0, 3.3)	1.8 (0.9, 3.6)	1.4 (0.6, 2.9)

[#] Adjusted for descriptive factors (age, gender, race, living status, education, employment, chronic knee pain, total knee replacement, comorbidities) with associated 95% confidence interval.

[##] Adjusted for all descriptive and other modifiable factors with associated 95% confidence interval.

[†] Normal includes 1 person with BMI below the range 18.5–24.9;

[††] Overweight BMI 25.0–29.9;

[†††] Obese BM 30;

[‡] WOMAC function tertiles based on maximum of left and right knees: no dysfunction 0.0, moderate >0–11.2; severe >11.2;

[‡‡] WOMAC pain tertiles based on maximum of left and right knees: none 0.0, moderate >0–3.9; severe>3.9.