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Association of Objectively Measured Physical Activity and Metabolic Syndrome among U.S. Adults with Osteoarthritis

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Abstract

Objective—To investigate the association between objectively-measured physical activity and metabolic syndrome among adults with osteoarthritis (OA).

Methods—Using cross-sectional data from 2003–2006 NHANES, we identified 566 adults with OA with available accelerometer data assessed using Actigraph AM-7164 and measurements necessary to determine metabolic syndrome by Adult Treatment Panel III. Analysis of variance was conducted to examine the association between continuous variables in each activity level and metabolic syndrome components. Logistic models estimated the relationship of quartile of daily minutes of different physical activity levels to odds of metabolic syndrome adjusted for socioeconomic and health factors.

Results—Among persons with OA, most were female with average age 62.1 years and average duration of disease of 12.9 years. Half of adults with OA had metabolic syndrome (51.0%; 95% Confidence Interval (CI): 44.2% to 57.8%), and only 9.6% engaged in the recommended 150 minutes per week of moderate/vigorous physical activity. Total sedentary time was associated with higher rates of metabolic syndrome and its components while light and moderate/vigorous objectively-measured physical activity were inversely associated with metabolic syndrome and its components. Higher levels of light activity was associated with lower prevalence of metabolic syndrome (quartile 4 versus quartile 1: adjusted odds ratio: 0.45; 95% CI: 0.24 to 0.84; p-value for linear trend < 0.005).

Conclusion—Most U.S. adults with OA are sedentary. Increased daily minutes in physical activity, especially in light intensity, is more likely to be associated with decreasing prevalence of metabolic syndrome among persons with OA.

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Introduction

Metabolic syndrome increases the risk of osteoarthritis (OA) (1,2). The prevalence of metabolic syndrome is also increased in patients with OA, and the association remains after adjustment for body mass index (BMI) (3). The accumulation of components of the metabolic syndrome is associated with a gradual increase in the risk of development and progression of knee OA (3–5). Thus, improving metabolic syndrome may also slow disease progression among patients with OA.

Modifying physical activity may be a viable strategy to decrease the prevalence of metabolic syndrome (6,7). While in general populations engaging in physical activity protects against the development of the components of metabolic syndrome (8,9), the magnitude of the association between physical activity and metabolic syndrome components among patients with OA is unknown. Exercise intervention programs showed improved indexes relating to metabolic diseases among persons with OA (10). However, OA patients are usually older and more likely to engage in sedentary behavior because of difficulties in following exercise programs (11). Given that OA is a progressive disease for which there is no cure, exploring opportunities to modify risk factors is warranted.

This study sought to quantify the association between objectively measured levels of daily physical activity and metabolic syndrome among adults with OA. The addition of accelerometers to the examination component of the National Health and Nutrition Examination Survey (NHANES) provides for the first time national estimates of physical activity using objective measured physical activity. Since accelerometers can offer an alternative to self-reported physical activity data by assessing and storing the measures of the duration and intensity of bodily movement (12), this study offers a unique opportunity as existing studies examining the association between physical activity and metabolic syndrome among persons with OA are limited by self-reported physical activity and varying definitions of physical activity (10). We hypothesized that higher duration and intensity of daily physical activity would be associated with lower prevalence of metabolic syndrome among OA patients.

Methods

The Institutional Review Board of the University of Massachusetts reviewed this study and considered it exempt.

Data Source and Population

We used cross-sectional data from the National Health and Nutrition Examination Survey (NHANES). Details of NHANES protocols are available on-line (13). Briefly, NHANES uses a stratified, multistage probability design to obtain a nationally representative sample of the U.S. household population based on a sample of ~5,000 persons each year. Trained staffs conducted an interview and for a subset of participants a physical examination and laboratory tests in mobile examination centers (MEC). The most recently available information on objectively measured physical activity as measured by accelerometer was collected in 2003–2004 and 2005–2006 (n=20,470). The average response rate was 79.7%.

To be eligible for the current study, we identified persons with OA. Participants were asked, “Has a doctor or other health professional ever told you that you had arthritis?” Individuals who responded affirmatively were asked a follow-up question: “Which type of arthritis was it?” Responses included rheumatoid arthritis, OA, other types of arthritis, unknown type, and declined to answer. Self-report of OA in other cohorts have been shown to be reasonably reliable and valid (14). There were 877 participants ≥18 years old who indicated OA. Physical activity was assessed on participants who are able to walk or wear an accelerometer for 7 consecutive days while they were awake except water activities including bathing (15). For physical activity estimates to be valid and reliable, participants had to provide 4-7 days of valid accelerometer monitoring in a week (16). Valid days of monitoring were considered those in which the device indicated that it was worn for at least 10 hours per day (16). Of the 877 participants with OA, 170 did not have any accelerometer monitoring data and 126 did not have valid accelerometer monitoring data. Fifteen participants who did not have sufficient data to determine the status of metabolic syndrome were excluded. The final analytic sample size was 566.

Measures of Physical Activity

Physical activity was assessed with the uniaxial Actigraph AM-7164 accelerometer worn over the right hip on an elasticized belt (ActiGraph, Fort Walton Beach, FL). Accelerometers provide a reliable and sensitive measure for the duration and intensity of bodily movement (17,18). The accelerometer measures the duration and intensity of physical activity by capturing the magnitude of acceleration (intensity) and summing up the magnitudes (intensity counts) within a specified time interval (epoch). A one-minute epoch was used. Any block of time greater than or equal to 60 minutes where the activity count was equal to zero was considered time when the monitor was not worn (16). The activity counts derived from accelerometers were used to differentiate overall physical activity levels: 1) sedentary (<100 counts/minute); 2) light physical activity (100 to 759 counts/minute; 3) lifestyle (760 to 2,019 counts/minute); and 4) moderate to vigorous activity (≥2,020 counts/minute) (16). Using these commonly applied cut points obtained from calibration studies relating accelerometer counts to measured activity energy expenditure, time spent in a level of physical activity intensity (e.g., sedentary, light physical activity, lifestyle, and moderate to vigorous) was determined by a 3 step process. First, we summed minutes in a day where the count met the threshold for the level of physical activity intensity. Then, for each day, we calculated the minutes spent in each physical activity level. Lastly, we averaged the daily mean across all valid days.

We used the physical activity data in 2 ways. First, we treated each of the four variables describing physical activity as continuous variables. Second, summary measures were used to represent the average minutes across valid days per person for the four activity levels and examined as quartiles. Within each physical activity intensity level, we also evaluated: 1) the duration of time in each activity level per week determined by summing up the minutes in each level across all available valid days (valid days ranging from 4 to 7 days, minutes/week); 2) the duration of time in each activity level per day (minutes/day); and 3) proportion of total valid wear time in each activity level. Furthermore, using accelerometer can also better provide estimates in time spent in moderate to vigorous activity compared to self-reported data (19), participants were also classified as having met or not met the 2008 U.S. Department of Health and Human Services (DHHS) physical activity recommendations of ≥ 150 minutes per week moderate to vigorous activity (20).

Metabolic Syndrome

Using the National Cholesterol Education Program Adult Treatment Panel III definition (NCEP ATPIII) (21), we defined metabolic syndrome present if 3 of the 5 following criteria were met: 1) abdominal obesity based on high waist circumference (>102 cm (>40 in) for men and >88 cm (>35 in) for women), 2) elevated blood pressure (≥130 mmHg systolic or ≥85 mmHg diastolic) or hypertension medications, 3) elevated fasting plasma glucose (≥100 mg/dL), 4) high serum triglycerides (>150 mg/dL) or medication to reduce triglycerides, and 5) low high-density cholesterol (HDL) levels (<40 mg/dL for men and <50 mg/dL in women) or medication to improve HDL (22). Weight, height, waist circumference, and blood pressure were measured in the mobile exam center (23). Blood was typically drawn from an antecubital vein of the left arm following an overnight fasting. Each participant had up to four blood pressure readings. For participants without missing 2 or 3 measurements (n=379), the blood pressure readings were averaged to determine blood pressure status. For 187 participants with either one of two blood pressure readings missing, the last reading was used. The Multum Lexicon Drug Database was used for drug names and codes in NHANES 2003-2006 (24).

Information on Potential Confounders

We considered as potential confounders factors known to be associated with metabolic syndrome and/or physical activity based on a literature review. Potential confounders included measurements of self-reported socioeconomic status such as ethnicity, age, sex, and education (25–27). Race/ethnicity was based on self-report (non-Hispanic white, non-Hispanic black, and other). Educational levels were collapsed into: <high school, high school, some college, and college graduate or above. Body mass index (BMI) was calculated from measured height and weight [weight (kg)/height (m)^2]. Participants were then classified as underweight (BMI<18.5 kg/m^2), normal weight (BMI 18.5-24.9 kg/m^2), overweight (BMI 25.0-29.9 kg/m^2), or obese (BMI ≥ 30 kg/m^2) (28,29). Smoking status was based on self-report (current, past, never) (30). General health status was self-reported as excellent, very good, good, fair, or poor and collapsed into excellent/very good, good, and fair/poor (31). The duration of disease was determined using the difference between participant's current age and the self-reported age of being told that have the disease (32). Conditions that may limit physical functioning included stroke, congestive heart failure, angina, chronic bronchitis, and emphysema (33).

Statistical Analyses

To allow valid population estimations among distinct demographic groups, weighted analyses were used appropriately to account for the complex sampling design of the NHANES. NHANES-provided weights for participants incorporate adjustments for different selection probabilities and certain types of non-response, as well as an adjustment to independent estimates of population sizes for specific age, sex, and race/ethnicity categories (34). Descriptive characteristics were calculated for OA participants with and without metabolic syndrome. The mean daily activity counts during active minutes, mean daily minutes spent in each level of activities, and the proportion of mean daily total valid wear time were described in relation to presence of metabolic syndrome. Analysis of variance was conducted to examine the association between continuous variables in each activity level and all five metabolic syndrome components. Means adjusted for sex and age were derived from these models (25,26). To estimate the association between quartiles of four physical activity intensity (minutes/day) and presence of metabolic syndrome (Yes/No), four separate logistic models for each level of physical activity intensity were developed. The referent group for each variable was the lowest quartile for each activity type. We initially estimated three models for each physical activity intensity level: 1) crude; 2) age and sex adjusted (data not shown owing to their similarity to crude estimates); and 3) additionally adjusted for other potential confounders whose inclusion changed the estimates of effect by at least 10% in addition to age and sex controlled in the models. From the final models, we estimated adjusted odds ratios (OR) and 95% confidence intervals (CI). Quartiles of minutes per day spent engaging in each type of physical activity were also used to test for linear trend. Multicollinearity was evaluated and ruled out.

Results

Of adults in the United States with OA, 51.0% (95% Confidence Interval (CI): 44.2% to 57.8%) met the criteria for having metabolic syndrome (Table 1). Regardless of metabolic syndrome prevalence, most adults with OA were women and non-Hispanic white. Relative to persons without metabolic syndrome, those with metabolic syndrome were older, had a higher prevalence of obesity (55.5% versus 30.7%), and 3 years longer in disease duration. Participants without metabolic syndrome had a higher percentage of self-reported general health in excellent or very good condition compared to participants with metabolic syndrome (48.3% versus 28.3%).

Table 2 displays the objectively measured physical activity by metabolic syndrome. Regardless of metabolic syndrome status, persons with OA spent approximately 60% of their time being sedentary. About 1 in 10 (9.6%) of adults with metabolic syndrome engaged in the recommended level of moderate to vigorous physical activity compared to 28.2% of adults without metabolic syndrome. Overall, those without metabolic syndrome had 50 minutes more of total activity time than those with metabolic syndrome. Participants without metabolic syndrome spent nearly 30 minutes more per day in combination of lifestyle activity and moderate to vigorous activity compared to participants without metabolic syndrome.

The individual components of metabolic syndrome were highly prevalent among US adults with OA (Table 3). The least common component was high triglycerides (40.9%) and the most common was high blood pressure (73.0%). Participants with large waist circumference, high triglycerides, high blood pressure, and high fasting glucose, the proportion of sedentary time out of total wear time were higher compared to those without these conditions (all $P < 0.05$). Participants with low HDL cholesterol and high triglycerides, the duration of minutes per day in light physical activity were 10 minutes fewer compared to participants without these conditions. Participants with large waist, high blood pressure, and high fasting glucose had between 10-15 fewer minutes per day in lifestyle activity compared to participants without the conditions (all P <0.05). Results when examining physical activity as a categorical variable were very similar (data not shown).

Table 4 provides the relationship between metabolic syndrome and quartiles of average minutes in each level of physical activity. For all but sedentary minutes, the percentage of participants with metabolic syndrome was lower when the quartile of daily minutes in each level of physical activity was higher. After adjusting age, sex, BMI, and general health, the participants in the highest quartile of daily minutes in light activity compared to those in the lowest quartile had half the odds of having metabolic syndrome (quartile 4 versus quartile 1 adjusted odds ratio: 0.45; 95% CI: 0.24 to 0.84; p-value for linear trend < 0.005).

Discussion

This study used the most recent available NHANES accelerometer data to examine the relationship between objectively-measured physical activity levels and metabolic syndrome in a representative sample of people with OA living in the United States. Half of US adults with OA had metabolic syndrome. We found that percentage of sedentary time of total wear time was associated with cluster components of metabolic syndrome such as large waist circumference, high triglycerides, high blood pressure, and high fasting glucose. Adults who engaged in more light, lifestyle, or moderate to vigorous physical activity were less likely to have each component of metabolic syndrome. Furthermore, the decreased prevalence of metabolic syndrome was associated with increasing daily light physical activity.

Metabolic syndrome is a cluster of metabolic risk factors that could increase the risk of mortality or chronic conditions, such as coronary heart disease, stroke, and type 2 diabetes. Our findings are consistent with previous research suggesting that time spent in light physical activity was inversely associated with the continuous risk score for metabolic syndrome (35). Furthermore, the weekly or daily duration in light or moderate to vigorous was associated with cluster components of metabolic syndrome. Accumulated weekly volume of physical activity, rather than the frequency of physical activity throughout the week, has been shown to be strongly associated with metabolic syndrome (36). We found a significant linear trend between daily minutes of light activity and prevalent metabolic syndrome. This finding is in conflict with previous work including relatively healthy and active adults (37). The discrepancies between our findings could be also be due to differences in accelerometers. The previous study used a monitor which recorded some light-intensity activities, such as standing, as sedentary activities.

With respect to the sedentary behaviors, studies using objectively measures showed that not only the total time in sedentary activity were associated with components of metabolic syndrome but also the proportion of sedentary time of total wear time (38,39). However, we found that only the proportion of sedentary time was associated with metabolic risk factors in our study (Table 3). This discrepancy may come from the bias of accelerometer wear time. A national survey reported that the average waking time was 15.4 (hour/day) in the U.S. (40). In our study, the amount of monitor-wearing time was approximately 1.2 hours/day less than the average (14.2 hours/day). This difference may have accounted for the different findings derived from analyses with total minutes versus as proportion of wear time.

The United States DHHS recommend that adults, including those with arthritis, engage in at least 150 minutes a week or more of moderate to vigorous activity (20). Our study showed that 36.2% of U.S. adults met the guidelines. Only 18.7% of U.S adults with OA and 9.6% of U.S adults with both metabolic syndrome and OA met the guidelines. The extent to which such guidelines are reasonable for populations with OA who may experience limitations in mobility is a concern. Whether reduced levels of physical activity may also confer better health related outcomes in patients with OA remains unknown. Increasing daily time spent in light physical activity can reduce onset and progression of disabilities among OA adults (41). Although the OA populations are less likely to meet the guidelines, the daily or weekly minutes in light physical activity was associated with lower prevalence of metabolic syndrome. Investigating the amount of time in relation to different levels of physical activity to promote a better health related outcomes for people with OA is warranted.

However, the proportion of participants who met or did not meet OA physical activity guidelines was higher than previous findings (16). The physical activity recommendations used were adopted from the Centers for Disease Control and Prevention (CDC) and the American College of Sports Medicine published (ACSM) in 1995 which suggested that every US adult should accumulate 30 minutes or more of moderate intensity physical activity on every day and had 5 out of 7 days (42). Furthermore, 10-minute activity bouts were used to present the duration of the activity. This approach has been used to represent the sustained minutes of aerobic exercise that can be accumulated to the desired amount of daily exercise, especially for the purpose of improving the cardiorespiratory performance. In our analysis, we used the physical activity recommendations adopted from 2008 DHHS Physical Activity Guidelines. The discrepancy between these two guidelines may be because they are intended for different groups, and may be age-specific or relevant to overweight or obese individuals. In addition, we included every minute that met the specific criteria rather than 10-minute activity bouts analysis to present the duration of activity. Rather than stressing cardiorespiratory performance, we consider that people with OA should match the type and amount of physical activity to their abilities and severity of their conditions and thus we used every minute accumulated to 150 minutes a week. We believe that this is a reasonable approach for this population.

Engaging in physical activity can not only promote arthritis-specific health benefits such as reduced disability, depression, and pain among OA patients (43–45) but also general health benefits (46). Despite substantial evidence showing that health benefits are related to physical activity, persons with OA are generally physical inactive. Our study is consistent with the findings from a longitudinal study that individuals with OA seldom perform moderate and vigorous physical activity and had approximately more than half of time in sedentary activity in relation to total wear time (47). Socioeconomic status, obesity, quality of diet, severe pain, and severe dysfunction were identified as factors that could be barriers associated with physically inactive/ or being physically active, among OA populations (31,48). These findings point to the urgent need for development of public health interventions that work to increase the physical activity level among the 27 million adults with OA.

Our study has strengths and limitations. To our knowledge, this is the first study to explore relationship between objectively-measured physical activity level and metabolic syndrome among adults with OA using a large nationally representative sample of participants living in the community. However, our study is limited by its cross-sectional study design and prospective studies to confirm these findings are needed. No subjective data of physical activity levels were presented thus hampering comparisons with previous studies. Furthermore, residual confounding could be a possibility due to the lack of information on disease severity and affected joints (i.e. hand OA versus knee OA). In addition, the uniaxial accelerometer used by NHANES is not sensitive to detect all activities such as bicycling, weightlifting, standing, and upper-body movement and thus undercounting the levels of activities and may miss water activities such as swimming (49). Approximately 35% of participants with self-reported OA were excluded from our analytic sample. However, we did not find substantive differences between excluded and included groups, especially in the measured exposure factors.

In summary, U.S. adults with OA are largely sedentary and physical activity, especially daily minutes in activity of light intensity, is inversely related to the prevalence of metabolic syndrome. These findings demonstrate an opportunity to improve health in terms of metabolic syndrome among patients with OA. We may consider to modify messages and guidelines for OA populations by including increases in light activity in addition to engaging in moderate to vigorous activity.

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Significance and Innovations

- This report contributes to population-based studies of objectively-measured physical activity in adults with OA, which are lacking.
- Few adults with OA engage in the recommended 150 minutes/week moderate/ vigorous physical activity.
- Physical activity, especially daily minutes in activity of light intensity, is inversely related to the prevalence of metabolic syndrome in adults with OA.
- The percentage of sedentary time of total wear time, duration of light, lifestyle, and moderate to vigorous physical activity was inversely associated with metabolic syndrome components among adults with OA.

Table 1

Characteristics of adults in the United States with osteoarthritis by presence of metabolic syndrome, NHANES 2003-2006.

	Metabolic syndrome	**No metabolic syndrome**
Sample N	291	275
Weighted N	6,584,786	6,336,424
	Weighted Percentages	
Age, years		
18-34	0.2	5.2
35-49	9.1	19.9
50-64	35.4	38.2
65+	55.3	36.6
Women	66.4	68.1
Race/ethnicity		
Non-Hispanic white	89.1	87.3
Non-Hispanic black	4.5	5.4
Other race/ethnicity	6.3	7.3
Education		
< High school	16.0	11.2
High school	25.3	28.0
Some college	32.8	28.3
College graduate or above	25.9	32.4
Body Mass Index		
Underweight	0.0	1.6
Normal	10.3	35.4
Overweight	34.2	32.3
Obese	55.5	30.7
Smoking		
Current	7.9	14.1
Past	41.0	36.8
Never	51.1	49.1
General Health		

	Metabolic syndrome	No metabolic syndrome
Excellent/very good	28.3	48.3
Good	43.8	34.6
Fair/poor	27.9	17.1
Duration of the disease (years, (SEM))	14.4 (0.8)	11.3 (0.8)
Conditions limiting physical activity		
Stroke	7.2	2.6
Congestive heart failure	7.1	3.0
Angina	9.6	4.1
Chronic bronchitis	15.8	13.8
Emphysema	5.7	3.6

Table 2

Characteristics of objectively measured physical activity by metabolic syndrome for adults with osteoarthritis in the United States, NHANES 2003-2006.

	Metabolic syndrome	No metabolic syndrome
Sample N	291	275
Weighted N	6,584,786	6,336,424
	Weighted Percentages and Means	
Meeting physical activity guideline (%)	9.6	28.2
Total wear time (hours/day)	13.9	14.4
Mean counts during active minutes (SEM)	210.9 (7.3)	272.1 (8.5)
Sedentary:		
Mean duration (minutes/day (SEM))	531.0 (6.3)	509.5 (9.1)
Proportion of total wear time (%)	63.6	58.9
Light Activity:		
Mean duration (minutes/day (SEM))	238.4 (5.6)	259.7 (4.2)
Proportion of total wear time (%)	28.6	30.1
Lifestyle Activity		
Mean duration (minutes/day (SEM))	56.7 (2.1)	78.9 (3.3)
Proportion of total wear time (%)	6.8	9.1
Moderate to vigorous activity:		
Mean duration (minutes/day (SEM))	9.0 (1.0)	16.2 (1.0)
Proportion of total wear time (%)	1.1	1.9

Note. Proportion of wear time may not total to 100% due to rounding.

Table 3

Physical activity level according to components of metabolic syndrome among adults in the United States with osteoarthritis, NHANES 2003-2006.

	Sedentary Activity		Light Activity		Lifestyle Activity		Moderate to Vigorous Activity	
	Duration per day (minutes)	**% of total wear time**	**Duration per day (minutes)**	**% of total wear time**	**Duration per day (minutes)**	**% of total wear time**	**Duration per day (minutes)**	**% of total wear time**
Large waist (N=394, (71.9%))								
Yes	532	53.9	240	28.5	62	7.3	11	1.3
No	525	52.6	247	28.9	71	8.3	14	1.7
***p*-value**	0.54	<0.001	0.23	0.55	0.007	0.01	0.09	0.11
Low HDL (N=260, (44.3%))								
Yes	534	63.9	232	27.8	60	7.1	11	1.3
No	529	61.7	248	28.9	68	7.9	13	1.5
***p*-value**	0.63	0.06	0.02	0.11	0.07	0.11	0.12	0.17
High triglycerides (N=210, (40.9%))								
Yes	540	64.2	234	27.9	58	6.9	9	1.1
No	525	61.7	245	28.7	69	8.0	14	1.6
***p*-value**	0.21	0.05	0.04	0.11	0.08	0.13	0.001	0.002
High blood pressure (N=408, (73.0%))								
Yes	530	63.2	239	28.4	61	7.2	11	1.2
No	523	60.2	249	29.0	76	8.9	17	1.9
***p*-value**	0.65	0.03	0.15	0.51	0.003	0.006	0.003	0.004
High fasting glucose (N=295, (58.1%))								
Yes	549	65.3	249	27.4	52	6.2	9	1.1
No	516	61.3	230	29.5	67	7.7	13	1.5
***p*-value**	0.02	<0.001	0.06	0.04	0.008	0.01	0.05	0.07

*Adjusted for age and sex. Totals may not equal 100% due to rounding.

Table 4

Association between physical activity and prevalence of metabolic syndrome among adults in the United States with osteoarthritis, NHANES 2003-2006.

Mean duration of activity (minutes/day)		Crude odds ratios		Adjusted odds ratios*	
	% with metabolic syndrome	95% Confidence Interval		95% Confidence Interval	
Sedentary					
1 (lowest: ≤455.7)	42.5	1.00		1.00	
2 (>455.7 – 515.9)	51.9	1.46	0.87 to 2.43	1.36	0.79 to 2.35
3 (>515.9 – 584.3)	53.5	1.55	1.02 to 2.36	1.58	0.99 to 2.53
4 (highest: >584.3)	55.9	1.71	0.95 to 3.09	1.22	0.73 to 2.02
p-value for trend				0.34	
Light activity					
1 (lowest: ≤207.7)	61.0	1.00		1.00	
2 (>207.7 – 249.8)	61.4	1.02	0.66 to 1.57	1.31	0.84 to 2.03
3 (>249.8– 289.1)	47.3	0.57	0.29 to 1.12	0.88	0.44 to 1.77
4 (highest: >289.1)	34.3	0.33	0.20 to 0.56	0.45	0.24 to 0.84
p-value for trend				<0.005	
Lifestyle activity					
1 (lowest: ≤35.1)	59.6	1.00		1.00	
2 (>35.1 – 60.3)	64.5	1.23	0.83 to 1.83	2.17	1.10 to 4.30
3 (60.3 – 90.7)	45.2	0.56	0.32 to 0.99	1.09	0.49 to 2.43
4 (highest: >90.7)	34.6	0.36	0.20 to 0.65	0.79	0.36 to 1.72
p-value for trend				0.18	
Moderate to vigorous					
1 (lowest: ≤2.0)	60.7	1.00		1.00	
2 (>2.0 – 7.2)	60.0	0.97	0.54 to 1.75	1.09	0.54 to 2.23
3 (>7.2 – 18.3)	54.2	0.77	0.47 to 1.26	1.00	0.42 to 2.40
4 (highest: >18.3)	29.2	0.27	0.15 to 0.48	0.53	0.22 to 1.28
p-value for trend				0.18	

* All models were adjusted for age (linear term), sex, body mass index, and general health.