Evidence Portfolio – Exposure Subcommittee, Question 5[1]

What is the relationship between bout duration of physical activity and health outcomes?

a. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, or weight status?

Source of Evidence: Original Research

Conclusion Statements and Grades

Moderate evidence indicates that bouts of any length of moderate-to-vigorous physical activity contribute to the health benefits associated with accumulated volume of physical activity. **PAGAC Grade: Moderate.**

Insufficient evidence is available to determine whether the relationship between physical activity accumulated in bouts with a duration of less than 10 minutes and health outcomes varies by age, sex, race/ethnicity, or socioeconomic status. **PAGAC Grade: Not assignable.**

Description of the Evidence

An initial search for systematic reviews, meta-analyses, pooled analyses, and reports did not identify sufficient literature to answer the research question as determined by the Exposure Subcommittee. A complete de novo search of original research was conducted.

Original Research

Overview

A total of 25 original research studies that examined the relationship between bouts of physical activity and different health outcomes were included as sources of evidence. Of the 25 studies, 11 were randomized control trials,[1-11] 2 prospective cohort,[12, 13] and 12 cross-sectional.[14-25] The studies were published from 1995 to 2017.

The analytical sample size ranged from 22[4] to 6,321.[22] Of the studies that reported location, 11 were conducted in the United States,[4, 7, 10, 13, 16, 18-20, 22, 23, 25] 3 in Japan,[5, 14, 15] and 1 in Canada.[17] Other locations included Finland,[24] Italy,[12] and United Kingdom.[8, 11, 21]

Exposures

The included studies examined physical activity performed in short bouts of different durations. The majority of studies (n=16) used accelerometers to measure physical activity,[6, 7, 12-25] and 4[1, 3, 5, 8] used self-report (exercise logs/diaries). Other methods of exposure assessment included heart rate monitor and pedometer,[10] combination of self-report and heart rate monitor,[2, 9, 11] and direct supervision of exercise session.[4]

[1] Question 2 in Chapter 1. Physical Activity Behaviors: Steps, Bouts, And High Intensity Training

Outcomes

The included studies examined various cardiometabolic risk factors, including weight status, body composition, blood lipids, blood pressure, metabolic syndrome, risk of type 2 diabetes, and risk of cardiovascular disease.

Populations Analyzed

The table below lists the populations analyzed in each article.

Table 1. Populations Analyzed by All Sources of Evidence

	Sex	Race/ Ethnicity	Age	Weight Status	Other
Alizadeh, 2013	Female		20–45 years	Overweight and Obese	
Asikainen, 2003	Female		48–63 years		Post-menopausal
Asikainen, 2002	Female		47–64 years		Post-menopausal
Ayabe, 2013	Female	Asian	40–60 years		
Ayabe, 2012	Female	Asian	40–60 years		
Cameron, 2017	Male, Female	Hispanic or Latino, Non-Hispanic or Latino, Other	≤43, >43 years	Overweight and Obese	
Clarke, 2014			18–64 years		
Di Blasio, 2014	Female		<65 years		Post-menopausal
Donnelly, 2000	Female		Mean age 54 and 49 years	Overweight and Obese	
Eguchi, 2013	Male		Mean age 43 years		
Fan, 2013	Male, Female	Black or African American, Hispanic or Latino, Other	18–64 years	Normal/Healthy Weight, Overweight, Obese	
Gay, 2016			>18 years		
Glazer, 2013		White	Mean age 47 years		
Jakicic, 1995	Female		25–50 years	Obese (BMI: 30 and above)	
Jakicic, 1999	Female		25–45 years	Overweight and Obese	
Jefferis, 2016	Male		71–91 years		
Loprinzi, 2013			18–85 years		
Murtagh, 2005			Mean age 45 years		
Quinn, 2006			29–65 years		
Schmidt, 2001	Female		Mean age 20 years	Overweight and Obese	

	Sex	Race/ Ethnicity	Age	Weight Status	Other
Strath, 2008			>18 years		
Vasankari, 2017			18–85 years		
White, 2015			37–55 years		
Wolff-Hughes, 2015			≥20 years		
Woolf-May, 1999	Male, Female		40–66 years		

Supporting Evidence

Original Research

Table 2. Original Research Individual Evidence Summary Tables

<table>
<tr><td colspan="2">Original Research
Citation: Alizadeh, Z, Kordi, et al. Comparison between the effects of continuous and intermittent aerobic exercise on weight loss and body fat percentage in overweight and obese women: a randomized controlled trial. Int J Prev Med. 2013;4(8):881–888.</td></tr>
<tr><td colspan="2">Purpose: To compare the effect of intermittent and continuous exercise on weight and fat percentage of overweight and obese women.</td></tr>
<tr><td>Study Design: Group randomized trial</td><td rowspan="5">Abstract: BACKGROUND: Prevalence of obesity and overweightness in different societies is increasing. Role of physical activity in weight loss and also prevention from some chronic diseases has been discussed previously. The objective of this study was to compare the effect of two different aerobic exercises (intermittent and continuous exercises) while prescribed with concurrent calorie-restrict diet on the weight loss and body fat of overweight and obese females. METHODS: Fifteen individuals in intermittent group performed 40 min moderate Intensity exercise in 3 bouts per day for 5 days per week; the 15 participants of continuous group exercised a single 40 min bout per day, 5 days per week. Also, 15 participants were included in control group without exercise program. A self-monitoring calorie-restrict diet was recommended to all participants. The body fat percentage, waist circumference, and also skin fold thickness of all participants were assessed at baseline and 12(th) weeks. RESULTS: The reduction of weight and BMI of participants in intermittent group (-3.33 +/- 1.80 and -1.34 +/- 0.70, respectively) was significantly more than comparable changes in continuous group (-1.23 +/- 1.60 and 0.49 +/- 0.65, respectively) (P = 0.048 and 0.041, respectively). After the intervention, there was no significant difference between case and controls in terms of body fat percentage, waist circumference, and sum of skin fold thickness. CONCLUSIONS: It seems that moderate intensity intermittent exercise for more than 150 min/ week is more efficient than continuous exercise in weight loss of obese and overweight women.</td></tr>
<tr><td>Location: Not Reported</td></tr>
<tr><td>Sample: 45
Attrition Rate: 0.00%
Sample Power: Not Reported</td></tr>
<tr><td>Intervention: Yes
Intervention Type: Provision of Information/Education, Behavioral
Intervention Length: 12 weeks</td></tr>
<tr><td>Exposure Measurement
Self-Reported: Walking
Exposure/Intervention
Frequency: Group 1: one bout per day, five days per week; Group 2: three bouts per day, five days per week with adaptation period of two bouts per day during first and second week.
Intensity: Moderate intensity (64–75% maximum heart rate, RPE between 13 and 14, ability of talking is around two words).
Time: Group 1: 40 min per day with adaptation period of 20 and 30 min per day in first and second week; Group 2: all bouts more than 10 min and sum was 40 min (with adaptation period of two and three bouts of 10 min for 20 and 30 min per day in first and second week).
Type: Cardiorespiratory, Aerobic exercises (such as brisk walking)
Measures Steps: No
Measures Bouts: Yes
Examines HIIT: No</td></tr>
<tr><td>Refers to Other Materials: No
Adverse Events Addressed: No</td><td>Outcomes Examined: Anthropometric measures: weight, BMI, skin fold thickness, waist circumference, and fat percentage.</td></tr>
</table>

Examine Cardiorespiratory Fitness as Outcome: No	
Populations Analyzed: Female, 20–45 years, Overweight and Obese	**Author-Stated Funding Source:** Shariati Hospital, Tehran University of Medical Sciences

Original Research **Citation:** Asikainen TM, Miilunpalo S, Kukkonen-Harjula K, et al. Walking trials in postmenopausal women: effect of low doses of exercise and exercise fractionization on coronary risk factors. *Scand J Med Sci Sports*. 2003;13(5):284–292.	
Purpose: To evaluate a fractionization of walking training and the minimum dose to affect coronary risk factors in two randomized controlled trials.	
Study Design: Randomized trial **Location:** Not Reported **Sample:** 226 **Attrition Rate:** 11.37% **Sample Power:** Not Reported **Intervention:** Yes **Intervention Type:** Behavioral **Intervention Length:** Study 1 (Group 1 and 2: 15 weeks); Study 2 (Group 3–6: 24 weeks) **Exposure Measurement** **Self-Reported:** Questionnaire at beginning and end of study, in addition to exercise diary. **Device-Measured:** Heart rate monitors and step counters used to measure exercise **Other:** 2/5 weekly sessions were supervised **Exposure/Intervention** **Frequency:** Group 1: 1 session per day, 5 days per week; Group 2: 2 sessions per day, 5 days per week; Control: no training; Group 3–6: 5 days per week. **Intensity:** Group 1 and 2: 65% of VO2 max; Group 3: 55%; Group 4: 45%; Group 5: 55%; Group 6: 45% of VO2 max. **Time:** Group 1–2: time to expend 300 kcal; Group 3–4: time to expend 300 kcal; Group 5–6 time to expend 200 kcal. **Type:** Cardiorespiratory, walking **Examines HIIT:** No **Measures Steps:** No **Measures Bouts:** Yes	**Abstract:** We studied the fractionization of walking training and searched for the minimum dose to affect coronary risk factors in two randomized controlled trials. Altogether 134 (Study I) and 121 (Study II) healthy, sedentary postmenopausal women started the trials, and 130 (Study I) and 116 (Study II) completed them. In Study I the exercise intensity was 65% of the maximal aerobic power (VO2max) and a total of 300 kcal was expended in one (Group W1) or two (Group W2) daily walking bouts. In Study II the exercise was continuous, and the exercise intensity (% of VO2max) and energy expenditure (kcal session(-1)) were 55% and 300 kcal (Group W3), 45% and 300 kcal (Group W4), 55% and 200 kcal (Group W5) and 45% and 200 kcal (Group W6). All the subjects walked 5 days a week. The outcome measures were blood pressure, serum lipoproteins and blood glucose and plasma insulin in fasting state and also during 2-h oral glucose tolerance test in Study I. There was no change in diastolic pressure in the original study groups, but in the combined exercise group (W1+W2) in Study I, the mean diastolic pressure declined by -3.0 mmHg (95% con-fidence interval (CI) -5.5 to -0.4) (P=0.025) in comparison with that of the controls. The mean blood glucose declined by -0.21 mmol L(-1) (CI -0.33 to -0.09) in Group W1 and -0.13 mmol L(-1) (CI -0.25 to -0.01) in Group W2 compared to controls (P=0.03). Also the 2-h glucose concentration decreased in Groups W1 and W2 compared to controls. Systolic blood pressure, serum lipoproteins and insulin levels did not change in Study I or Study II. We conclude that our training program with the greatest exercise dose, exercise intensity 65% of VO2max and weekly expenditure of 1500 kcal had a minimal, positive effect on diastolic pressure and blood glucose, and the effect was similar in one or two daily exercise session groups. This exercise dose is probably close to the minimum to affect coronary risk factors in healthy postmenopausal women. To get a more pronounced and clinically relevant effect, a greater exercise dose is needed.

Refers to Other Materials: Yes **Adverse Events Addressed:** No **Examine Cardiorespiratory Fitness as Outcome:** Yes	**Outcomes Examined:** Blood pressure: random zero sphygomanometer after resting. Blood lipids (HDL-C, LDL-C, total cholesterol, and triglycerides): standard measure. Blood glucose: glucose dehydrogenase method. Cardiorespiratory fitness: maximal exercise test. Body mass: not described.
Populations Analyzed: Female, 48–63 years, Post-menopausal	**Author-Stated Funding Source:** Finnish Ministry of Education, the Juho Vainio Foundation, Finnish Foundation for Cardiovascular Research, Ulla Kauhanen Foundation

Original Research **Citation:** Asikainen TM, Miilunpalo S, Oja P, Rinne M, Pasanen M, Vuori I. Walking trials in postmenopausal women: effect of one vs two daily bouts on aerobic fitness. *Scand J Med Sci Sports*. 2002;12(2):99–105. doi:10.1034/j.1600-0838.2002.120206.x.	
Purpose: To compare the effects of equivolume brisk walking, once or twice a day, on aerobic fitness and body composition on 134 post-menopausal women.	
Study Design: Randomized trial **Location:** Not Reported **Sample:** 134 **Attrition Rate:** 0.00% **Sample Power:** Yes **Intervention:** Yes **Intervention Type:** Behavioral **Intervention Length:** 15 weeks **Exposure Measurement** **Self-Reported:** Exercise diaries to record programmed exercise and other habitual exercise. **Other:** Heart rate monitor to control the walking pace in the 2-weekly supervised sessions and every third week in all weekly sessions. **Measures Steps:** Yes **Measures Bouts:** Yes **Examines HIIT:** No **Exposure/Intervention** **Frequency:** 5 days/week. Group S1: once/day; Group S2: twice/day; Control: no daily walking **Intensity:** 65% of the VO2 max and the weekly exercise volume 1,500 kcal (6,276kJ). **Time:** Duration of daily exercise corresponding to 300 kcal (1,256 kJ) calculated individually. Group 1: Continuous activity; Group 2: divided into two equally long sessions with at least a 5-h interval. **Type:** Cardiorespiratory: two supervised and three unsupervised walking sessions per week.	**Abstract:** We compared the effects of one vs two daily bouts of walking on aerobic fitness and body composition in postmenopausal women. One hundred and thirty-four subjects were randomized into exercise groups or a control group and 130 completed the study. The subjects walked 5 d/week for 15 weeks at 65% of their maximal aerobic power expending 300 kcal (1255 kJ) in exercise in one (Group S1) or two daily sessions (Group S2). VO(2max) was measured in a direct maximal treadmill test. Body mass index (BMI) was calculated and the percentage of body fat (fat%) estimated using skinfold measurements. The net change in the VO(2max) was 2.5 mL min/kg (95% CI 1.5, 3.5) (8.7%) in Group S1 and 2.5 mL min/kg (95% CI 1.5, 3.5) (8.8%) in Group S2. The net change in body mass was -1.2 kg (95% CI-1.9, -0.5) in Group S1 and -1.1 kg (95% CI -1.8, -0.4) in Group S2. The net fat% change was -2.1% (95% CI-2.7, -1.4) in Group S1 and -1.7% (95% CI-2.3, -1.0) in Group S2. Exercise improved the maximal aerobic power and body composition equally when walking was performed in one or two daily bouts.
Refers to Other Materials: No **Adverse Events Addressed:** No **Examine Cardiorespiratory Fitness as Outcome:** Yes	**Outcomes Examined:** Changes in VO2max (ml/kg/min). Submaximal cardiorespiratory fitness (heart rate max at 65%, 75%VO2 max). Body composition: weight (kg), body mass index (kg/m2), and body fat (%).
Populations Analyzed: Female, 47–64 years, Post-menopausal	**Author-Stated Funding Source:** The Finnish Ministry of Education, the Juho Vainio Foundation, the Finnish Foundation for Cardiovascular Research

Original Research **Citation:** Ayabe M, Kumahara H, Morimura K, Sakane N, Ishii K, Tanaka H, et al. Accumulation of short bouts of non-exercise daily physical activity is associated with lower visceral fat in Japanese female adults. *Int J Sports Med*. 2013;34(1):62–67. doi:10.1055/s-0032-1314814.	
Purpose: To assess the relationship between the very short physical activity (PA) bout lasting 32 seconds to 5 minutes and abdominal fat.	
Study Design: Cross-sectional study **Location:** Japan **Sample:** 42 **Attrition Rate:** 0.00% **Sample Power:** Not Reported **Intervention:** No **Exposure Measurement** **Device-Measured:** Accelerometer, minutes per day spent performing PA of various intensities including light (LPA), moderate (MPA), vigorous (VPA), and moderate-to-vigorous (MVPA) were assessed; PA also assessed according to the duration of the bout: daily time spent on LPA, MPA, VPA, and MVPA lasting at least 32 s, 1 min, 3 min, 5 min and 10 min were assessed along with the frequency (bouts/day) for each bout duration. **Measures Steps:** No **Measures Bouts:** Yes **Examines HIIT:** No	**Abstract:** The purpose of the present investigation was to assess the relationship between bouts of very short daily physical activity (PA) lasting <10 min with obesity and abnormal fat distributions. A total of 42 females (age 50+/-6 years, height 156+/-5 cm, body weight 54+/-8 kg, body mass index 22+/-3 kg/m2) participated in the present investigation. Computed tomography was used to evaluate the area of visceral adipose tissue and subcutaneous adipose tissue (VAT and SAT). All participants wore a pedometer with a one-axial accelerometer (Lifecorder, Kenz, Japan) in order to determine their frequency (bouts/day) of PA and moderate to vigorous intensity PA (MVPA). The total frequency of PA and MVPA, including all bout durations, was not significantly associated with the body fat distribution. The frequency of PA lasting longer than 3 min and 5 min, and MVPA lasting longer than 1 min and 3 min were significantly associated with the area of the VAT ($p<0.05$). A smaller area of VAT was associated with a higher frequency of PA and MVPA lasting 1-5 min. The present investigation did not find that very short bouts of PA lasting<1 min played a significant role in controlling abdominal fat distribution.
Refers to Other Materials: No **Examine Cardiorespiratory Fitness as Outcome:** No	**Outcomes Examined:** Body Mass Index: weight and height directly measured. Waist circumference: standard tape measure at height of navel. Whole body body fat percentage: 2-site skinfold thickness. Abdominal fat area: computed tomography (CT) to determine visceral adipose tissue (VAT) and subcutaneous adipose tissue (SAT).
Populations Analyzed: Female, Asian, 40–60 years	**Author-Stated Funding Source:** Fukuoka University

Original Research **Citation:** Ayabe, M, Kumahara, H, et al. Very short bouts of non-exercise physical activity associated with metabolic syndrome under free-living conditions in Japanese female adults. *Eur J Appl Physiol*. 2012;112(10):3525–3532. doi:10.1007/s00421-012-2342-8.	
Purpose: To assess the relationship between very short physical activity (PA) lasting <5 min with obesity and metabolic syndrome (MS).	
Study Design: Cross-sectional study **Location:** Japan **Sample:** 42 **Attrition Rate:** 0.00% **Sample Power:** Not Reported **Intervention:** No **Exposure Measurement** **Device-Measured:** One-axial accelerometer, determined the time and the frequency of PA and the moderate to vigorous intensity PA (MVPA). PA and MVPA were also analyzed based on the bout duration, such as >32 s, >1 min, >3 min, and >5 min. **Measures Steps:** Yes **Measures Bouts:** Yes **Examines HIIT:** No	**Abstract:** To assess the association between very short daily non-exercise physical activity (PA) lasting <5 min and metabolic syndrome (MS). A total of 42 females (50 +/- 6 years) wore a pedometer with a one-axial accelerometer (Lifecorder, Kenz, Japan) to determine the time and the frequency of PA and the moderate to vigorous intensity PA (MVPA). In addition to the PA and the MVPA (PA(all) and MVPA(all)), the PA and MVPA were analyzed based on the bout duration, such as >32 s, >1 min, >3 min, and >5 min (PA(32S), PA(1M), PA(3M), PA(5M); MVPA(32S), MVPA(1M), MVPA(3M), MVPA(5M)). MS was defined according to the Japanese standard based on waist circumfluence, blood lipids, blood glucose, and blood pressure. The frequency of the MVPA(1M) was significantly lower in subjects with MS compared with that in subjects without MS (P < 0.05). The frequency of MVPA(32S) and MVPA(1M) was significantly associated with the HDL cholesterol (P < 0.05). The frequency of PA(3M) and PA(5M) was significantly associated with the fasting glucose level (P < 0.05). In contrast, we could not find any significant relationships between MS and the components of MS and the frequency of PA lasting <32 s. These results demonstrated that very short non-exercise PA, such as MVPA lasting >32 s to 3 min, has significantly associated with the components of MS. The specific advantages with regard to PA lasting <32 s remain unclear.
Refers to Other Materials: No **Examine Cardiorespiratory Fitness as Outcome:** No	**Outcomes Examined:** Metabolic syndrome (MS) was defined according to the Japanese standard based on waist circumfluence (≥90 cm), blood lipids, blood glucose, and blood pressure. For the diagnosis of MS, a waist circumference (WC) ≥90 cm is considered to be an essential component, along with at least two of the other components, including dyslipidemia (triglycerides ≥150 mg/dl and/or HDL-C level <40 mg dl-1, or specific treatment for these lipid abnormalities), hypertension (SBP ≥130 mmHg and/or DBP ≥85 mmHg, or treatment of previously diagnosed hypertension), or hyperglycemia (fasting plasma glucose ≥110 mg/dl).
Populations Analyzed: Female, Asian, 40–60 years	**Author-Stated Funding Source:** Fukuoka University, Kao Research Council for the Study of Health Science

Original Research **Citation:** Cameron N, Godino J, Nichols JF, Wing D, Hill L, Patrick K. Associations between physical activity and BMI, body fatness, and visceral adiposity in overweight or obese Latino and non-Latino adults. *Int J Obes (Lond).* 2017;41(6):873–877. doi:10.1038/ijo.2017.49.	
Purpose: To evaluate the associations between body composition and moderate-to-vigorous physical activity (MVPA) in Latino and non-Latino adults.	
Study Design: Cross-sectional study **Location:** United States **Sample:** 236 **Attrition Rate:** 20.80% **Sample Power:** Not Reported **Intervention:** No **Exposure Measurement Device-Measured:** Accelerometer, MVPA outcome variables of interest included: (1) average minutes of MVPA per day (MVPA), (2) average minutes of MVPA performed in bouts of ≥10 min per day (MVPA bouts), (3) average minutes of MVPA performed in <10 min bouts (non-bouts MVPA) and (4) a yes/no binary determined upon performing at least 150 min of MVPA in bouts of ≥10 min (Meeting Guidelines). **Measures Steps:** No **Measures Bouts:** Yes	**Abstract:** BACKGROUND/OBJECTIVES: Although several studies have reported associations between moderate to vigorous physical activity (MVPA), body fatness and visceral adipose tissue (VAT), the extent to which associations differ among Latinos and non-Latinos remains unclear. This study evaluated the associations between body composition and MVPA in Latino and non-Latino adults. SUBJECTS/METHODS: An exploratory, cross-sectional analysis was conducted using baseline data collected from 298 overweight adults enrolled in a 12-month randomized controlled trial that tested the efficacy of text messaging to improve weight loss. MVPA, body fatness and VAT were assessed by waist-worn accelerometry, dual-energy x-ray absorptiometry (DXA), and DXA-derived software (GE CoreScan GE, Madison, WI, USA), respectively. Participants with <5 days of accelerometry data or missing DXA data were excluded; 236 participants had complete data. Multivariable linear regression assessed associations between body composition and MVPA per day, defined as time in MVPA, bouts of MVPA (time per bout 10 min), non-bouts of MVPA (time per bout <10 min) and meeting the 150-min MVPA guideline. The modifying influence of ethnicity was modeled with a multiplicative interaction term. RESULTS: The interaction between ethnicity and MVPA in predicting percent body fat was significant (P=0.01, 95% confidence interval (CI) (0.58, 4.43)) such that a given increase in MVPA was associated with a greater decline in total body fat in non-Latinos compared with Latinos (adjusted for age, sex and accelerometer wear time). There was no interaction between ethnicity and MVPA in predicting VAT (g) (P=0.78, 95% CI (-205.74, 273.17)) and body mass index (BMI) (P=0.18, 95% CI (-0.49, 2.26)). CONCLUSIONS: An increase in MVPA was associated with a larger decrease in body fat, but neither BMI nor VAT, in non-Latinos compared with Latinos. This suggests that changes in VAT and BMI in response to MVPA may be less influenced by ethnicity than is total body fatness.
Refers to Other Materials: No **Examine Cardiorespiratory Fitness as Outcome:** No	**Outcomes Examined:** Body mass index: objectively measured. Percentage body fat: dual-energy x-ray absorptiometry. Visceral adipose tissue (g): dual-energy x-ray absorptiometry.
Populations Analyzed: Male, Female, Hispanic or Latino, Non-Hispanic or Latino, Other, ≤43 years, >43 years, Overweight and Obese	**Author-Stated Funding Source:** National Institutes of Health

Original Research **Citation:** Clarke J, Janssen I. Sporadic and bouted physical activity and the metabolic syndrome in adults. *Med Sci Sports Exerc*. 2014;46(1):76–83. doi:10.1249/MSS.0b013e31829f83a0.	
Purpose: To determine whether bouted moderate-to-vigorous PA (MVPA) is more strongly associated with cardiometabolic risk factors, specifically with the metabolic syndrome, than an equivalent volume of sporadic MVPA among adults.	
Study Design: Cross-sectional study **Location:** Canada **Sample:** 1,119 **Attrition Rate:** 0.00% **Sample Power:** Not Reported **Intervention:** No **Exposure Measurement** **Self-Reported:** **Device-Measured:** Calculated bouted MVPA (accumulated in at least 10-min bouts) and sporadic MVPA (accumulated in period of 9 min or less); participants were also divided into three groups for both sporadic and bouted MVPA using cutpoints in metabolic equivalent (MET) min/week equivalent to the physical activity guidelines: inactive (0–249), somewhat active (250–499 or meeting 50% of the guideline), and active (≥500 MET-minutes or meeting 100% of the guideline). **Measures Steps:** No **Measures Bouts:** Yes **Examines HIIT:** No	**Abstract:** PURPOSE: Physical activity guidelines recommend that adults accumulate at least 150 min of moderate-to-vigorous physical activity (MVPA) per week in bouts of at least 10 min. However, sporadic MVPA contributes significantly to total physical activity and may also affect health. The study objective was to determine, within adults age 18 to 64 yr, whether MVPA accumulated in bouts is more strongly associated with metabolic syndrome (MetS) than an equivalent volume of MVPA accumulated sporadically. METHODS: The study sample included 1119 adults age 18 to 64 yr from the 2007-2009 Canadian Health Measures Survey, a nationally representative cross-sectional study. The energy expenditure from bouted (at least 10 consecutive minutes) and sporadic (<10 consecutive minutes) MVPA was measured for 7 d using Actical accelerometers. The presence of MetS was determined using established criteria. Associations were examined using logistic regression and controlled for covariates (age, sex, education, diet, and smoking). RESULTS: After adjusting for the covariates and each other, bouted and sporadic MVPA were independently associated with the MetS. For each additional MET-hour per week of bouted MVPA, the relative odds of the MetS decreased by 9% (95% confidence interval, 3%-14%). For each additional MET-hour per week of sporadic MVPA, the relative odds of the MetS decreased by 11% (5%-16%). Overlapping confidence interval indicates no difference in the effect estimates for bouted and sporadic MVPA. Secondary analyses revealed that small bursts of sporadic MVPA (1-3 min) were meaningful when predicting the MetS. CONCLUSION: Within this representative sample of Canadian adults, sporadic MVPA was associated with the MetS to a similar order of magnitude as an equivalent volume of bouted MVPA.
Refers to Other Materials: Yes **Examine Cardiorespiratory Fitness as Outcome:** No	**Outcomes Examined:** Metabolic syndrome (MetS): presence of three or more of the following conditions: high blood pressure, high triglycerides, low HDL cholesterol, high fasting blood glucose, and high waist circumference. Also estimates for each risk factor presented independently.
Populations Analyzed: 18–64 years	**Author-Stated Funding Source:** Heart and Stroke Foundation of Ontario

Original Research **Citation:** Di Blasio A, Bucci I, Ripari P, et al. Lifestyle and high density lipoprotein cholesterol in postmenopause. *Climacteric*. 2014;17(1):37–47. doi:10.3109/13697137.2012.758700.	
Purpose: To investigate variables linked with basal plasma high density lipoprotein (HDL) cholesterol levels and the effects of aerobic training, on their variations, in 40 post-menopausal women.	
Study Design: Prospective cohort study **Location:** Italy **Sample:** 40 **Attrition Rate:** 0.00% **Sample Power:** Not Reported **Intervention:** Yes **Intervention Type:** Behavioral **Intervention Length:** 14 weeks **Exposure Measurement** **Device-Measured:** Daily physical activity (PA) in a free-living context assessed before and after the exercise program over 3 consecutive days using SenseWear Pro 2 armbands; the number of daily bouts of PA spent at moderate and/or vigorous intensity that lasted for at least 5 and 10 consecutive minutes were measured. Other measures included: metabolic equivalent (MET) min/day, daily steps, time per day spent on moderate (3 METs) and on vigorous-intensity PA (6 METs), energy expenditure from moderate and vigorous PA, and low-intensity PA. Volume of the exercise program was also calculated (sum of the volume for each completed session calculated by multiplying time of the session, in minutes, by the ratings of the perceived exertion (RPE) points. **Measures Steps:** Yes **Measures Bouts:** Yes **Examines HIIT:** No **Exposure/Intervention** **Frequency:** 1 time per day, 4 days per week **Intensity:** Moderate intensity (i.e., 11–13 RPE) that was differently modulated with the duration of the training according to the month of training. **Time:** 40 min for the first month and 50 min for the second month. **Type:** Cardiorespiratory, walking	**Abstract:** OBJECTIVES: Menopause is characterized by hormonal and metabolic changes. These are linked to increased risk of cardiovascular disease, for which low blood plasma levels of high density lipoprotein (HDL) cholesterol are an independent risk factor. The present study investigated variables linked with basal plasma HDL cholesterol levels and the effects of aerobic training, on their variations, in 40 postmenopausal women. METHODS: We assessed body composition, dietary habits and maximal aerobic capacity of participants. Characteristics of daily physical activity and plasma lipoproteins were measured. The women walked on 4 days/week, for 14 weeks, at moderate intensity, and they were grouped according to the resulting tertiles of basal plasma HDL cholesterol levels. RESULTS: Logistic regression analysis showed that waist-to-hip ratio and number of daily bouts of moderate-intensity physical activity, held for at least 10 consecutive minutes (B10m/day), are predictive variables of basal plasma HDL cholesterol levels. After the training period, the first and second tertiles increased plasma HDL cholesterol levels, while the third tertile decreased plasma HDL cholesterol levels. The tertiles showed different remodelling of spontaneous physical activity: the third tertile reduced B10m/day, while the others did not. CONCLUSIONS: This study provides knowledge about the relationships of plasma HDL cholesterol levels with characteristics of physical activity. Furthermore, it shows that physical exercise engagement can result in negative compensation of spontaneous physical activity that could counteract or reduce the positive effects of the aerobic training on plasma HDL cholesterol levels.

Refers to Other Materials: No **Examine Cardiorespiratory Fitness as Outcome:** Yes	**Outcomes Examined:** Tertiles of basal plasma HDL cholesterol levels.
Populations Analyzed: Female, <65 years, Post-menopause	**Author-Stated Funding Source:** Italian Ministry for Education

Original Research **Citation:** Donnelly JE, Jacobsen DJ, Heelan KS, Seip R, Smith S. The effects of 18 months of intermittent vs. continuous exercise on aerobic capacity, body weight and composition, and metabolic fitness in previously sedentary, moderately obese females. *Int J Obe Relat Metab Disord*. 2000;24(5):566–572.	
Purpose: To compare the effects of 18 months of continuous vs intermittent exercise on aerobic capacity, body weight and composition, and metabolic fitness in previously sedentary, moderately obese females.	
Study Design: Randomized trial **Location:** United States **Sample:** 22 **Attrition Rate:** 0.00% **Sample Power:** Not Reported **Intervention:** Yes **Intervention Type:** Behavioral **Intervention Length:** 18 months **Exposure Measurement** **Other:** Recorded by research assistant, distance walked, heart rate at the end of exercise, duration, and rating of perceived exertion (RPE) after each session for the Continuous group (CON) and randomly two times per week for the Intermittent group (INT) to ensure compliance. **Measures Steps:** No **Measures Bouts:** Yes **Examines HIIT:** No **Exposure/Intervention** **Frequency:** CON: 3 times/week; INT: 5 days/week, 2 times per day **Intensity:** CON: 60–75% maximal aerobic capacity; INT: 50–65% heart rate reserve. **Time:** CON: 30 min; INT: 15 min/session (2 times/day) **Type:** Cardiorespiratory: Brisk walking at home and twice a week supervised for the INT group, onsite supervised at all times for the CON group.	**Abstract:** OBJECTIVES: To compare the effects of 18 months of continuous vs intermittent exercise on aerobic capacity, body weight and composition, and metabolic fitness in previously sedentary, moderately obese females. DESIGN: Randomized, prospective, long-term cohort study. Subjects performed continuous exercise at 60-75% of maximum aerobic capacity, 3 days per week, 30 min per session, or exercised intermittently using brisk walking for two, 15 min sessions, 5 days per week. MEASURES: Aerobic capacity, body weight, body composition, and metabolic fitness (blood pressure, lipids, glucose and insulin). RESULTS: Significant improvements for aerobic capacity of 8% and 6% were shown for the continuous and intermittent exercise groups, respectively. Weight loss for the continuous exercise group was significant at 2.1% from baseline weight and the intermittent group was essentially unchanged. The continuous group showed a significant decrease in percentage of body fat and fat weight while the intermittent group did not. HDL cholesterol and insulin were significantly improved for both groups. CONCLUSIONS: In previously sedentary, moderately obese females, continuous or intermittent exercise performed long-term may be effective for preventing weight gain and for improving some measures of metabolic fitness.
Refers to Other Materials: No **Adverse Events Addressed:** No **Examine Cardiorespiratory Fitness as Outcome:** Yes	**Outcomes Examined:** Aerobic capacity: graded treadmill walk test. Body fat percentage: hydrostatic weighing. Hip and waist circumference (Waist-to-Hip Ratio). Total cholesterol, triglycerides, glucose, insulin, high density lipoprotein cholesterol: blood sample, Oral glucose tolerance test, resting systolic and diastolic blood pressure. All outcomes assessed at baseline, 9, and 18 months.

Populations Analyzed: Female, Mean age 54 years (CON), 49 years (INT), Overweight and Obese	**Author-Stated Funding Source:** American Heart Association

Original Research **Citation:** Eguchi M, Ohta M, Yamato H. The effects of single long and accumulated short bouts of exercise on cardiovascular risks in male Japanese workers: a randomized controlled study. *Ind Health*. 2013;51(6):563–571.	
Purpose: To determine if several bouts of exercise can achieve the same effects on cardiovascular risk factors in sedentary male Japanese workers as single long bouts of exercise during a period of 20 weeks and to compare the relative effects of these exercise programs on oxidative stress.	
Study Design: Randomized trial **Location:** Japan **Sample:** 23 **Attrition Rate:** 0.00% **Sample Power:** Not Reported **Intervention:** Yes **Intervention Type:** Behavioral **Intervention Length:** 20 weeks **Exposure Measurement** **Self-Reported:** Self monitored exercise, subjects recorded the time of day for each bout. **Measures Steps:** No **Measures Bouts:** Yes **Examines HIIT:** No **Exposure/Intervention** **Frequency:** Group 1: 1 session per day, 3 days per week; Group 2: 3 sessions separated by at least 2 hrs per day, 3 days per week **Intensity:** 50% of maximal oxygen consumption, ≤70% maximum heart rate **Time:** Group 1: 30 min per session; Group 2: 10 min per bout **Type:** Cardiorespiratory, Cycle ergometers	**Abstract:** The aim of this study was to determine whether accumulated short bouts of exercise can achieve the same cardiovascular benefits as a single long bout of exercise in sedentary male Japanese workers and to compare the programs' relative effects on oxidative stress. Twenty-three sedentary male workers were randomly assigned into 2 different exercise programs: a Long-bout group, which performed a single period of continuous exercise (Long-bout group: 30?min × 1) 3 d per week, and a Short-bouts group, which performed 3 short bouts of exercise (Short-bouts group: 10?min × 3) 3 d per week. Cardiovascular risk factors, including the plasma thiobarbituric acid-reactive substances (TBARS) level, were examined at baseline and after both 10 and 20 wk. In the Long-bout group, waist circumference and maximum oxygen uptake (VO2max) significantly improved after 20 wk. The Short-bouts group demonstrated significant increases in VO2max after 10 weeks and in HDL-C after 20 wk. Plasma TBARS significantly decreased after 20 weeks in the Long-bout group and tended to decrease (but not significantly) in the Short-bouts group. These results indicate that accumulated short bouts of exercise are an effective option, especially for busy workers, for incorporating exercise into one's lifestyle.
Refers to Other Materials: No **Adverse Events Addressed:** No **Examine Cardiorespiratory Fitness as Outcome:** Yes	**Outcomes Examined:** Height, weight and waist circumference: objectively measured. Blood pressure: seated using an automatic sphygmomanometer. Blood lipids (total cholesterol, HDL-C, and triglycerides): objectively measured after fasting for 12 hours. Maximum oxygen uptake: submaximal test with cycle ergometer.
Populations Analyzed: Male, Mean age 43 years	**Author-Stated Funding Source:** Not Reported

Original Research **Citation:** Fan JX, Brown BB, Hanson H, Kowaleski-Jones L, Smith KR, Zick CD. Moderate to vigorous physical activity and weight outcomes: does every minute count? *Am J H Promot*. 2013;28(1):41–49. doi:10.4278/ajhp.120606-QUAL-286.	
Purpose: To test if moderate-to-vigorous physical activity (MVPA) in less than the recommended ≥10-min bouts is related to weight outcomes.	
Study Design: Cross-sectional study **Location:** United States **Sample:** 4,511 **Attrition Rate:** 46.92 **Sample Power:** Not Reported **Intervention:** No **Exposure Measurement** **Device-Measured:** Accelerometer, four physical activity measures were created: higher-intensity long bouts (≥10-min bouts and ≥2,020 counts per minute [cpm]), higher-intensity short bouts (<10-min bouts and ≥2,020 cpm), lower-intensity long bouts (≥10-min bouts and 760–2,019 cpm), and lower-intensity short bouts (<10-min bouts and 760–2,019 cpm). The average daily minutes for each category were calculated across all valid days. **Measures Steps:** No **Measures Bouts:** Yes **Examines HIIT:** No	**Abstract:** PURPOSE: The purpose of this study was to test if moderate to vigorous physical activity (MVPA) in less than the recommended >/=10-minute bouts related to weight outcomes. DESIGN: Secondary data analysis. SETTING: Random sample from the U.S. civilian noninstitutionalized population included in the National Health and Nutrition Examination Survey (NHANES). PARTICIPANTS: A total of 4511 adults aged 18 to 64 years from the 2003-2006 NHANES. METHOD: Clinically measured body mass index (BMI) and overweight/obese status were regressed on accelerometer measures of minutes per day in higher-intensity long bouts (>/=10 minutes, >/=2020 accelerometer counts per minute [cpm]), higher-intensity short bouts (<10 minutes, >/=2020 cpm), lower-intensity long bouts (>/=10 minutes, 760-2019 cpm), and lower-intensity short bouts (<10 minutes, 760-2019 cpm). Socioeconomic and demographic characteristics were controlled. RESULTS: Both higher-intensity short bouts and long bouts of PA related to lower BMI and risk of overweight/obesity. Neither lower-intensity short bouts nor long bouts related to BMI or risk of overweight/obesity. CONCLUSION: The current >/=10-minute MVPA bouts guideline was based on health benefits other than weight outcomes. Our findings showed that for weight gain prevention, accumulated higher-intensity PA bouts of <10 minutes are highly beneficial, supporting the public health promotion message that "every minute counts."
Refers to Other Materials: No **Examine Cardiorespiratory Fitness as Outcome:** No	**Outcomes Examined:** Body Mass Index: clinically measured to determine categorical measure of overweight/obesity. Overweight and obesity risk.
Populations Analyzed: Male, Female, Black or African American, Hispanic or Latino, Other, 18–64 years, Normal/Healthy Weight (BMI: 18.5-24.9), Overweight (BMI: 25–29.9) and Obese (BMI: 30 and above)	**Author-Stated Funding Source:** National Institutes of Health

Original Research
Citation: Gay JL, Buchner DM, Schmidt MD. Dose-response association of physical activity with HbA1c: intensity and bout length. *Prevent Med*. 2016;86:58-63. doi:10.1016/j.ypmed.2016.01.008.

Purpose: To characterize the dose–response relationship between moderate-to-vigorous physical activity (MVPA) and total physical activity (light, moderate, and vigorous) with HbA1c in adults at low, moderate, and high risks of type 2 diabetes.

Study Design: Cross-sectional study

Location: United States

Sample: 5,302
Attrition Rate: 0
Sample Power: Not Reported

Intervention: No

Exposure Measurement
Device-Measured: Accelerometer, PA measured in counts/minutes and classified into intensity categories of sedentary, light, and MVPA; total minutes, total counts, and average daily counts calculated and partitioned by intensity category: daily MVPA in long bouts (≥10 min), daily MVPA counts in short bouts (≤10 min), proportion of activity counts in MVPA, and in short bouts of MVPA, and light-intensity activity.
Measures Steps: No
Measures Bouts: Yes

Abstract: OBJECTIVE: The aims of this study were to characterize the dose-response relationship between moderate-to-vigorous intensity physical activity (MVPA), and light-intensity activity with HbA1c in adults at low, moderate, and high risks of type 2 diabetes, and to compare the relationship of short (1 to 9min) versus long (10+min) bouts of MVPA with HbA1c. METHODS: Data from 2707 participants from the 2003-2006 National Health And Nutrition Examination Survey were analyzed in 2014-2015. Type 2 diabetes risk was classified into three groups based upon age (<40years; >/=40years) and BMI (<30; >/=30). The relationship between HbA1c and accelerometer-based physical activity variables was assessed using multiple regression models. RESULTS: There was a curvilinear dose-response relationship between HbA1c with total activity and MVPA in adults at moderate or high risk for type 2 diabetes: higher amounts of physical activity were associated with lower HbA1c. The association of physical activity on HbA1c was stronger at lower levels of physical activity. There was no dose-response relationship in adults at low risk for type 2 diabetes. The relationship between short bouts with HbA1c was stronger than for bouts>/=10min. CONCLUSIONS: In adults at risk for type 2 diabetes, there is a dose-response relationship between physical activity and HbA1c levels such that the relationship: (1) is curvilinear; (2) is stronger when a higher percent of total activity comes from MVPA; and (3) is more potent with short bouts of MVPA. Fractionalized physical activity of at least moderate-intensity may contribute to long-term glucose control.

Refers to Other Materials: Yes
Examine Cardiorespiratory Fitness as Outcome: No

Outcomes Examined: Risk of type 2 diabetes: classified as low, moderate, or high risk based on age and body mass index. Glycated hemoglobin (HbA1c).

Populations Analyzed: >18 years

Author-Stated Funding Source: Not Reported

Original Research

Citation: Glazer NL, Lyass A, Esliger DW, et al. Sustained and shorter bouts of physical activity are related to cardiovascular health. *Med Sci Sports Exerc*. 2013;45(1):109–115. doi:10.1249/MSS.0b013e31826beae5.

Purpose: To investigate the relationship between moderate-to-vigorous PA (MVPA), measured in bouts ≥10 min and <10 min, and cardiovascular disease risk factors in a well-characterized, community-based sample of white adults.

Study Design: Cross-sectional study

Location: United States

Sample: 2,109
Attrition Rate: 0.00%
Sample Power: Not Reported

Intervention: No

Exposure Measurement
Device-Measured: Accelerometer, MVPA defined as 1,486–5,558 counts per minute for moderate intensity and ≥5,559 counts for vigorous intensity, corresponding to metabolic equivalent (MET) values of 3–6 for moderate intensity and >6 for vigorous intensity activities; total physical activity time at each intensity level is the sum of the minutes at a given intensity while the accelerometer is worn. MVPA10+ calculated as the sum of MVPA accumulated in bouts of at least 10 min allowing for a 1–2 min interruption. MVPA<10 was calculated as the sum of MVPA accumulated <10 min at a time.
Measures Steps: No
Measures Bouts: Yes
Examines HIIT: No

Abstract: PURPOSE: Whereas greater physical activity (PA) is known to prevent cardiovascular disease (CVD), the relative importance of performing PA in sustained bouts of activity versus shorter bouts of activity on CVD risk is not known. The objective of this study was to investigate the relationship between moderate-to-vigorous PA (MVPA), measured in bouts >/=10 and <10 min, and CVD risk factors in a well-characterized community-based sample of white adults. METHODS: We conducted a cross-sectional analysis of 2109 participants in the Third Generation Cohort of the Framingham Heart Study (mean age = 47 yr, 55% women) who underwent objective assessment of PA by accelerometry over 5-7 d. Total MVPA, MVPA done in bouts >/=10 min (MVPA(10+)), and MVPA done in bouts <10 min (MVPA(<10)) were calculated. MVPA exposures were related to individual CVD risk factors, including measures of adiposity and blood lipid and glucose levels, using linear and logistic regression. RESULTS: Total MVPA was significantly associated with higher HDL levels and with lower triglycerides, BMI, waist circumference, and Framingham risk score (P < 0.0001). MVPA(<10) showed similar statistically significant associations with these CVD risk factors (P < 0.001). Compliance with national guidelines (>/=150 min of total MVPA) was significantly related to lower BMI, triglycerides, Framingham risk score, waist circumference, higher HDL, and a lower prevalence of obesity and impaired fasting glucose (P < 0.001 for all). CONCLUSIONS: Our cross-sectional observations on a large middle-age community-based sample confirm a positive association of MVPA with a healthier CVD risk factor profile and indicate that accruing PA in bouts <10 min may favorably influence cardiometabolic risk. Additional investigations are warranted to confirm our findings.

Refers to Other Materials: Yes
Examine Cardiorespiratory Fitness as Outcome: No

Outcomes Examined: Cardiovascular disease risk factors: anthropometric measures (BMI, waist circumference), fasting glucose, triglycerides, high density lipoprotein cholesterol, systolic and diastolic blood pressure, and Framingham risk score. Binary outcomes: hypertension, obesity, impaired glucose tolerance, and diabetes.

Populations Analyzed: White, Mean age 47 years	**Author-Stated Funding Source:** National Heart, Lung and Blood Institute

Original Research

Citation: Jakicic JM, Wing RR, Butler BA, Robertson RJ. Prescribing exercise in multiple short bouts versus one continuous bout: effects on adherence, cardiorespiratory fitness, and weight loss in overweight women. *Int J Obe Relat Metab Disord*. 1995;19(12):893–901.

Purpose: To investigate whether exercise adherence in obese females participating in a behavioral weight loss program is improved by prescribing daily exercise in multiple short-bouts compared to the standard recommendation of one continuous bout of exercise, and to determine whether these multiple short-bouts of daily exercise can produce significant improvements in cardiorespiratory fitness.

Study Design: Randomized trial

Location: Not Reported

Sample: 48
Attrition Rate: 14.28%
Sample Power: Not Reported

Intervention: Yes
Intervention Type: Behavioral
Intervention Length: 20 weeks

Exposure Measurement
Self-Reported: Weekly exercise records (completed by study subjects), calculate weekly exercise participation; information included type and duration of session.
Device-Measured: Accelerometers randomly assign to subjects for two 5-day periods during the study (weeks 5–10 and weeks 12–18); assessed number of minutes of continuous energy expenditure (>12.5 kJ min-1 was calculated and the number of bouts of 5–14.0 min, 15–24.9 min, 25–24.9 min, and ≥35 min).
Measures Steps: No
Measures Bouts: Yes
Examines HIIT: No
Exposure/Intervention
Frequency: Group 1: 1 session per day, 5 days per week; Group 2: 2–4 bouts per day, 5 days a week (varied by time of study).
Intensity: 70% of heart rate reserve
Time: Group 1: 20–40 min (varied during time of study); Group 2: 10 min per bout
Type: Cardiorespiratory: primarily walking prescribed.

Abstract: DESIGN: Randomized controlled trial with subjects randomized to either a short-bout exercise group (SB, n = 28, age = 40.4 +/- 5.9 yrs) or a long-bout exercise group (LB, n = 28, age = 40.9 +/- 7.3 yrs), with subjects followed for a period of 20 weeks. Both groups were instructed to exercise 5 days per week with exercise duration progressing from 20 to 40 min per day. The LB group performed one exercise bout per day, whereas the SB group performed multiple 10 min bouts of exercise per day. The recommended caloric intake for all subjects was 5022-6277 kJ/day (1200-1500 kcal/day), with fat reduced to 20% of caloric intake.SUBJECTSFifty-six obese, sedentary females (BMI = 33.9 +/- 4.1 kg/m2). MEASUREMENTS: Exercise participation was assessed from self-reported diaries and Tri-Trac Accelerometers. Cardiorespiratory fitness was assessed using a submaximal cycle ergometer test. RESULTS: Exercising in multiple short-bouts per day improved adherence to exercise: the SB group reported exercising on a greater number of days (mean +/- s.d. = 87.3 +/- 29.5 days vs 69.1 +/- 28.9 days; P < 0.05) and for a greater total duration (223.8 +/- 69.5 min/week vs 188.2 +/- 58.4 min/week; P = 0.08) than the LB group. Predicted VO2Peak increased by 5.6% and 5.0% for the LB and SB groups, respectively (P < 0.05). There was a trend for the weight loss to be greater in the SB group (-8.9 +/- 5.3 kg) compared to the LB group (-6.4 +/- 4.5 kg; P < 0.07). CONCLUSION: These results suggest that short-bouts of exercise may enhance exercise adherence. Short-bouts of exercise may also enhance weight loss and produce similar changes in cardiorespiratory fitness when compared to long-bouts of exercise. Thus, short-bouts of exercise may be preferred when prescribing exercise to obese adults. OBJECTIVE: To investigate whether prescribing exercise in several short-bouts versus one long-bout per day would enhance exercise adherence, cardiorespiratory fitness, and weight loss in overweight adult females in a behavioral weight control program.

Refers to Other Materials: No **Adverse Events Addressed:** No **Examine Cardiorespiratory Fitness as Outcome:** Yes	**Outcomes Examined:** Height and weight: objectively measured. Blood pressure and heart rate: objectively measured after a 5 minute rest period. Cardiorespiratory fitness: submaximal cycle ergometer.
Populations Analyzed: Female, 25–50 years, Obese (BMI: 30 and above)	**Author-Stated Funding Source:** Not Reported

<table>
<tr><td colspan="2">Original Research
Citation: Jakicic JM, Winters C, Lang W, Wing RR. Effects of intermittent exercise and use of home exercise equipment on adherence, weight loss, and fitness in overweight women: a randomized trial. JAMA. 1999;282(16):1554–1560.</td></tr>
<tr><td colspan="2">Purpose: To compare the effects of intermittent exercise with traditional continuous exercise on weight loss, adherence, and fitness, and to examine the effect of combining intermittent exercise with that using home exercise equipment.</td></tr>
<tr><td>Study Design: Randomized trial</td><td rowspan="6">Abstract: CONTEXT: Enhancing participation in long-term exercise may translate into improved long-term weight loss in overweight adults. OBJECTIVES: To compare the effects of intermittent with traditional continuous exercise on weight loss, adherence, and fitness, and to examine the effect of combining intermittent exercise with that using home exercise equipment. DESIGN: Randomized trial from September 1996 through September 1998. SETTING AND PARTICIPANTS: A total of 148 sedentary, overweight (mean [SD] body mass index, 32.8 [4.0] kg/m2) women (mean [SD] age, 36.7 [5.6] years) in a university-based weight control program. INTERVENTIONS: Eighteen-month behavioral weight control program with 3 groups: long-bout exercise (LB), multiple short-bout exercise (SB), or multiple short-bout exercise with home exercise equipment (SBEQ) using a treadmill. MAIN OUTCOME MEASURES: Body weight, body composition, cardiorespiratory fitness, and exercise adherence. RESULTS: Of 148 subjects, 115 (78%) completed the 18-month program. At 18 months, mean (SD) weight loss was significantly greater in subjects in the SBEQ group compared with subjects in the SB group (-7.4 [7.8] kg vs -3.7 [6.6] kg; P<.05). Mean (SD) weight loss for subjects in the LB group (-5.8 [7.1] kg) was not significantly different than for subjects in the SB or SBEQ groups. Subjects in the SBEQ group maintained a higher level of exercise than subjects in both the SB and LB groups (P<.05) at 13 to 18 months of treatment. All groups showed an increase in cardiorespiratory fitness from baseline to 18 months, with no difference between groups. Mean (SD) weight loss at 18 months was significantly greater in individuals exercising more than 200 min/wk throughout the intervention (-13.1 [8.0] kg) compared with individuals exercising 150 to 200 min/wk (-8.5 [5.8] kg) or less than 150 min/wk (-3.5 [6.5] kg) (P<.05). CONCLUSIONS: Compared with the LB group, subjects in the SB group did not experience improved long-term weight loss, exercise participation, or cardiorespiratory fitness. Access to home exercise equipment facilitated the maintenance of SB, which may improve long-term weight loss. A dose-response relationship exists between amount of</td></tr>
<tr><td>Location: United States</td></tr>
<tr><td>Sample: 115
Attrition Rate: 22.29%
Sample Power: Yes</td></tr>
<tr><td>Intervention: Yes
Intervention Type: Behavioral
Intervention Length: 18 months</td></tr>
<tr><td>Exposure Measurement
Self-Reported: Subjects recorded exercise performed in a log. Information used to calculate weekly exercise.
Device-Measured: Triaxial accelerometer, randomly assigned to subjects to wear for 1-week period within the initial 6 months of the study to verify weekly exercise logs.
Measures Steps: No
Measures Bouts: Yes
Examines HIIT: No
Exposure/Intervention
Frequency: Long-bout (LB): 5 days/week; Short-bout (SB) and SB with exercise equipment (SBEQ): 5 days/week; subjects instructed to progress from 2 to 4 exercise bouts/day by week 9.
Intensity: Not Specified.
Time: LB: 20 min/day progressed to 40 min/day; SB and SBEQ: 10-min bouts (progressed from 2–4 bouts/day)
Type: Cardiorespiratory: Home-based exercise; subjects instructed to choose a mode of exercise similar to brisk walking; subjects from the short-bout plus exercise equipment group were also provided with motorized treadmills delivered at subject's home.</td></tr>
</table>

	exercise and long-term weight loss in overweight adult women.
Refers to Other Materials: No **Adverse Events Addressed:** No **Examine Cardiorespiratory Fitness as Outcome:** Yes	**Outcomes Examined:** Body mass index: Weight and height using objective measures. Change in body weight. Body composition: Fat mass, lean body mass using dual x-ray absorptiometry. Waist girth. Waist-to-hip ratio. Cardiorespiratory fitness: submaximal graded exercise test on cycle ergometer.
Populations Analyzed: Female, 25–45 years, Overweight and Obese	**Author-Stated Funding Source:** National Institutes of Health

<table>
<tr><td colspan="2">Original Research
Citation: Jefferis BJ, Parsons TJ, Sartini C, et al. Does duration of physical activity bouts matter for adiposity and metabolic syndrome? A cross-sectional study of older British men. Int J Behav Nutri Phys Act. 2016;13:36. doi:10.1186/s12966-016-0361-2.</td></tr>
<tr><td colspan="2">Purpose: To investigate how total volume and specific patterns of moderate to vigorous PA (MVPA), light PA (LPA), and sedentary behavior are related to adiposity and metabolic syndrome (MS).</td></tr>
<tr><td>Study Design: Cross-sectional study
<hr>Location: Britain
<hr>Sample: 1,009
Attrition Rate: 39.03%
Sample Power: Not Reported
<hr>Intervention: No
<hr>Exposure Measurement Device-Measured:
Accelerometer: Counts per minute (CPM) threshold values developed: <100 for sedentary behavior (<1.5 metabolic equivalents [MET]),100–1,040 for LPA (1.5–<3 MET) and >1,040 for MVPA,(≥3 MET) used to categorize the number of minutes/day spent in each intensity level. Total daily minutes of SB, LPA, and MVPA and total daily minutes spent in bouts of LPA lasting 1–9 min and ≥10 min and bouts of MVPA lasting 1–9 min and ≥10 min were measured.
Measures Steps: No
Measures Bouts: Yes
Examines HIIT: No
Sedentary Behavior Intervention: 1,224</td>
<td>Abstract: BACKGROUND: Older adults have low physical activity(PA) and high sedentary behaviour(SB) levels. We investigate how total volume and specific patterns of moderate to vigorous PA(MVPA), light PA(LPA) and SB are related to adiposity and metabolic syndrome (MS). Then, with reference to physical activity guidelines which encourage MVPA in bouts > =10 min and avoiding "long" sedentary bouts, we investigate whether accumulating PA and SB in bouts of different defined durations are differently associated with these outcomes. METHODS: Cross-sectional study of men (71-91 years) recruited in UK primary care centres. Nurses made physical measures (weight, height, bio-impedance, blood pressure) and took fasting blood samples. 1528/3137 (49%) surviving men had >/=3 valid days (>/=600 min) accelerometer data. 450 men with pre-existing chronic disease were excluded. 1009/1078 (93.6%) had complete covariate data. RESULTS: Men (n = 1009, mean age 78.5(SD 4.7) years) spent 612(SD 83), 202(SD 64) and 42(SD 33) minutes in SB, LIPA and MVPA respectively. Each additional 30 min/day of SB and MVPA were associated with 0.32 (95% CI 0.23, 0.40)Kg/m(2) higher Body Mass Index (BMI) and -0.72(-0.93, -0.51) lower BMI Kg/m(2) respectively. Patterns for waist circumference (WC), fat mass index (FMI), fasting insulin and MS were similar. MVPA in bouts lasting <10 min or >/=10 min duration were not associated differently with outcomes. In models adjusted for total MVPA, each minute accumulated in SB bouts lasting 1-15 min was associated with lower BMI -0.012 kg/m(2), WC -0.029 cm, and OR 0.989 for MS (all p < 0.05), and coefficients for LPA bouts 1-9 min were very similar in separate models adjusted for total MVPA. Minutes accumulated in SB bouts 1-15 min and LPA bouts 1-9 min were correlated, r = 0.62. CONCLUSIONS: Objectively measured MVPA, LPA and SB were all associated with lower adiposity and metabolic risk. The beneficial associations of LPA are encouraging for older adults for whom initiating MVPA and maintaining bouts lasting >/=10 min may be particularly challenging. Findings that short bouts of LPA (1-9 min) and SB (1-15 min), but that all MVPA, not just MVPA accumulated in bouts >/=10 min were associated with lower adiposity and better metabolic health could help refine older adult PA guidelines.</td></tr>
<tr><td>Refers to Other Materials: Yes
Examine Cardiorespiratory Fitness as Outcome: No</td><td>Outcomes Examined: Body mass index. Waist circumference. Fat Mass Index: Bioelectrical impedance analysis measured body fat percentage standardized to height.Insulin, triglycerides, HDL-C,</td></tr>
</table>

	glucose: blood sample. Metabolic syndrome. Systolic and diastolic blood pressure.
Populations Analyzed: Male, 71–91 years	**Author-Stated Funding Source:** British Heart Foundation

<table>
<tr><td colspan="2">Original Research
Citation: Loprinzi PD, Cardinal BJ. Association between biologic outcomes and objectively measured physical activity accumulated in >/= 0-min bouts and <10-min bouts. Am J Health Promot. 2013;27(3):143–151. doi:10.4278/ajhp.110916-QUAN-348.</td></tr>
<tr><td colspan="2">Purpose: To examine the influence of bout and nonbout activity on additional cardiovascular disease risk factors, including presence of metabolic syndrome among adults.</td></tr>
<tr><td>Study Design: Cross-sectional study</td><td rowspan="6">Abstract: PURPOSE: Examine whether nonbout physical activity (i.e., <10 minutes' duration of physical activity [PA]) demonstrates a stronger association with health outcomes than bout physical activity (i.e., >/= 10 minutes' duration). DESIGN: Cross-sectional study. SETTING: NHANES 2003-2006. SUBJECTS: A total of 6321 participants ranging in age from 18 to 85 years. MEASURES: Objectively measured PA was assessed using accelerometry. A variety of health outcomes (e.g., triglyceride levels) were objectively measured, including an assessment of metabolic syndrome. ANALYSIS: Multivariate regression analyses examined the association between bouts and nonbouts on each of the biologic health outcomes. Additionally, differences in each of the biologic variables among those who met PA guidelines for both approaches were evaluated. RESULTS: After adjustments, results were similar for both approaches. For example, the odds ratio (OR) for metabolic syndrome for nonbouts (OR, 1.89; p < .001) was similar to that for bouts (OR, 1.87; p = .002). With the exception of body mass index, similar values for the biologic variables were found between those meeting guidelines for the two PA approaches. CONCLUSION: Engaging in nonbouts, as opposed to bouts of PA, is just as strongly associated with several biologic health outcomes, suggesting that adults who perceive themselves as having little time to exercise may still be able to enhance their health by adopting an active lifestyle approach.</td></tr>
<tr><td>Location: United States</td></tr>
<tr><td>Sample: 6,321
Attrition Rate: 0.00%
Sample Power: Not Reported</td></tr>
<tr><td>Intervention: No</td></tr>
<tr><td>Exposure Measurement
Device-Measured: Acccelerometer, moderate-to-vigorous PA (MVPA,) and meeting physical activity guidelines (150 min of moderate or 75 min of vigorous-intensity PA per week) assessed for PA accumulated in nonbouts (i.e., <10 min in duration) and in bouts (i.e., ≥10 min in duration).
Measures Steps: No
Measures Bouts: Yes
Examines HIIT: No</td></tr>
<tr><td></td></tr>
<tr><td>Refers to Other Materials: Yes
Examine Cardiorespiratory Fitness as Outcome: No</td><td>Outcomes Examined: Cardiovasular disease risk factors: triglyceride, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, total cholesterol, glucose levels, C-reactive protein, blood pressure. Anthropometric measures: waist circumference, triceps skinfold, subscapularis skinfold, height, weight, BMI. Risk of metabolic syndrome.</td></tr>
<tr><td>Populations Analyzed: 18–85 years</td><td>Author-Stated Funding Source: Not Reported</td></tr>
</table>

Original Research

Citation: Murtagh EM, Boreham CA, Nevill A, Hare LG, Murphy MH. The effects of 60 minutes of brisk walking per week, accumulated in two different patterns, on cardiovascular risk. *Prevent Med*. 2005;41(1):92–97.

Purpose: To evaluate the effectiveness of instructing sedentary individuals to undertake 20-min brisk walks (in one continuous bout or two 10-min bouts) 3 days per week, on cardiovascular disease risk factors in previously sedentary adults.

Study Design: Randomized trial

Location: North Ireland

Sample: 32
Attrition Rate: 33.33%
Sample Power: Not Reported

Intervention: Yes
Intervention Type: Behavioral
Intervention Length: 12 weeks

Exposure Measurement
Self-Reported: Recorded speed, duration, distance, and rate of perceived exertion for each session in a training diary.
Other: One session each week was supervised and walking speed and heart rate recorded.
Measures Steps: No
Measures Bouts: Yes
Exposure/Intervention
Frequency: Group 1: 1 session per day, 3 times per week, Group 2: 2 sessions per day, 3 times per week
Intensity: Group 1: mean of 72.1% maximum heart rate; Group 2: mean of 73.1% maximum heart rate
Time: Group 1: 20 min, Group 2: 10 min per bout
Type: Cardiorespiratory; brisk walking in treadmills
Examines HIIT: No

Abstract: METHODS: Forty-eight subjects (31 women) mean (+/-SD) age 45.7 +/- 9.4 year were randomly assigned to either one 20-min walk (single bout), two 10-min walks (accumulated bouts) 3 days week(-1) for 12-week, or no training (control). Oxygen consumption (VO2), heart rate (HR), and ratings of perceived exertion (RPE) were measured during a 4-stage treadmill test at pre- and post-intervention. Body composition, resting blood pressure and fasting lipoproteins were also assessed. Thirty-two subjects completed the study. RESULTS: There was a significant difference between single-bout and accumulated-bout walkers in the reduction of HR at stages 2 and 3 of the treadmill test from pre- to post-intervention (P < 0.05). There were no differences between groups for changes in VO2 or RPE from pre- to post-intervention. There were also no changes in body mass, adiposity, blood pressure, waist and hip circumferences, or lipid/lipoproteins. CONCLUSION: Brisk walking for 20 min on 3 days of the week fails to alter cardiovascular disease risk factors in previously sedentary adults. BACKGROUND: Current ACSM guidelines recommend that adults should exercise for 20-60 min on 3-5 days.week(-1) (M.L. Pollock, et al., The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. Medicine and Science in Sports and Exercise, 30 (6) (1998) 975-991.). For individuals constrained by a busy lifestyle, an exercise prescription that delivers benefits with the minimum investment of time is attractive. The purpose of the present study, therefore, was to examine the effect of instructing sedentary individuals to undertake 20 min of brisk walking, in two different patterns, 3 days per week, on fitness and other cardiovascular disease (CVD) risk factors.

Refers to Other Materials: No
Adverse Events Addressed: No
Examine Cardiorespiratory Fitness as Outcome: Yes

Outcomes Examined: Height and weight: objectively measured. Body fat: bioelectrical impedance analysis. Waist and hip measurements: objectively measured. Blood pressure: validated automated device after 5 minutes of rest. Cardiovascular fitness: graded submaximal treadmill test. Blood lipids (total cholesterol, HCL-C, triglycerides, and LDL-c): evaluated using standard measures.

Populations Analyzed: Mean age 45 years

Author-Stated Funding Source: Not Reported

Original Research **Citation:** Quinn TJ, Klooster JR, Kenefick RW. Two short, daily activity bouts vs. one long bout: are health and fitness improvements similar over twelve and twenty-four weeks? *J Strength Cond Res*. 2006;20(1):130–135. doi:10.1519/R-16394.1.	
Purpose: To determine whether an incremental 12-week interval (INT) (2 x 15 min/day) exercise program yielded improvements in health-related variables that were similar to benefits resulting from a traditional 12- week, 30 min/day continuous (CON) exercise program.	
Study Design: Randomized trial **Location:** Not Reported **Sample:** 37 **Attrition Rate:** 17.77% **Sample Power:** Not Reported **Intervention:** Yes **Intervention Type:** Behavioral **Intervention Length:** 12 weeks **Exposure Measurement** **Self-Reported:** Exercise logs, total and average time of exercise per week (minutes), average exercise heart rate (HR), average rating of perceived exertion, percentage of prescribed exercise time, percentage of time in HR zone, percentage of time above HR zone, percentage of time under HR zone. **Other:** HR recording HR values for a 24-hour period. This monitoring assured subject compliance of exercise intensity and duration. **Measures Steps:** No **Measures Bouts:** Yes **Exposure/Intervention** **Frequency:** Group 1 (CON): 1 session per day, 4 days/week; Group 2 (INT): 2 bouts per day, 4 days/week **Intensity:** Intensity was increased progresively over 6 weeks. Weeks 1–2: HR zone of 50–60% of heart rate reserve (HRR). Weeks 3–4: 60–70% of HRR, and weeks 5–6: 70–80% of HRR. **Time:** CON: 30 continuous minutes each day; INT: 15 min per bout **Type:** Cardiorespiratory: a variety of aerobic exercise modalities including walking, jogging, cycling, cross-country skiing, rowing, and stair-climbing machines	**Abstract:** This study sought to determine whether a 12-week intermittent (INT; 2 x 15 min.d(-1)) exercise program yielded similar improvements in cardiovascular health and fitness, compared with a traditional 12-week, 30-minute continuous (CON; 1 x 30 min.d(-1)) exercise program. A second purpose was to determine the effects of switching exercise programs and continuing training for an additional 12 weeks. Twenty women and 17 men, (age 48.8 +/- 9.0 years) were divided randomly into 2 groups: INT (n = 20) and CON (n = 17). Aerobic exercise was performed 4 d.wk(-1) for 12 weeks. Subjects then crossed over to the opposite training program for an additional 12 weeks of training. Subjects exercised incrementally for weeks 1-4 and training was conducted at 70-80% heart rate reserve for weeks 5-24. Both groups showed comparable exercise adherence, completing 96.6 +/- 12.2% (CON) and 96.3% +/- 17.7% (INT) of the prescribed exercise time. The INT walked at a lower percentage of Vo(2)max, maximum heart rate, systolic blood pressure, and diastolic blood pressure (p < 0.05). Maximal oxygen consumption increased by 4.5% in CON and by 8.7% in INT. Following the second 12 weeks, Vo(2)max increased by 3.6 and 7.7% in CON and INT, respectively. Treadmill test time increased by 41 seconds in CON (p < 0.05) and 71 seconds in INT (p < 0.05) after 12 weeks of training. High-density lipoproteins significantly increased in the INT group following the first 12 weeks of training. This study suggests that an INT exercise program, which is incremental in nature, provides comparable, and in some cases greater, health and fitness benefits than those expected following traditional CON exercise training.

Refers to Other Materials: No **Adverse Events Addressed:** No **Examine Cardiorespiratory Fitness as Outcome:** Yes	**Outcomes Examined:** Heart rate (bpm), systolic and diastolic blood pressure (mmHg), VO2max and Hrmax. Body composition: body weight (kg), lean mass. Blood lipids (mg/dl): total cholesterol, HDL, triglycerides, LDL, ratio of total cholesterol to HDL.
Populations Analyzed: 29–65 years	**Author-Stated Funding Source:** Not Reported

Original Research **Citation:** Schmidt WD, Biwer CJ, Kalscheuer LK. Effects of long versus short bout exercise on fitness and weight loss in overweight females. *J Am Coll Nutr*. 2001;20(5):494–501.	
Purpose: To compare the effect of monitored exercise program differing in daily frequency and exercise bout duration on aerobic fitness and weight loss during a period of caloric restriction.	
Study Design: Non-randomized trial **Location:** United States **Sample:** 38 **Attrition Rate:** 20.83% **Sample Power:** Not Reported **Intervention:** Yes **Intervention Type:** Behavioral **Intervention Length:** 12 weeks **Exposure Measurement** **Self-Reported:** **Device-Measured:** Heart rate monitors, measured exercise heart rate during session; Pedometer worn during waking hours **Other:** Researcher recorded attendance and exercise heart rates **Measures Steps:** Yes **Measures Bouts:** Yes **Examines HIIT:** No **Exposure/Intervention** **Frequency:** Group 1: 1 session per day, 5 days per week; Group 2: 2 sessions per day, 5 days per week, with 4 hours in between sessions; Group 3: 3 sessions per day, 5 days per week with at least 4 hours between each session; Control: usual activity (no exercise). **Intensity:** Group 1–3: 75% of heart rate reserve **Time:** Group 1: 30 min; Group 2: 15 min per bout; Group 3: 10 min per bout **Type:** Cardiorespiratory, cycling	**Abstract:** OBJECTIVE: The specific aim of this study was to determine if three 10 minute bouts of exercise per day (3 x 10) and two 15 minute bouts per day (2 x 15) were as effective as one 30 minute bout per day (1 x 30) for improving VO2 max and weight loss. METHODS: Overweight, female college students (body mass index > or = 28 kg/m2) were recruited and assessed at baseline and post-treatment for aerobic fitness (Astrand maximal cycle test), weight, skinfold thickness (7-site), and circumference measures (4-site). Following measurement of resting energy expenditure (REE), subjects were asked to follow a self-monitored calorie restricted diet (80% of REE) for the twelve week duration of the study and were assigned (non-random) to one of four treatment groups: 1) a nonexercising control group (control, n = 8), 2) a 30 minutes continuous exercise group (1 x 30, n = 12), 3) a 30 minutes accumulated exercise group (2 x 15, n = 10) and 4) a second 30 minutes accumulated exercise group (3 x 10, n = 8). The exercising subjects participated in aerobic exercise training at 75% of heart rate reserve three to five days per week with all exercise monitored. RESULTS: VO2 max increased significantly while weight, body mass index, sum of skinfolds, and sum of circumferences decreased significantly from baseline to post-treatment in the 1 x 30, 2 x 15 and the 3 x 10 groups, but not in the control group. A tertiary finding was that exercise participation did not differ among the exercising groups with regard to the average number of days per week. CONCLUSIONS: These results support the hypothesis that exercise accumulated in several short bouts has similar effects as one continuous bout with regard to aerobic fitness and weight loss during caloric restriction in overweight, young women.
Refers to Other Materials: No **Examine Cardiorespiratory Fitness as Outcome:** Yes	**Outcomes Examined:** Height and weight: objectively measured. Body fat: skinfold thickness from seven sites. Waist, upper arm, and circumference: objectively measured. Cardiovascular fitness: Astrand maximal cycle test. Resting energy expenditure: using oxygen uptake readings from a metabolic cart.

Populations Analyzed: Female, Mean age 20 years, Overweight and Obese	**Author-Stated Funding Source:** University of Wisconsin

Original Research
Citation: Strath SJ, Holleman RG, Ronis DL, Swartz AM, Richardson CR. Objective physical activity accumulation in bouts and nonbouts and relation to markers of obesity in US adults. *Prev Chronic Dis*. 2008;5(4):A131.

Purpose: To compare the effects of physical activity in bouts (≥10 min) to the effects of physical activity in nonbouts (<10 min) on markers of obesity.

Study Design: Cross-sectional study **Location:** United States **Sample:** 3,348 **Attrition Rate:** 0.00% **Sample Power:** Not Reported **Intervention:** No **Exposure Measurement** **Device-Measured:** Calculated average daily minutes of moderate-to-vigorous physical activity (MVPA) in bouts and nonbouts; a bout was defined as ≥10 consecutive minutes of MVPA. Bout and nonbout accelerometer counts also examined. **Measures Steps:** No **Measures Bouts:** Yes **Examines HIIT:** No	**Abstract:** INTRODUCTION: Little is known about the relation between duration of physical activity and obesity. The objective of this study was to compare the effects of physical activity in bouts (> or = 10 minutes) to the effects of physical activity in nonbouts (<10 minutes) on markers of obesity. METHODS: We used data from the 2003-2004 National Health and Nutrition Examination Survey on body mass index, waist circumference, and objectively determined physical activity levels for 3,250 adults aged 18 years or older. After controlling for relevant confounding variables, we performed multiple linear regression analyses to predict body mass index and waist circumference for bout and nonbout minutes of moderate- to vigorous-intensity physical activity (MVPA) and for bout and nonbout accelerometer counts of physical activity. RESULTS: MVPA bout minutes and MVPA nonbout minutes are independently associated with body mass index and waist circumference, after controlling for confounding variables. The strength of the association between lower body mass index and MVPA bout minutes (beta = -0.04, P <.001) was nearly 4 times greater than for MVPA nonbout minutes (beta = -0.01, P = .06). For smaller waist circumference the association was nearly 3 times greater for MVPA bout minutes (beta = -0.09, P <.001) than for MVPA nonbout minutes (beta = -0.03, P = .01). Bout minutes of physical activity were at a higher intensity of activity compared with nonbout minutes of physical activity. CONCLUSION: Accumulating MVPA in nonbouts may be a beneficial starting point for individuals to increase physical activity levels and decrease body mass index and waist circumference. However, bouts of physical activity lasting > or = 10 minutes may be a more time-efficient strategy to decrease body mass index and waist circumference.
Refers to Other Materials: Yes **Examine Cardiorespiratory Fitness as Outcome:** No	**Outcomes Examined:** Body mass index: objectively measured. Waist circumference.
Populations Analyzed: ≥18 years	**Author-Stated Funding Source:** National Institute on Aging, National Heart Lung and Blood Institute

<table>
<tr><td colspan="2">Original Research
Citation: Vasankari V, Husu P, Vähä-Ypyä H. Association of objectively measured sedentary behaviour and physical activity with cardiovascular disease risk. Eur J Prev Cardiol. 2017;24(12):1311–1318. doi:10.1177/2047487317711048.</td></tr>
<tr><td colspan="2">Purpose: To evaluate the association of accelerometer-based sedentary behavior and physical activity (PA) with the risk of cardiovascular disease.</td></tr>
<tr><td>Study Design: Cross-sectional study</td><td rowspan="5">Abstract: Background: We evaluated the association of accelerometer-based sedentary behaviour and physical activity with the risk of cardiovascular disease. Design: The design of this study used a population-based, cross-sectional sample. Methods: A subsample of participants in the Health 2011 Study in Finland used the tri-axial accelerometer (>/=4 days, >10 h/day, n = 1398). Sedentary behaviour (sitting, lying) and standing still in six-second epochs were recognised from raw acceleration data based on intensity and device orientation. The intensity of physical activity was calculated as one-minute moving averages of mean amplitude deviation of resultant acceleration and converted to metabolic equivalents. Metabolic equivalents were categorised to light physical activity (1.5-2.9 metabolic equivalents) and moderate-to-vigorous physical activity (moderate-to-vigorous physical activity>/=3.0 metabolic equivalents). Daily sedentary behaviour, standing still, light physical activity and moderate-to-vigorous physical activity were expressed as mean daily total time, accumulated time and number of different bouts (from 30 s to >30 min), mean daily metabolic equivalent and weekly peak metabolic equivalent levels of different bout lengths and number of breaks in sedentary behaviour. The ten-year cardiovascular disease risk was based on the Framingham risk model. Results: The mean number of daily sedentary behaviour bouts was more strongly associated with cardiovascular disease risk than mean daily total time. In the best model, smaller waist circumference, greater value of mean daily metabolic equivalent levels of one-minute bouts, higher accumulated time of moderate-to-vigorous physical activity lasting </=30 min, higher number of >5 min standing bouts and a higher number of long (>30 min) bouts of light physical activity were significantly associated with lower cardiovascular disease risk (R2 = 0.836). Conclusions: The objectively measured number and accumulated time from different bout lengths of physical activity and sedentary behaviour were associated with cardiovascular disease risk, which is considered relevant for estimating cardiovascular diseases and for devising preventive actions.</td></tr>
<tr><td>Location: Finland</td></tr>
<tr><td>Sample: 1,398
Attrition Rate: 31.97%
Sample Power: Not Reported</td></tr>
<tr><td>Intervention: No</td></tr>
<tr><td>Exposure Measurement
Device-Measured: Accelerometer, PA categorized into: moderate-to-vigorous PA (≥3.0 metabolic equivalents [METs]) and light PA (1.5-2.9 METs); examined mean daily total PA time, accumulated time, and number of different bouts (30 s–5 min, ≤10 min, ≤15 min, >5 min, >10 min, >15 min, >30 min), mean daily and weekly peak MET levels of different bout lengths, and total number of steps.
Measures Steps: Yes
Measures Bouts: Yes</td></tr>
</table>

Refers to Other Materials: Yes **Examine Cardiorespiratory Fitness as Outcome:** No	**Outcomes Examined:** Cardiovascular disease risk: Framingham risk model that estimates the 10-year absolute risk (in %) using data collected during the health examinations of the Health 2011 Study (cholesterol and blood pressure) or by questionnaires (medication, smoking and diagnosed diabetes).
Populations Analyzed: 18–85 years	**Author-Stated Funding Source:** No funding source reported.

Original Research **Citation:** White DK, Gabriel KP, Kim Y, Lewis CE, Sternfeld B. Do short spurts of physical activity benefit cardiovascular health? The CARDIA Study. *Med Sci Sports Exerc*. 2015;47(11):2353–2358. doi:10.1249/MSS.0000000000000662.	
Purpose: To investigate the impact of short spurts of moderate-to-vigorous intensity physical activity (MVPA) on the development of hypertension and obesity over 5 years in a large observational prospective cohort study of cardiovascular disease risk factors among middle-aged adults.	
Study Design: Prospective cohort study **Location:** United States **Sample:** 2,076 **Attrition Rate:** 41.50% **Sample Power:** Not Reported **Intervention:** No **Exposure Measurement** **Device-Measured:** Accelerometer, classified minutes per day of MVPA into: bouted MVPA (activity lasting ≥10 continuous minutes) or short spurts of MVPA (activity lasting <10 continuous minutes). For analysis, data was classified continuously into 10-min increments of time spent in short spurts of MVPA and bouted MVPA and categorically into separate tertiles of time spent in short spurts of MVPA (Least, Middle, Most) and bouted MVPA (Lowest, Middle, Highest). **Direct Observation:** 1,374 **Measures Steps:** No **Measures Bouts:** Yes **Examines HIIT:** No	**Abstract:** BACKGROUND: For optimal health benefits, moderate- to vigorous-intensity physical activity (MVPA) is recommended in sustained bouts lasting >/=10 min. However, short spurts of MVPA lasting <10 min are more common in everyday life. It is unclear whether short spurts of MVPA further protect against the development of hypertension and obesity in middle-age adults beyond bouted MVPA. METHODS: Objectively measured physical activity was collected in the Coronary Artery Risk Development in Young Adults study at the 20-yr (2005-2006) examination, and blood pressure and BMI were collected at the 20- and 25-yr (2010-2011) examinations. Time spent in MVPA was classified as either bouted MVPA, i.e., >/=10 continuous minutes or short spurts of MVPA, i.e., <10 continuous minutes. To examine the association of short spurts of MVPA with incident hypertension and obesity over 5 yr, we calculated risk ratios adjusted for bouted MVPA and potential confounders. RESULTS: Among 1531 and 1251 participants without hypertension and obesity, respectively, at year 20 (age, 45.2 +/- 3.6 yr; 57.3% women; body mass index, 29.0 +/- 7.0 kg.m(-2)), 14.8% and 12.1% developed hypertension and obesity by year 25. Study participants in the highest tertile of short spurts of MVPA were 31% less likely to develop hypertension 5 yr later (risk ratio = 0.69 (0.49-0.96)) compared with those in the lowest tertile. There was no statistically significant association of short spurts of MVPA with incident obesity. CONCLUSIONS: These findings support the notion that accumulating short spurts of MVPA protects against the development of hypertension but not obesity in middle-age adults.
Refers to Other Materials: Yes **Examine Cardiorespiratory Fitness as Outcome:** No	**Outcomes Examined:** Incidence of hypertension: systolic (140 mmHg) and diastolic (90 mmHg) blood pressure. Incidence of obesity: body mass index measured objectively.
Populations Analyzed: 37–55 years	**Author-Stated Funding Source:** National Heart, Lung, and Blood Institute, National Institute on Aging

Original Research **Citation:** Wolff-Hughes DL, Fitzhugh EC, Bassett DR, Churilla JR. Total activity counts and bouted minutes of moderate-to-vigorous physical activity: relationships with cardiometabolic biomarkers using 2003–2006 NHANES. *J Phys Act Health*. 2015;12(5):694–700. doi:10.1123/jpah.2013-0463.	
Purpose: To compare the associations of objectively measured moderate-to-vigorous intensity physical activity (MVPA), accumulated in ≥10-min bouts, and total activity counts (TAC) with biomarkers in a representative sample of U.S. adults.	
Study Design: Cross-sectional study **Location:** United States **Sample:** 5,668 **Attrition Rate:** 0.00% **Sample Power:** Not Reported **Intervention:** No **Exposure Measurement** **Device-Measured:** Accelerometer, created the TAC by summing the TAC per day and dividing by the total number of valid wear days. The threshold for MVPA was defined as ≥ 2,020 counts per minute. Bouted MVPA was assessed as minutes of MVPA accumulated during bouts (>10 consecutive minutes, allowing for 1 to 2 min below the 2,020 cpm threshold). Minutes of bouted MVPA were then averaged across the total number of valid days. **Direct Observation:** 1,379 **Measures Steps:** No **Measures Bouts:** Yes **Examines HIIT:** No	**Abstract:** PURPOSE: To contrast associations of accelerometer-measured moderate-to-vigorous physical activity (MVPA) accumulated in bouts and total activity counts (TAC) with cardiometabolic biomarkers in U.S. adults. METHODS: Using 2003-2006 National Health and Nutrition Examination Survey (NHANES) data, the sample was comprised of adults >/= 20 years, not pregnant or lactating, with self-reported PA and at least 4 days of >/= 10 hours accelerometer wear time (N = 5668). Bouted MVPA represented the minutes/day with >/= 2020 counts/minute in bouts of 10 minutes or longer and TAC represented the total activity counts per day. Biomarkers included: cholesterol, triglyceride, glycohemoglobin, plasma glucose, C-peptide, insulin, C-reactive protein, homocysteine, blood pressure, body mass index (BMI), waist circumference, and skinfolds. Nested regression models were conducted which regressed each biomarker on bouted MVPA and TAC simultaneously, while adjusting for relevant covariates. RESULTS: Results indicated TAC was more strongly associated with 11 biomarkers: HDL-C, triglyceride, plasma glucose, C-peptide, insulin, C-reactive protein, homocysteine, systolic blood pressure, waist circumference, triceps skinfold, and subscapular skinfold. Bouted MVPA, however, only displayed stronger associations with BMI. CONCLUSIONS: The total volume of physical activity, represented by TAC, appears to have stronger associations with cardiometabolic biomarkers than MVPA accumulated in bouts.
Refers to Other Materials: Yes **Adverse Events Addressed:** **Examine Cardiorespiratory Fitness as Outcome:** No	**Outcomes Examined:** Systolic blood pressure, diastolic blood pressure. Body mass index. Waist circumference: tricep and subscapular skinfolds. Blood biomarkers: total cholesterol, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), triglycerides, glycohemoglobin, plasma glucose, C-peptide, insulin, C-reactive protein, and homocysteine.
Populations Analyzed: ≥20 years	**Author-Stated Funding Source:** Not Reported

Original Research **Citation:** Woolf-May K, Kearney EM, Owen A, Jones DW, Davison RC, Bird SR. The efficacy of accumulated short bouts versus single daily bouts of brisk walking in improving aerobic fitness and blood lipid profiles. *Health Educ Res*. 1999;14(6):803–815.	
Purpose: To further investigate the effects of single and accumulated short bouts of walking upon aerobic capacity and blood lipid profile.	
Study Design: Randomized trial	**Abstract:** Fifty-six subjects (19 men and 37 woman) aged between 40 and 66 completed the study. They were allocated into three walking groups and a control group (C). The three walking groups performed the same total amount of walking for 18 weeks, but completed it in bouts of differing durations and frequencies. These were Long Walkers (LW; 20-40 min/bout), Intermediate Walkers (IW; 10-15 min/bout) and Short Walkers (SW; 5-10 min/bout); with the IW and SW performing more than one bout of walking a day. Following the 18 week walking programme, compared to the C group all walking groups showed similar improvements in fitness as determined by a reduction in blood lactate during a graded treadmill walking test (LW 1.0 mmol/l; IW 0. 8 mmol/l; SW 1.2 mmol/l; C 0.2 mmol/l; P = 0.003) and reduction in final heart rate (LW 8 beats/min; IW 6 beats/min; SW 10 beats/min; C 0 beats/min; P = 0.056). Also compared to the C group, the LW and IW groups recorded statistically significant decreases in low-density lipoprotein cholesterol (LW 0.29 mmol/l; IW 0.41 mmol/l; P = 0.024), whereas the control group showed a mean increase of 0.22 mmol/l. The LW and IW groups also showed significant reductions in apolipoprotein (apo) A-II (LW 0.05 g/l; IW 0.02 g/l; SW 0.01 g/l; C 0.00 g/l; P = 0.012) with the LW recording a statistically significant increase in the ratio of apo A-I/A-II (LW, 0.19, P = 0. 044). In conclusion, some health benefits were achieved from all walking programmes. However, whilst the changes in aerobic fitness were similar, the effects upon blood lipid profiles were not. The findings from this study suggest that the LW regimen was most effective in benefiting blood lipid profile, followed by the IW regimen, with the SW being least potent. Nevertheless, for the sedentary/low-active members of society, any improvement in health may be considered as important. Therefore accumulated bouts of moderate intensity exercise, which according to theories of exercise behaviour may be more easily incorporated into an individual's lifestyle than single prolonged bouts, may be advocated for health promotion but may not be as effective as the traditionally prescribed 20-40 min bouts.
Location: United Kingdom	
Sample: 56 **Attrition Rate:** 29.11% **Sample Power:** Not Reported	
Intervention: Yes **Intervention Type:** Behavioral **Intervention Length:** 18 weeks	
Exposure Measurement **Self-Reported:** Training diary, all walking subjects recorded the duration and intensity of all walking bouts; also offered optional once-weekly supervised walking sessions. **Device-Measured:** Heart rate monitor: 20 of the subjects were allocated heart rate monitors and also instructed to take manual heart rate. **Measures Steps:** No **Measures Bouts:** Yes **Examines HIIT:** No **Exposure/Intervention** **Frequency:** Long Walkers (LW): 1 session per day; Intermediate Walkers (IW): up to 3 bouts per day; SW: up to 4 bouts per day **Intensity:** 70–75% predicted VO2 max **Time:** LW: 20–40 min; IW: 10–15 min bouts (up to 3 bouts); SW: 5–10 min bouts (up to 4 bouts). **Type:** Cardiorespiratory: Walking in an environment that best fit into their lifestyle.	

Refers to Other Materials: No **Adverse Events Addressed:** No **Examine Cardiorespiratory Fitness as Outcome:** Yes	**Outcomes Examined:** Triacylglycerol (TAG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C). Total apolipoprotein (apo): blood samples. Aerobic fitness: graded treadmill walking test.
Populations Analyzed: Male, Female, 40–66 years.	**Author-Stated Funding Source:** Not Reported

Table 3. Original Research Bias Assessment Chart

Nutrition Evidence Library (NEL) Bias Assessment Tool (BAT): Original Research					
	Alizadeh, 2013	Asikainen, 2003	Asikainen, 2002	Ayabe, 2012	Ayabe, 2013
(???) = Can't Determine					
Inclusion/exclusion criteria similar across study groups.	N/A	N/A	N/A	N/A	N/A
Strategy for recruiting or allocating participants similar across study groups.	N/A	N/A	N/A	N/A	N/A
Allocation sequence randomly generated.	Yes	Yes	Yes	N/A	N/A
Group allocation concealed (i.e., assignments could not be predicted).	???	???	???	N/A	N/A
Distribution of critical confounding factors similar across study groups at baseline, or analysis controlled for differences between groups.	Yes	Yes	No	N/A	N/A
Accounted for variations in execution of study from proposed protocol or research plan.	N/A	N/A	N/A	N/A	Yes
Adherence to study protocols similar across study groups.	Yes	Yes	No	Yes	N/A
Investigators accounted for unintended concurrent exposures that were differentially experienced by study groups and might bias results.	Yes	Yes	No	N/A	N/A
Participants blinded to their intervention or exposure status.	No	No	No	N/A	N/A
Investigators blinded to participants' intervention or exposure status.	No	No	No	N/A	N/A
Outcome assessors blinded to participants' intervention or exposure status.	No	No	No	Yes	Yes
Valid and reliable measures used consistently across study groups to assess inclusion/exclusion criteria, exposures, outcomes, and confounders.	Yes	Yes	Yes	N/A	Yes
Length of follow-up similar across study groups.	Yes	No	N/A	N/A	N/A
In cases of high or differential loss to follow-up, impact assessed through sensitivity analysis or other adjustment.	N/A	N/A	N/A	N/A	N/A
Other sources of bias taken into account in design and/or analysis of study through matching or other statistical adjustment.	Yes	Yes	Yes	Yes	Yes
Adequate statistical methods used to assess primary outcomes.	Yes	Yes	Yes	Yes	Yes

Nutrition Evidence Library (NEL) Bias Assessment Tool (BAT): Original Research					
	Cameron, 2017	Clarke, 2014	Di 2014	Donnelly, 2000	Eguchi, 2013
(???) = Can't Determine					
Inclusion/exclusion criteria similar across study groups.	N/A	Yes	Yes	N/A	N/A
Strategy for recruiting or allocating participants similar across study groups.	N/A	Yes	Yes	N/A	N/A
Allocation sequence randomly generated.	N/A	N/A	N/A	???	Yes
Group allocation concealed (i.e., assignments could not be predicted).	N/A	N/A	N/A	???	No
Distribution of critical confounding factors similar across study groups at baseline, or analysis controlled for differences between groups.	N/A	???	Yes	Yes	Yes
Accounted for variations in execution of study from proposed protocol or research plan.	Yes	N/A	N/A	N/A	N/A
Adherence to study protocols similar across study groups.	N/A	Yes	N/A	Yes	No
Investigators accounted for unintended concurrent exposures that were differentially experienced by study groups and might bias results.	No	Yes	N/A	Yes	Yes
Participants blinded to their intervention or exposure status.	N/A	N/A	No	No	No
Investigators blinded to participants' intervention or exposure status.	N/A	N/A	No	No	No
Outcome assessors blinded to participants' intervention or exposure status.	Yes	Yes	No	Yes	Yes
Valid and reliable measures used consistently across study groups to assess inclusion/exclusion criteria, exposures, outcomes, and confounders.	Yes	Yes	Yes	Yes	No
Length of follow-up similar across study groups.	N/A	Yes	N/A	Yes	Yes
In cases of high or differential loss to follow-up, impact assessed through sensitivity analysis or other adjustment.	No	N/A	N/A	N/A	N/A
Other sources of bias taken into account in design and/or analysis of study through matching or other statistical adjustment.	Yes	Yes	Yes	Yes	Yes
Adequate statistical methods used to assess primary outcomes.	Yes	Yes	Yes	Yes	Yes

Nutrition Evidence Library (NEL) Bias Assessment Tool (BAT): Original Research					
	Fan, 2013	Gay, 2016	Glazer, 2013	Jakicic, 1995	Jakicic, 1999
(???) = Can't Determine					
Inclusion/exclusion criteria similar across study groups.	N/A	N/A	N/A	N/A	N/A
Strategy for recruiting or allocating participants similar across study groups.	N/A	N/A	N/A	N/A	N/A
Allocation sequence randomly generated.	N/A	N/A	N/A	???	???
Group allocation concealed (i.e., assignments could not be predicted).	N/A	N/A	N/A	???	???
Distribution of critical confounding factors similar across study groups at baseline, or analysis controlled for differences between groups.	N/A	N/A	N/A	Yes	Yes
Accounted for variations in execution of study from proposed protocol or research plan.	Yes	N/A	Yes	N/A	Yes
Adherence to study protocols similar across study groups.	N/A	N/A	N/A	Yes	Yes
Investigators accounted for unintended concurrent exposures that were differentially experienced by study groups and might bias results.	N/A	Yes	N/A	Yes	Yes
Participants blinded to their intervention or exposure status.	N/A	N/A	N/A	No	No
Investigators blinded to participants' intervention or exposure status.	N/A	N/A	N/A	No	No
Outcome assessors blinded to participants' intervention or exposure status.	Yes	Yes	Yes	No	Yes
Valid and reliable measures used consistently across study groups to assess inclusion/exclusion criteria, exposures, outcomes, and confounders.	Yes	Yes	Yes	Yes	Yes
Length of follow-up similar across study groups.	N/A	N/A	N/A	Yes	Yes
In cases of high or differential loss to follow-up, impact assessed through sensitivity analysis or other adjustment.	No	N/A	Yes	N/A	Yes
Other sources of bias taken into account in design and/or analysis of study through matching or other statistical adjustment.	Yes	Yes	Yes	Yes	Yes
Adequate statistical methods used to assess primary outcomes.	Yes	Yes	Yes	Yes	Yes

Nutrition Evidence Library (NEL) Bias Assessment Tool (BAT): Original Research					
	Jefferis, 2016	Loprinzi, 2013	Murtagh , 2005	Quinn, 2006	Schmidt, 2001
(???) = Can't Determine					
Inclusion/exclusion criteria similar across study groups.	N/A	Yes	N/A	N/A	Yes
Strategy for recruiting or allocating participants similar across study groups.	N/A	Yes	N/A	N/A	Yes
Allocation sequence randomly generated.	N/A	N/A	???	Yes	N/A
Group allocation concealed (i.e., assignments could not be predicted).	N/A	N/A	???	???	N/A
Distribution of critical confounding factors similar across study groups at baseline, or analysis controlled for differences between groups.	N/A	???	???	Yes	Yes
Accounted for variations in execution of study from proposed protocol or research plan.	Yes	Yes	N/A	N/A	N/A
Adherence to study protocols similar across study groups.	N/A	Yes	Yes	Yes	Yes
Investigators accounted for unintended concurrent exposures that were differentially experienced by study groups and might bias results.	N/A	Yes	No	No	Yes
Participants blinded to their intervention or exposure status.	N/A	N/A	No	No	No
Investigators blinded to participants' intervention or exposure status.	N/A	N/A	No	No	No
Outcome assessors blinded to participants' intervention or exposure status.	Yes	Yes	No	No	Yes
Valid and reliable measures used consistently across study groups to assess inclusion/exclusion criteria, exposures, outcomes, and confounders.	Yes	Yes	Yes	Yes	Yes
Length of follow-up similar across study groups.	N/A	Yes	Yes	Yes	Yes
In cases of high or differential loss to follow-up, impact assessed through sensitivity analysis or other adjustment.	Yes	N/A	No	No	???
Other sources of bias taken into account in design and/or analysis of study through matching or other statistical adjustment.	Yes	Yes	Yes	Yes	Yes
Adequate statistical methods used to assess primary outcomes.	Yes	Yes	Yes	Yes	Yes

Nutrition Evidence Library (NEL) Bias Assessment Tool (BAT): Original Research					
	Strath, 2008	Vasankari, 2017	White, 2015	Wolff-Hughes, 2015	Woolf-May, 1999
(???) = Can't Determine					
Inclusion/exclusion criteria similar across study groups.	N/A	N/A	N/A	N/A	N/A
Strategy for recruiting or allocating participants similar across study groups.	N/A	N/A	N/A	N/A	N/A
Allocation sequence randomly generated.	N/A	N/A	N/A	N/A	Yes
Group allocation concealed (i.e., assignments could not be predicted).	N/A	N/A	N/A	N/A	???
Distribution of critical confounding factors similar across study groups at baseline, or analysis controlled for differences between groups.	N/A	N/A	N/A	N/A	Yes
Accounted for variations in execution of study from proposed protocol or research plan.	Yes	Yes	Yes	N/A	N/A
Adherence to study protocols similar across study groups.	N/A	N/A	N/A	N/A	No
Investigators accounted for unintended concurrent exposures that were differentially experienced by study groups and might bias results.	N/A	Yes	N/A	Yes	No
Participants blinded to their intervention or exposure status.	N/A	N/A	N/A	N/A	No
Investigators blinded to participants intervention or exposure status.	N/A	N/A	N/A	N/A	No
Outcome assessors blinded to participants intervention or exposure status.	Yes	No	No	No	Yes
Valid and reliable measures used consistently across study groups to assess inclusion/exclusion criteria, exposures, outcomes, and confounders.	Yes	Yes	Yes	Yes	Yes
Length of follow-up similar across study groups.	N/A	Yes	Yes	N/A	Yes
In cases of high or differential loss to follow-up, impact assessed through sensitivity analysis or other adjustment.	N/A	No	Yes	N/A	Yes
Other sources of bias taken into account in design and/or analysis of study through matching or other statistical adjustment.	Yes	Yes	Yes	Yes	Yes
Adequate statistical methods used to assess primary outcomes.	Yes	Yes	Yes	Yes	Yes

Appendices

Appendix A: Analytical Framework

Topic Area
Exposure

Systematic Review Questions

Q5. What is the relationship between bout duration of physical activity and health outcomes?

a. Does the relationship vary by age, sex, race/ethnicity, or socio-economic status?

Population
Adults, 18 years and older

Exposure
- Physical activity (PA) performed in short bouts (10 minutes or less)
- PA exposure of at least 12 weeks

Comparison
- Different PA bout durations

Endpoint Health Outcomes
- All-cause and cardiovascular disease (CVD) mortality
- CVD incidence
- Type 2 Diabetes
- Cardiorespiratory fitness
- Cardio metabolic risk factors:
    - Blood Pressure
    - Blood lipids (total cholesterol, HDL-cholesterol, LDL-cholesterol, triglycerides)
    - Body mass, BMI
    - Waist circumference

Key Definitions
- Bouts: physical activity of specified intensity (or range of intensities) performed for a limited and specified period of time (e.g., 10 minutes or less). Time spent during each of these bouts can be added together to meet a specific dose of physical activity in a given day.

Appendix B: Final Search Strategy

Search Strategy: PubMed (Systematic Reviews, Meta-Analyses, Pooled Analyses, and High-Quality Reports)

Database: PubMed; Date of Search: 5/4/2017; 233 results

Set	Search Strategy
Physical activity	(("Activity bouts"[tiab] OR "Daily steps"[tiab] OR "High intensity activity"[tiab] OR "Interval training"[tiab] OR "Pedometer"[tiab] OR "Step count"[tiab] OR "Steps/day"[tiab] OR 'high intensity interval training'[tiab]) OR ((("High intensity"[tiab] AND "training")[tiab] OR 'Interval training'[tiab] OR 'Pedometer'[tiab]) NOT medline[sb])
Limit: Publication Type Include (Systematic Reviews/Meta-Analyses)	AND (systematic[sb] OR meta-analysis[pt] OR review [tiab] OR "systematic review"[tiab] OR "systematic literature review"[tiab] OR metaanalysis[tiab] OR "meta analysis"[tiab] OR metanalyses[tiab] OR "meta analyses"[tiab] OR "pooled analysis"[tiab] OR "pooled analyses"[tiab] OR "pooled data"[tiab])
Limit: Publication Type Exclude (Systematic Reviews/Meta-Analyses)	NOT ("comment"[Publication Type] OR "editorial"[Publication Type])
Limit: language	AND (English[lang])
Limit: Exclude animal only	NOT ("Animals"[Mesh] NOT ("Animals"[Mesh] AND "Humans"[Mesh]))
Limit: Exclude child only	NOT (("infant"[Mesh] OR "child"[mesh] OR "adolescent"[mh]) NOT (("infant"[Mesh] OR "child"[mesh] OR "adolescent"[mh]) AND "adult"[Mesh]))

Search Strategy: CINAHL (Systematic Reviews, Meta-Analyses, Pooled Analyses, and High-Quality Reports)

Database: CINAHL; Date of Search: 5/4/2017; 16 unique results
Terms searched in title or abstract

Set	Search Strategy
Physical activity	("Activity bouts" OR "Daily steps" OR "High intensity activity" OR "Interval training" OR Pedometer OR "Step count" OR "Steps/day" OR 'high intensity interval training" OR ("High intensity" AND "training"))
Systematic Reviews and Meta-Analyses	AND (“systematic review” OR “systematic literature review” OR review OR metaanalysis OR "meta analysis" OR metanalyses OR "meta analyses"" OR "pooled analysis" OR “pooled analyses” OR "pooled data")
Limits	English language Peer reviewed Exclude Medline records Human All years searched

Search Strategy: Cochrane (Systematic Reviews, Meta-Analyses, Pooled Analyses, and High-Quality Reports)

Database: Cochrane; Date of Search: 5/4/17; 25 Results
Terms searched in title, abstract, or keywords

Set	Search Terms
Physical activity	("Activity bouts" OR "Daily steps" OR "High intensity activity" OR "Interval training" OR Pedometer OR "Step count" OR "Steps/day" OR “high intensity interval training" OR ("High intensity" AND training))
Limits	Word variations not searched Cochrane Reviews and Other Reviews All years searched

Search Strategy: PubMed (Original Research)

Database: PubMed; Date of Search: 6/28/2017; 1,087 results

Set	Search Strategy
Physical activity (bouts)	((“intermittent activity”[tiab] OR “intermittent exercise”[tiab] OR "accumulated activity"[tiab] OR bouts[tiab]) AND ("Physical activity"[tiab] OR "Exercise"[mh] OR "Exercise"[tiab]))
Outcomes (Cardiovascular Disease Incidence OR Mortality OR Cardiometabolic Risk Factors OR Cardiorespiratory Fitness)	AND (((("Arteriosclerosis"[mh] OR "Heart failure"[mh] OR "Myocardial ischemia"[mh] OR "myocardial infarction"[mh] OR "Stroke"[mh] OR "Subarachnoid hemorrhage"[mh] OR "Intracranial hemorrhages"[mh]) OR ((Arterioscleró*[tiab] OR Atheroscleró*[tiab] OR "Cerebral infarction"[tiab] OR "Cerebrovascular diseases"[tiab] OR "Cerebrovascular disease"[tiab] OR "Coronary heart disease"[tiab] OR "Heart failure"[tiab] OR "Intracerebral Hemorrhage"[tiab] OR "Intracerebral Hemorrhages"[tiab] OR "Intracranial hemorrhage"[tiab] OR "Intracranial hemorrhages"[tiab] OR "myocardial infarction"[tiab] OR "Stroke"[tiab] OR "Subarachnoid hemorrhages"[tiab] OR "Subarachnoid hemorrhage"[tiab] OR "Ischemic heart diseases"[tiab] OR "Ischemic heart disease"[tiab]) NOT medline[sb])) AND ("risk"[tiab] OR "risks"[tiab] OR "Incidence"[tiab] OR "incident"[tiab] OR "Death"[mh] OR "Death"[tiab] OR "Dying"[tiab] OR Fatal*[tiab] OR Mortalit*[tiab] OR "Mortality"[mh] OR "Postmortem"[tiab])) OR ("blood pressure"[mh] OR "blood pressure"[tiab] OR "systolic pressure"[tiab] OR "diastolic pressure"[tiab] OR "mean arterial"[tiab] OR "bp response"[tiab] OR "bp decrease"[tiab] OR "bp reduction"[tiab] OR "normotensive"[tiab] OR “hypertension”[tiab] OR “hypotension”[tiab] OR “normotension”[tiab] OR “hypertensive”[tiab] OR “hypotensive”[tiab] OR "Body weight"[mh] OR "Body composition"[mh] OR "Body Mass Index"[mh] OR “Waist circumference”[mh] OR "Body weight"[tiab] OR "Body weight change"[tiab] OR "Weight gain"[tiab] OR "Weight status"[tiab] OR "Overweight"[tiab] OR "Weight Control"[tiab] OR "Weight maintenance"[tiab] OR "Weight regulation"[tiab] OR "Weight stability"[tiab] OR "Body composition"[tiab] OR "Body Mass Index"[tiab] OR “Waist circumference”[tiab] OR "insulin resistance"[mh] OR "glucose intolerance"[mh] OR "glucose control"[tiab] OR "insulin resistance"[tiab] OR "prediabetes"[tiab] OR "pre-diabetes"[tiab] OR "glucose intolerance"[tiab] OR (diabetes[tiab] AND ("type 2"[tiab] OR "type II"[tiab])) OR “cholesterol”[mh] OR “triglycerides”[mh] OR “lipoproteins”[mh] OR “cholesterol”[tiab] OR “triglycerides”[tiab] OR “triglyceride”[tiab] OR “blood lipids”[tiab] OR "lipoprotein"[tiab]) OR (("Cardiorespiratory fitness"[mh] OR "VO2 max"[tiab] OR "maximal oxygen uptake"[tiab] OR "peak oxygen uptake"[tiab] OR "aerobic capacity"[tiab]) OR (("Cardiorespiratory fitness"[tiab]) NOT medline[sb])))

Set	Search Strategy
Limit: Publication Type Exclude (Original)	NOT (“comment”[Publication Type] OR “editorial”[Publication Type] OR “review”[Publication Type] OR systematic[sb] OR "meta-analysis"[publication type] OR “systematic review”[tiab] OR “systematic literature review”[tiab] OR metaanalysis[tiab] OR "meta analysis"[tiab] OR metanalyses[tiab] OR "meta analyses"[tiab] OR "pooled analysis"[tiab] OR “pooled analyses”[tiab] OR "pooled data"[tiab])
Limit: Language	(English[lang])
Limit: Exclude animal only	NOT ("Animals"[Mesh] NOT ("Animals"[Mesh] AND "Humans"[Mesh]))
Limit: Exclude child only	NOT (("infant"[Mesh] OR "child"[mesh] OR "adolescent"[mh]) NOT (("infant"[Mesh] OR "child"[mesh] OR "adolescent"[mh]) AND "adult"[Mesh]))
Limit: Date	((“1990/01/01”[PDAT] : “2018/1/31”[PDAT])

Search Strategy: CINAHL (Original Research)

Database: CINAHL; Date of Search: 6/28/2017; 101 unique results
Terms searched in title or abstract

Set	Search Strategy
Physical activity (bouts)	((“intermittent activity” OR “intermittent exercise” OR "accumulated activity" OR bouts) AND ("Physical activity" OR "Exercise"))
Outcomes (Cardiovascular Disease Incidence OR Mortality OR Cardiometabolic Risk Factors OR Cardiorespiratory Fitness)	AND (((Arteriosclero* OR "Arteriosclerosis" OR Atherosclero* OR "Cerebral infarction" OR "Cerebrovascular diseases" OR "Cerebrovascular disease" OR "Coronary heart disease" OR "Heart failure" OR "Intracerebral Hemorrhage" OR "Intracerebral Hemorrhages" OR "Intracranial hemorrhage" OR "Intracranial hemorrhages" OR "Myocardial ischemia" OR "myocardial infarction" OR "Stroke" OR "Subarachnoid hemorrhage" OR "Subarachnoid hemorrhages" OR "Ischemic heart diseases" OR "Ischemic heart disease") AND ("risk" OR "risks" OR "Incidence" OR "incident" OR "Death" OR "Dying" OR Fatal* OR "Mortality" OR "Postmortem")) OR ("blood pressure" OR "systolic pressure" OR "diastolic pressure" OR "mean arterial" OR "bp response" OR "bp decrease" OR "bp reduction" OR "normotensive” OR “hypertension” OR “hypotension” OR “normotension” OR “hypertensive” OR “hypotensive” OR "Body weight" OR "Body composition" OR "Body Mass Index" OR “Waist circumference” OR "Body weight change" OR "Weight gain" OR "Weight status" OR "Overweight" OR "Weight Control" OR "Weight maintenance" OR "Weight regulation" OR "Weight stability" OR "Body composition" OR "Body Mass Index" OR “Waist circumference” OR "glucose intolerance" OR "glucose control" OR "insulin resistance" OR "prediabetes" OR "pre-diabetes" OR (diabetes AND ("type 2" OR "type II")) OR “lipoproteins” OR “cholesterol” OR “triglycerides” OR “triglyceride” OR “blood lipids” OR "lipoprotein") OR ("Cardiorespiratory fitness" OR "VO2 max" OR "maximal oxygen uptake" OR "peak oxygen uptake" OR "aerobic capacity"))
Original Research	NOT (“systematic review” OR “systematic literature review” OR metaanalysis OR "meta analysis" OR metanalyses OR "meta analyses"" OR "pooled analysis" OR “pooled analyses” OR "pooled data")
Limits	English language Peer reviewed Exclude Medline records Human 1990-2018

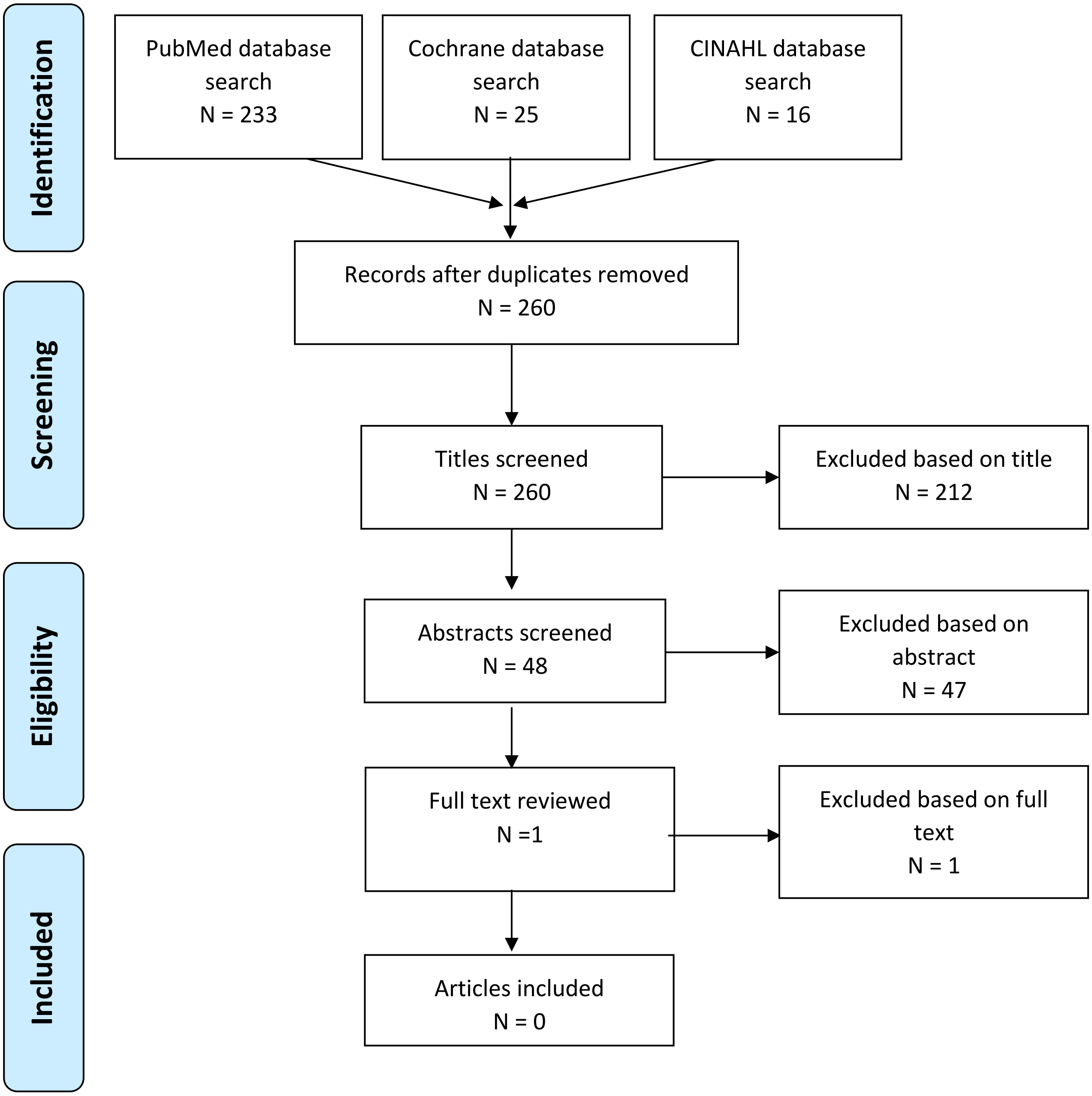
Search Strategy: Cochrane (Original Research)

Database: Cochrane; Date of Search: 6/28/17; 433 Results
Terms searched in title, abstract, or keywords

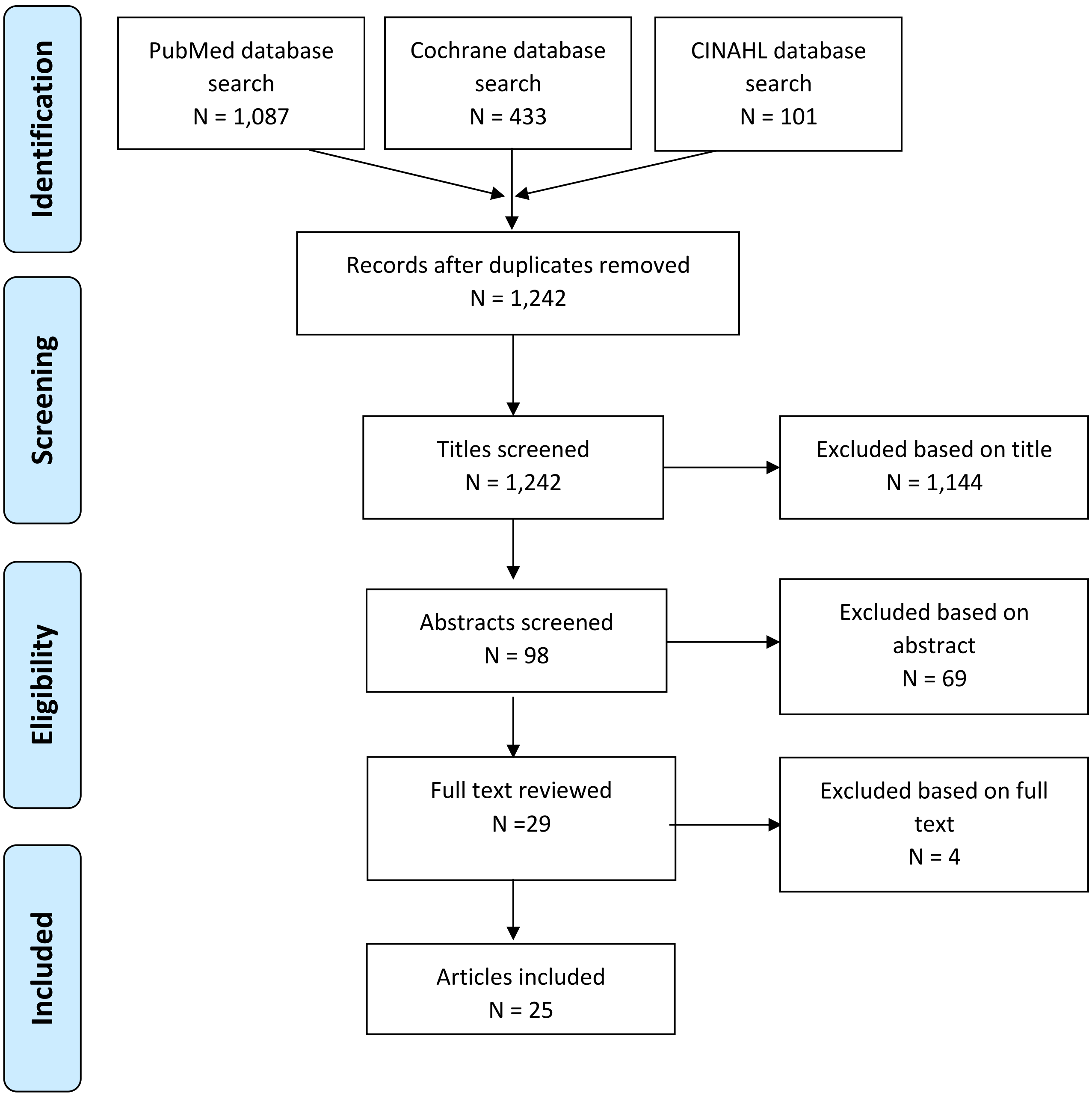
Set	Search Terms
Physical activity (bouts)	((“intermittent activity” OR “intermittent exercise” OR "accumulated activity" OR bouts) AND ("Physical activity" OR "Exercise"))
Outcomes (Cardiovascular Disease Incidence OR Mortality OR Cardiometabolic Risk Factors OR Cardiorespiratory Fitness)	AND (((Arteriosclero* OR "Arteriosclerosis" OR Atheroscler0* OR "Cerebral infarction" OR "Cerebrovascular diseases" OR "Cerebrovascular disease" OR "Coronary heart disease" OR "Heart failure" OR "Intracerebral Hemorrhage" OR "Intracerebral Hemorrhages" OR "Intracranial hemorrhage" OR "Intracranial hemorrhages" OR "Myocardial ischemia" OR "myocardial infarction" OR "Stroke" OR "Subarachnoid hemorrhage" OR "Subarachnoid hemorrhages" OR "Ischemic heart diseases" OR "Ischemic heart disease") AND ("risk" OR "risks" OR "Incidence" OR "incident" OR "Death" OR "Dying" OR Fatal* OR "Mortality" OR "Postmortem")) OR ("blood pressure" OR "systolic pressure" OR "diastolic pressure" OR "mean arterial" OR "bp response" OR "bp decrease" OR "bp reduction" OR "normotensive” OR “hypertension” OR “hypotension” OR “normotension” OR “hypertensive” OR “hypotensive” OR "Body weight" OR "Body composition" OR "Body Mass Index" OR “Waist circumference” OR "Body weight change" OR "Weight gain" OR "Weight status" OR "Overweight" OR "Weight Control" OR "Weight maintenance" OR "Weight regulation" OR "Weight stability" OR "Body composition" OR "Body Mass Index" OR “Waist circumference” OR "glucose intolerance" OR "glucose control" OR "insulin resistance" OR "prediabetes" OR "pre-diabetes" OR (diabetes AND ("type 2" OR "type II")) OR “lipoproteins” OR “cholesterol” OR “triglycerides” OR “triglyceride” OR “blood lipids” OR "lipoprotein") OR ("Cardiorespiratory fitness" OR "VO2 max" OR "maximal oxygen uptake" OR "peak oxygen uptake" OR "aerobic capacity"))
Limits	Trials Word variations will not be searched 1990-2018

Appendix C: Literature Tree

Existing Systematic Reviews, Meta-Analyses, Pooled Analyses, and Reports Literature Tree



Original Research Literature Tree



Appendix D: Inclusion/Exclusion Criteria

Exposure Subcommittee

What is the relationship between bout duration of physical activity and health outcomes?

a. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, or weight status?

Category	Inclusion/Exclusion Criteria	Notes/Rationale
Publication Language	**Include:** • Studies published with full text in English	
Publication Status	**Include:** • Studies published in peer-reviewed journals • Reports determined to have appropriate suitability and quality by PAGAC **Exclude:** • Grey literature, including unpublished data, manuscripts, abstracts, conference proceedings	
Research Type	**Include:** • Original research • Meta-analyses • Systematic reviews • Reports determined to have appropriate suitability and quality by PAGAC	
Study Subjects	**Include:** • Human subjects	
Age of Study Subjects	**Include:** • 18 years of age and above	
Health Status of Study Subjects	**Include:** • Only studies conducted in general population **Exclude:** • Studies on patients with existing cardiovascular disease (CVD) • Studies on high performance athletes	
Comparison	**Include studies in which the comparison is:** • Adults exposed to different doses of physical activity	
Date of Publication	**Include:** • 1990 to present	
Study Design/Type of research	**Include:** • Original Research articles • Intervention studies • Longitudinal • Cross-sectional studies	

Size of Study Groups	**Include:** • All	
Intervention/ Exposure	**Include:** • Intervention or observational studies that **use accelerometers or other objective measures** to assess physical activity (PA) performed in short bouts (bouts should be spread throughout the day, but not within the same session of exercise). • Studies with **any** bout (duration ideally less than 10 minutes) • For intervention studies, the duration of the PA exposure should be at least **12 weeks** **Exclude:** • Studies examining the metabolic response (e.g., insulin sensitivity, lipid values) to a <u>single dose</u> of PA or acute bouts • Exposure measured by a single measure of physical fitness (cardiovascular fitness, strength, flexibility, **walking speed in older adults**): where the measure of physical activity is based only on physical fitness measures (single or combined variables) • Studies that do not include physical activity (or the lack thereof) as the primary exposure variable or used solely as a confounding variable • Studies of a specific therapeutic exercise (range of motion exercise, inspiratory muscle training)	
Outcome	**Include studies in which the outcome is:** • All-cause and CVD mortality • CVD • Type 2 diabetes • Cardio metabolic risk factors: ○ Blood pressure ○ Blood lipids (total cholesterol, HDL-cholesterol, LDL- cholesterol, triglycerides. ○ Body mass, BMI ○ Waist circumference • Cardiorespiratory fitness **Exclude:** • Congenital heart disease • Studies on progression of CVD	
Multiple Publications of Same Data	**Exclude:** No restriction	

Appendix E: Rationale for Exclusion at Abstract or Full-Text Triage for Existing Systematic Reviews, Meta-Analyses, Pooled Analyses, and Reports

The table below lists the excluded articles with at least one reason for exclusion, but may not reflect all possible reasons.

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Albright C, Thompson DL. The effectiveness of walking in preventing cardiovascular disease in women: a review of the current literature. *J Womens Health (Larchmt).* 2006;15(3):271-280. doi:10.1089/jwh.2006.15.271.				X		
Azuma K, Matsumoto H. Potential universal application of high-intensity interval training from athletes and sports lovers to patients. *Keio J Med*. 2017;66(2):19-24. doi:10.2302/kjm.2016-0006-IR.			X			
Bacon AP, Carter RE, Ogle EA, Joyner MJ. VO2max trainability and high intensity interval training in humans: a meta-analysis. *PLoS One*. 2013;8(9):e73182. doi:10.1371/journal.pone.0073182.	X					
Baker G, Gray SR, Wright A, et al. The effect of a pedometer-based community walking intervention "Walking for Wellbeing in the West" on physical activity levels and health outcomes: a 12-week randomized controlled trial. *Int J Behav Nutr Phys Act*. Sept 2008:44. doi:10.1186/1479-5868-5-44.						
Barr-Anderson DJ, AuYoung M, Whitt-Glover MC, Glenn BA, Yancey AK. Integration of short bouts of physical activity into organizational routine: a systematic review of the literature. *Am J Prev Med*. 2011;40(1):76-93. doi:10.1016/j.amepre.2010.09.033.				X	X	
Batacan RB Jr, Duncan MJ, Dalbo VJ, Tucker PS, Fenning AS. Effects of high-intensity interval training on cardiometabolic health: a systematic review and meta-analysis of intervention studies. *Br J Sports Med*. 2017;51(6):494-503. doi:10.1136/bjsports-2015-095841.				X		
Bohannon RW. Number of pedometer-assessed steps taken per day by adults: a descriptive meta-analysis. *Phys Ther*. 2007;87(12):1642-1650. doi:10.2522/ptj.20060037.	X			X		
Bravata DM, Smith-Spangler C, Sundaram V, et al. Using pedometers to increase physical activity and improve health: a systematic review. *JAMA.* 2007;298(19):2296-2304. doi:10.1001/jama.298.19.2296.				X		
Buchheit M, Laursen PB. High-intensity interval training, solutions to the programming puzzle. Part II: anaerobic energy, neuromuscular load and practical applications.			X			

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Sports Med. 2013;43(10):927-954. doi:10.1007/s40279-013-0066-5.						
Buchheit M, Laursen PB. High-intensity interval training, solutions to the programming puzzle: Part I: cardiopulmonary emphasis. *Sports Med*. 2013;43(5):313-338. doi:10.1007/s40279-013-0029-x.			X			
Cassidy S, Thoma C, Houghton D, Trenell MI. High-intensity interval training: a review of its impact on glucose control and cardiometabolic health. *Diabetologia.* 2017;60(1):7-23. doi:10.1007/s00125-016-4106-1.			X			
Choi BC, Pak AW, Choi JC, Choi EC. Daily step goal of 10,000 steps: a literature review. *Clin Invest Med*. 2007;30(3):E146-E151.				X		
Eliakim A, Nemet D. Interval training and the GH-IGF-I axis—a new look into an old training regimen. *J Pediatr Endocrinol Metab*. 2012;25(9-10):815-821. doi:10.1515/jpem-2012-0209.			X			
Fleg JL. Salutary effects of high-intensity interval training in persons with elevated cardiovascular risk. *F1000 Research*. Sept 2016:F1000 Faculty Rev-2254. doi:10.12688/f1000research.8778.1.			X			
Freese EC, Gist NH, Cureton KJ. Effect of prior exercise on postprandial lipemia: an updated quantitative review. *J Appl Physiol (1985).* 2014;116(1):67-75. doi:10.1152/japplphysiol.00623.2013.				X		
Garcia-Hermoso A, Cerrillo-Urbina AJ, Herrera-Valenzuela T, Cristi-Montero C, Saavedra JM, Martínez-Vizcaíno V. Is high-intensity interval training more effective on improving cardiometabolic risk and aerobic capacity than other forms of exercise in overweight and obese youth? A meta-analysis. *Obes Rev.* 2016;17(6):531-540. doi:10.1111/obr.12395.		X				
Gibala MJ, Little JP, Macdonald MJ, Hawley JA. Physiological adaptations to low-volume, high-intensity interval training in health and disease. *J Physiol*. 2012;590(5):1077-1084. doi:10.1113/jphysiol.2011.224725.			X			
Gist NH, Fedewa MV, Dishman RK, Cureton KJ. Sprint interval training effects on aerobic capacity: a systematic review and meta-analysis. *Sports Med*. 2014;44(2):269-279. doi:10.1007/s40279-013-0115-0.	X					
Hoffmann JJ Jr, Reed JP, Leiting K, Chiang CY, Stone MH. Repeated sprints, high-intensity interval training, small-sided games: theory and application to field sports. *Int J Sports Physiol Perform*. 2014;9(2):352-357. doi:10.1123/ijspp.2013-0189.		X	X			

Exposure Subcommittee: Q5. What is the relationship between bout duration of continuous aerobic physical activity and cardiorespiratory fitness and health outcomes?

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Hussain SR, Macaluso A, Pearson SJ. High-intensity interval training versus moderate-intensity continuous training in the prevention/management of cardiovascular disease. *Cardiol Rev*. 2016;24(6):273-281. doi:10.1097/CRD.0000000000000124.			X			
Hwang CL, Wu YT, Chou CH. Effect of aerobic interval training on exercise capacity and metabolic risk factors in people with cardiometabolic disorders: a meta-analysis. *J Cardiopulm Rehabil Prev*. 2011;31(6):378-385. doi:10.1097/HCR.0b013e31822f16cb.		X				
Jelleyman C, Yates T, O'Donovan G, et al. The effects of high-intensity interval training on glucose regulation and insulin resistance: a meta-analysis. *Obes Rev*. 2015;16(11):942-961. doi:10.1111/obr.12317.				X		
Kang M, Marshall SJ, Barreira TV, Lee JO. Effect of pedometer-based physical activity interventions: a meta-analysis. *Res Q Exerc Sport*. 2009;80(3):648-655. doi:10.1080/02701367.2009.10599604.				X		
Karlsen T, Aamot IL, Haykowsky M, Rognmo Ø. High intensity interval training for maximizing health outcomes. *Prog Cardiovasc Dis*. 2017;60(1):67-77. doi:10.1016/j.pcad.2017.03.006.			X			
Kessler HS, Sisson SB, Short KR. The potential for high-intensity interval training to reduce cardiometabolic disease risk. *Sports Med*. 2012;42(6):489-509. doi:10.2165/11630910-000000000-00000.				X		
Kolmos M, Krawcyk RS, Kruuse C. Effect of high-intensity training on endothelial function in patients with cardiovascular and cerebrovascular disease: a systematic review. *SAGE Open Med*. Dec 2016:2050312116682253. doi:10.1177/2050312116682253.		X				
MacInnis MJ, Gibala MJ. Physiological adaptations to interval training and the role of exercise intensity. *J Physiol.* 2017;595(9):2915-2930. doi:10.1113/JP273196.			X			
Meyer J, Morrison J, Zuniga J. The benefits and risks of CrossFit: a systematic review. *Workplace Health Saf*. March 2017:2165079916685568. doi:2165079916685568.	X					
Milanovic Z, Sporis G, Weston M. Effectiveness of high-intensity interval training (HIT) and continuous endurance training for VO2max improvements: a systematic review and meta-analysis of controlled trials*. Sports Med*.	X					

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
2015;45(10):1469-1481. doi:10.1007/s40279-015-0365-0.						
Murtagh EM, Murphy MH, Boone-Heinonen J. Walking: the first steps in cardiovascular disease prevention. *Curr Opin Cardiol*. 2010;25(5):490-496. doi:10.1097/HCO.0b013e32833ce972.			X	X		
Oliveros MJ, Gaete-Mahn MC, Lanas F, Martinez-Zapata MJ, Seron P. Interval training exercise for hypertension. *Cochrane Database Syst Rev*. Jan 2017:CD012511. doi:10.1002/14651858.CD012511.			X			
Ramos JS, Dalleck LC, Tjonna AE, Beetham KS, Coombes JS. The impact of high-intensity interval training versus moderate-intensity continuous training on vascular function: a systematic review and meta-analysis. *Sports Med*. 2015;45(5):679-692. doi:10.1007/s40279-015-0321-z.		X				
Regnaux JP, Lefevre-Colau MM, Trinquart L, et al. High-intensity versus low-intensity physical activity or exercise in people with hip or knee osteoarthritis. *Cochrane Database Syst Rev*. 2015;(10):CD010203. doi:10.1002/14651858.CD010203.		X				
Shiraev T, Barclay G. Evidence based exercise— clinical benefits of high intensity interval training. *Aust Fam Physician*. 2012;41(12):960-962.		X	X			
Sloth M, Sloth D, Overgaard K, Dalgas U. Effects of sprint interval training on VO2max and aerobic exercise performance: a systematic review and meta-analysis. *Scand J Med Sci Sports*. 2013;23(6):e341-e352. doi:10.1111/sms.12092.					X	
Soares FH, de Sousa MB. Different types of physical activity on inflammatory biomarkers in women with or without metabolic disorders: a systematic review. *Women Health*. 2013;53(3):298-316. doi:10.1080/03630242.2013.782940.	X					
Tudor-Locke C, Bassett DR Jr. How many steps/day are enough? Preliminary pedometer indices for public health. *Sports Med*. 2004;34(1):1-8.			X			
Tudor-Locke C, Craig CL, Aoyagi Y, et al. How many steps/day are enough? For older adults and special populations. *Int J Behav Nutr Phys Act*. July 2011:80. doi:10.1186/1479-5868-8-80.				X		
Tudor-Locke C, Craig CL, Beets MW, et al. How many steps/day are enough? For children and adolescents. *Int J Behav Nutr Phys Act.* July 2011:78. doi:10.1186/1479-5868-8-78.		X		X		

Exposure Subcommittee: Q5. What is the relationship between bout duration of continuous aerobic physical activity and cardiorespiratory fitness and health outcomes?

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Tudor-Locke C, Craig CL, Brown WJ, et al. How many steps/day are enough? For adults. *Int J Behav Nutr Phys Act*. July 2011:79. doi:10.1186/1479-5868-8-79.				X		
Tudor-Locke C, Craig CL, Thyfault JP, Spence JC. A step-defined sedentary lifestyle index: <5000 steps/day. *Appl Physiol Nutr Metab*. 2013;38(2):100-114. doi:10.1139/apnm-2012-0235.			X	X		
Tudor-Locke C, Hart TL, Washington TL. Expected values for pedometer-determined physical activity in older populations. *Int J Behav Nutr Phys Act*. Aug 2009:59. doi:10.1186/1479-5868-6-59.	X					
Vollaard NB, Metcalfe RS, Williams S. Effect of number of sprints in a SIT session on change in VO2max: a meta-analysis. *Med Sci Sports Exerc*. 2017;49(6):1147-1156. doi:10.1249/MSS.0000000000001204.	X					
Weston KS, Wisloff U, Coombes JS. High-intensity interval training in patients with lifestyle-induced cardiometabolic disease: a systematic review and meta-analysis. *Br J Sports Med*. 2014;48(16):1227-1234. doi:10.1136/bjsports-2013-092576.		X				
Weston M, Taylor KL, Batterham AM, Hopkins WG. Effects of low-volume high-intensity interval training (HIT) on fitness in adults: a meta-analysis of controlled and non-controlled trials. *Sports Med*. 2014;44(7):1005-1017. doi:10.1007/s40279-014-0180-z.	X					
Wewege M, van den Berg R, Ward RE, Keech A. The effects of high-intensity interval training vs. moderate-intensity continuous training on body composition in overweight and obese adults: a systematic review and meta-analysis. *Obes Rev*. 2017;18(6):635-646. doi:10.1111/obr.12532.		X				
Wisloff U, Ellingsen O, Kemi OJ. High-intensity interval training to maximize cardiac benefits of exercise training? *Exerc Sport Sci Rev*. 2009;37(3):139-146. doi:10.1097/JES.0b013e3181aa65fc.			X			

Rationale for Exclusion at Abstract or Full-Text Triage for Original Research

The table below lists the excluded articles with at least one reason for exclusion, but may not reflect all possible reasons.

Citation	Outcome	Population	Study Design	Exposure	Other
Dugas LR, Kliethermes S, Plange-Rhule J, et al. Accelerometer-measured physical activity is not associated with two-year weight change in African-origin adults from five diverse populations. Marusic A, ed. *PeerJ*. 2017;5:e2902. doi:10.7717/peerj.2902.				X	
Jacobsen DJ, Donnelly JE, Snyder-Heelan K, Livingston K. Adherence and attrition with intermittent and continuous exercise in overweight women. *Int J Sports Med.* 2003;24(06):459-464. doi:10.1055/s-2003-41177.	X				
Snyder KA, Donnelly JE, Jabobsen DJ, Hertner G, Jakicic JM. The effects of long-term, moderate intensity, intermittent exercise on aerobic capacity, body composition, blood lipids, insulin and glucose in overweight females. *Int J Obes Relat Metab Dis.* 1997;21(12):1180-1189.					X
Tucker JM, Welk GJ, Beyler NK, Kim Y. Associations between physical activity and metabolic syndrome: comparison between self-report and accelerometry. *Am J Health Promot*. 2016;30(3):155-162. doi:10.4278/ajhp.121127-QUAN-576.				X	

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2. Asikainen TM, Miilunpalo S, Kukkonen-Harjula K, et al. Walking trials in postmenopausal women: effect of low doses of exercise and exercise fractionization on coronary risk factors. *Scand J Med Sci Sports*. 2003;13(5):284–292.

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