Do Short Spurts of Physical Activity Benefit Cardiovascular Health? The CARDIA Study

DANIEL K. WHITE[1], KELLEY PETTEE GABRIEL[2], YONGIN KIM[3], CORA E. LEWIS[3], and BARBARA STERNFELD[4]

[1]Department of Physical Therapy, University of Delaware, Newark, DE; [2]Health Science Center at Houston, School of Public Health—Austin Regional Campus, University of Texas, Austin, TX; [3]University of Alabama at Birmingham, Birmingham, AL; and [4]Division of Research, Kaiser Permanente, Northern California, Oakland, CA

ABSTRACT

WHITE, D. K., K. P. GABRIEL, Y. KIM, C. E. LEWIS, and B. STERNFELD. Do Short Spurts of Physical Activity Benefit Cardiovascular Health? The CARDIA Study. *Med. Sci. Sports Exerc.*, Vol. 47, No. 11, pp. 2353–2358, 2015. **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 $kg \cdot m^{-2}$), 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. **Key Words:** PHYSICAL ACTIVITY, COHORT STUDY, OBESITY, HYPERTENSION

APPLIED SCIENCES

Regular participation in moderate- to vigorous-intensity physical activity (MVPA) is associated with numerous health benefits including reduced risk of cardiovascular disease (CVD), functional limitation, and premature death (20). To maximize these and other health benefits from physical activity, the *2008 Physical Activity Guidelines for Americans* recommend all adults participate in ≥150 $min \cdot wk^{-1}$ of MVPA occurring in bouts ≥10 min (20). Exercise is one type of MVPA, which involves participation in planned, structured, recurring movements that typically last ≥10 min, such as aerobic walking. Consequently, time spent exercising counts toward meeting the physical activity recommendation.

Unstructured activity is another type of MVPA, which is typically unplanned and occurs during daily life, such as climbing a flight of stairs. However, unstructured activity typically occurs in short spurts lasting <10 min. Although being at the prerequisite intensity, short spurts do not count toward meeting physical activity guidelines by virtue of not being sustained for at least 10 min. Nevertheless, short spurts are commonly suggested to initiate behavioral change and increase total physical activity volume. For instance, commonly recommended strategies to increase physical activity that typically take less than 10 min to complete include parking the car in the back of a parking lot and taking the stairs instead of the elevator (21,25)

Little is known about the health benefits of short spurts of physical activity, i.e., MVPA <10 min (12,17). Short spurts of MVPA are not captured on self-report instruments because of issues related to accurate recall. Moreover, guidelines for physical activity are based on cohort studies that used self-reported questionnaire measures of physical activity. Subsequently, recommended guidelines for physical activity do not include recommendations related to unstructured physical activity. However, short spurts may still be associated with health benefits. Recent cross-sectional studies objectively measuring physical activity with monitors show that short spurts of MVPA have a similar protective association with the prevalence of CVD risk factors (10), markers of obesity (21), and metabolic syndrome (4) as bouted MVPA, i.e., MVPA lasting ≥10 min. However, the

Address for correspondence: Daniel K. White, P.T., Sc.D., M.Sc., STAR Health Sciences Complex, University of Delaware, 540 S. College Ave., Suite 210 L, Newark, DE 19713; E-mail: dkw@udel.edu.
Submitted for publication December 2014.
Accepted for publication March 2015.

0195-9131/15/4711-2353/0
MEDICINE & SCIENCE IN SPORTS & EXERCISE®

DOI: 10.1249/MSS.0000000000000662

cross-sectional design of these studies limits the ability to establish causal association. A prospective investigation would improve understanding of the potentially protective association of short spurts of MVPA with the development of unfavorable health outcomes.

Therefore, the purpose of this study was to investigate the effect of short spurts of MVPA on the development of hypertension and obesity over 5 yr in a large observational prospective cohort study of CVD risk factors among middle-age adults.

METHODS

We used data from the Coronary Artery Risk Development in Young Adults (CARDIA) study, which has been described in detail elsewhere (9,14). In brief, CARDIA is a population-based prospective epidemiologic study of the predictors and development of CVD risk factors and subclinical CVD in young adults. Study participants were 18–35 yr of age at the baseline examination that occurred from 1985 to 1986. For the current analysis using the 20-yr CARDIA follow-up visit, the age range was 37–55 yr of age. Subjects were enroled in approximately equal proportions of race (White/Black), sex, education (high school or lower or higher than high school), and age (≤24 and >24 yr) from Birmingham, AL, Chicago, IL, Minneapolis, MN, and Oakland, CA. All CARDIA study participants provided an informed consent, and each study site's institutional review board approved the parent study.

This particular analysis focused on a subset of the CARDIA cohort that attended both the year 20 (2005–2006) and year 25 (2010–2011) examinations. The year 20 and 25 examinations were attended by 3549 and 3498 study participants, respectively. The year 20 examination was the first study visit in which objectively measured physical activity was collected. Of the 3549 study participants who attended the year 20 examination, 41% or 2076 had valid accelerometer data and comprised our analytic cohort. For this secondary data analysis, the 20-yr examination was considered our study "baseline" and the 25-yr examination was the "5-yr follow-up."

Physical activity. Physical activity was measured with an ActiGraph monitor (model 7164; Pensacola, FL), a uniaxial accelerometer. CARDIA study participants were asked to wear an accelerometer around their waist except when sleeping or bathing for seven consecutive days after the 20-yr clinic visit. Data were collected and expressed as 60-s epochs.

Data from the accelerometer were downloaded and screened for wear time using methods reported by Troiano et al. (22). Briefly, device nonwear was defined as 60 consecutive minutes of 0 counts, with an allowance for 1–2 min of detected counts between 0 and 100. Wear time was determined by subtracting derived nonwear time from 24 h. A minimum of 10 $h \cdot d^{-1}$ of wear time on at least 4 of 7 d was necessary to be included in analyses.

MVPA was defined by the Freedson criteria, i.e., activity counts ≥1952 (8). Minutes of MVPA was classified into either 1) bouted MVPA, i.e., activity lasting ≥10 continuous minutes or 2) short spurts of MVPA, i.e., activity lasting <10 continuous minutes. Bouts were defined in accordance with the National Health and Nutrition Examination Survey criteria for a modified 10-min bout (22). In particular, bouted MVPA was defined as ≥10 consecutive minutes above the Freedson criteria, with allowance for 1- or 2-min interruptions below the 1952 count threshold. Time spent in short spurts was defined as MVPA not meeting the modified 10-min bout criteria (short spurts of MVPA = total time in MVPA − time spent in bouted MVPA). Minutes in bouted MVPA and short spurts of MVPA were averaged over the number of valid days and expressed as minutes per day. For analysis, we classified data in three ways, as follows: 1) continuously, into 10-min increments of time spent in short spurts of MVPA and bouted MVPA, 2) categorically, into separate tertiles of time spent in short spurts of MVPA and bouted MVPA, and 3) a nine-level categorical variable using each pair of bouted and short spurts of MVPA tertiles. The reference value for the nine-level categorical variable was the combination of the tertile for the least time spent in bouted MVPA and the tertile for the least time spent in short spurts of MVPA.

Hypertension. Blood pressure was measured using a standardized protocol (5). Briefly, blood pressure was measured three times at 1-min intervals after study participants sat for 5 min. The average of the second and third blood pressure measures was used for analysis. Incident hypertension was defined as systolic blood pressure ≥140 mm Hg, diastolic blood pressure, ≥90 mm Hg, or initiation of treatment with antihypertensive medications at follow-up among study participants not meeting these criteria at baseline (3).

Obesity. Height and body weight were measured using a standardized protocol, with participants wearing light clothing without shoes (5). Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Incident obesity was defined as BMI ≥ 30 $kg \cdot m^{-2}$ at follow-up among those with BMI < 30 $kg \cdot m^{-2}$ at baseline.

Potential confounders. The following factors were considered as potential confounders (on the basis of their association with physical activity and cardiovascular risk factors in previous studies: age (23), sex (22), BMI (7), race (Black or White) (22), and income (<$16,000, $16,000–$50,000, and ≥$50,000) (15). Age, sex, race, and income data were obtained from standardized self-report questionnaires (5).

Statistical analysis. We computed means, SD, medians, and 25th and 75th percentile values for continuous variables and proportions for categorical variables to describe the study sample. We also evaluated the correlation between bouted MVPA and short spurts of MVPA as continuous measures using Pearson correlation coefficient after confirming that data were normally distributed.

We examined the association of short spurts of MVPA with the incidence of obesity and hypertension determined at

TABLE 1. Subject characteristics from CARDIA.

	All Study Participants (N = 2076)	Incident Hypertension (n = 226)	Incident Obesity (n = 151)
Age (yr) (mean (SD))	45.2 (3.6)	45.4 (3.4)	45.4 (3.4)
Median (25th and 75th percentile)	46.0 (43, 48)	46.0 (42, 48)	46.0 (43, 48)
Women (%)	57.3	57.1	53.6
BMI (kg·m^{-2}) (mean (SD))	29.0 (7.0)	30.4 (6.4)	28.7 (1.2)
Median (25th and 75th percentile)	27.7 (24.2, 32.2)	29.6 (25.6, 34.0)	29.0 (28.1, 29.5)
Systolic blood pressure (mean (SD))	114.9 (13.8)	121.6 (9.2)	114.6 (13.6)
Median (25th and 75th percentile)	113.2 (105.5, 121.8)	121.8 (115.1, 128.5)	113.2 (105.5, 120.9)
Income (%)			
< \$16,000	8.7	23.9	5.3
\$16,000–\$50,000	23.3	15.2	23.8
>\$50,000	68.1	13.6	70.9
Race (% White)	58.2	44.7	57.6
Physical activity			
Bouted MVPA[a] (min·d^{-1} (SD))	11.9 (17.7)	9.2 (12.8)	10.0 (14.9)
Median (25th and 75th percentile))	5.4 (0, 17.1)	3.0 (0, 14.4)	4.6 (0, 13.3)
Short spurts of MVPA[b] (min·d^{-1} (SD))	27.9 (18.9)	25.5 (16.6)	27.8 (15.3)
Median (25th and 75th percentile)	23.6 (15.4, 35.3)	21.5 (14.7, 31.7)	26.0 (17.0, 35.0)

[a]Bouted activity is ≥10 consecutive minutes of MVPA, with allowance for 1- or 2-min interruptions.
[b]Short spurts of MVPA = total time in MVPA − time spent in bouted MVPA.

the 5-yr follow-up by calculating risk ratios (RR) using binomial regression with robust variance estimation (27). We conducted these analyses by classifying time in short spurts of MVPA as tertiles and as a continuous measure, i.e.,10-min increments, in separate models. All models were adjusted for bouted MVPA and potential confounders (27). For incident obesity, we did not adjust for baseline BMI because the bias introduced by such an adjustment may exceed the bias eliminated (11).

To disentangle confounding due to potential correlation between bouted MVPA and short spurts of MVPA tertiles, we evaluated the combined association of MVPA types with the incidence of hypertension and obesity. We calculated the association of each pair of bouted and short spurts of MVPA tertiles with our study outcomes. The tertile pair of the highest values of both bouted and short spurts of MVPA was the reference group. Similar approaches using combined associations with correlated measures have been applied with cardiorespiratory fitness and body fat change (16), sitting and physical activity (24), and gait speed and walking endurance (26).

RESULTS

Of the 3549 study participants who attended the year 20 CARDIA examination, 1041 did not wear an accelerometer, 428 wore a monitor for less than 4 d, and 4 had monitor malfunctions, resulting in an analytic sample of 2076. Of those included, the average (SD) age was 45.2 (3.6) yr, 57.3% were women, 58.2% were White, and 8.7% had income <\$16,000. At baseline, the average (SD) BMI was 29.0 (7.0) kg·m^{-2}, 34.6% were obese (BMI ≥ 30 kg·m^{-2}), the average systolic blood pressure was 114.9 (13.8) mm Hg, and 20.0% met criteria for having hypertension at baseline (Table 1). Participants attending the year 20 examination who did not wear an accelerometer (n = 1473) had a higher BMI, higher systolic blood pressure, and less income and were less likely to be White compared with those who wore an accelerometer (n = 2076) (Table 2).

The average (SD) time spent in short spurts of MVPA was 27.9 (18.9) min·d^{-1}, and the average time in bouted MVPA was 11.9 (17.7) min·d^{-1}. There was moderate and statistically significant correlation between bouted MVPA and short spurts of MVPA (r = 0.33, P < 0.0001).

At the 5-yr follow-up, 14.8% (226/1531) of study participants had developed hypertension. Study participants in the highest tertile of short spurts of MVPA were 31% less likely to develop hypertension compared with those in the tertile with the least short spurts of MVPA. Each 10-min increase in short spurts of MVPA was associated with a 9% decrease in the risk of developing hypertension at follow-up (adjusted RR, (95% confidence interval (CI)), 0.91 (0.84–0.99)). Those in the highest tertile of bouted MVPA were 26% less likely to develop hypertension compared with those in the lowest bouted MVPA tertile, which approached statistical significance. Each 10-min increase in bouted MVPA was associated with a 10% decrease in the risk of developing hypertension at follow-up (adjusted RR, 0.90 (0.82–0.99)) (Table 3). For the combined association of short spurts of MVPA and bouted MVPA, we observed more time in both to be associated with less risk of developing hypertension. Within each tertile of short spurts of MVPA (table columns), increasing time in bouted MVPA was generally associated with less risk of incident hypertension. Similarly, within each tertile of bouted MVPA (table rows), increasing time in

TABLE 2. Characteristics of subjects who attended the year 20 CARDIA examination and were included (n = 2076) and not included (n = 1473) in analyses.

	Included Study Participants (n = 2076)	Excluded Study Participants (n = 1473)	P Value
Age (yr) (mean (SD))	45.2 (3.6)	45.2 (3.7)	0.69
Women (%)	57.3	55.9	0.42
BMI (kg·m^{-2}) (mean (SD))	29.0 (7.0)	30.1 (7.5)	<0.0001
Systolic blood pressure (mean (SD))	114.9 (13.8)	116.9 (15.7)	<0.0001
Income (%)			<0.0001
< \$16,000	8.7	12.5	
\$16,000–\$50,000	23.3	27.5	
>\$50,000	68.1	60.0	
Race (% White)	58.2	46.8	<0.0001

APPLIED SCIENCES

TABLE 3. Association of short spurts of MVPA and bouted MVPA with incident hypertension.

Tertiles of Short Spurts of MVPA (Range) (min·d^{-1})	Incident Hypertension[a] (% (*n*))	Adjusted RR[b] (95% CI) for Incident Hypertension
1: Least short spurts (3.0–17.9)	18.3 (87/475)	1.00 (Reference)
2: Middle short spurts (18.0–30.6)	14.5 (78/538)	0.86 (0.65–1.13)
3: Most short spurts (30.7–116.8)	11.8 (61/518)	0.69 (0.49–0.96)
Per 10-min increase in short spurts of MVPA		0.91 (0.84–0.99)
Tertiles of Bouted MVPA (range) (min·d^{-1})	**Incident Hypertension[b] (% (*n*))**	**Adjusted RR[c] (95% CI) for Incident Hypertension**
1: Lowest bouted (0–1.5)	20.0 (90/450)	1.00 (Reference)
2: Middle bouted (1.6–12.1)	13.9 (73/524)	0.87 (0.65–1.16)
3: Highest bouted (12.3–287.9)	11.3 (63/557)	0.74 (0.54–1.01)
Per 10-min increase in bouted MVPA		0.90 (0.82–0.99)

Short spurts of MVPA = total time in MVPA − time spent in bouted MVPA
[a]Incident hypertension was defined as a systolic blood pressure > 130 mm Hg at the 5-yr follow-up among those with systolic blood pressure < 120 mm Hg at baseline.
[b]Adjusted for age, sex, BMI, race, income, and bouted MVPA. Quartiles of MVPA and 10-min increments of MVPA are in separate models.
[c]Adjusted for age, sex, BMI, race, income and short spurts of MVPA. Quartiles of MVPA and 10-min increments of MVPA are in separate models.

short spurts of MVPA was associated with less risk of incident hypertension (Table 4).

Obesity developed in 12.1% (151/1251) of study participants at the 5-yr follow-up. Increased time spent in short spurts of MVPA did not change the risk of incident obesity materially, both quantified as tertiles of MVPA and 10-min increments. However, more time spent in bouted MVPA reduced the risk of incident obesity. For each 10-min increase in bouted MVPA, the risk of obesity was reduced 21% (adjusted RR, 0.79 (0.68–0.92)) (Table 5). Within each tertile of short spurts of MVPA (table columns), increasing time in bouted MVPA was generally associated with less risk of incident obesity. However, within each tertile of bouted MVPA (table rows), increasing time in short spurts of MVPA was not associated with less risk of incident obesity (Table 6).

DISCUSSION

More time spent in short spurts of MVPA reduced the risk of developing hypertension but not obesity over 5 yr.

TABLE 5. Association of short spurts of MVPA with incident obesity.

Tertiles of Short Spurts of MVPA (Range) (min·d^{-1})	Incident Obesity[a] (% (*n*))	Adjusted RR[b] (95% CI) for Incident Obesity
1: Least short spurts (3.0–17.9)	11.2 (42/376)	1.00 (Reference)
2: Middle short spurts (18.0–30.6)	12.3 (53/431)	1.32 (0.89–1.94)
3: Most short spurts (30.7–116.8)	12.6 (56/444)	1.40 (0.94–2.10)
Per 10-min increase in short spurts of MVPA		1.11 (0.96–1.27)
Tertiles of Bouted MVPA (Range) (min·d^{-1})	**Incident Obesity (% (*n*))**	**Adjusted RR[c] (95% CI) for Incident Obesity**
1: Lowest bouted (0–1.5)	16.3 (54)	1.00 (Reference)
2: Middle bouted (1.6–12.1)	12.3 (54)	0.72 (0.50–1.04)
3: Highest bouted (12.3–287.9)	9.0 (43)	0.54 (0.36–0.81)
Per 10-min increase in bouted MVPA		0.79 (0.68–0.92)

Short spurts of MVPA = total time in MVPA − time spent in bouted MVPA
[a]Incident obesity was defined as BMI ≥ 30 kg·m^{-2} at the 5-yr follow-up among those with a BMI < 27 kg·m^{-2} at baseline.
[b]Adjusted for age, sex, race, income, and bouted MVPA. Quartiles of MVPA and 10-min increments of MVPA are in separate models.
[c]Adjusted for age, sex, race, income, and short spurts of MVPA. Quartiles of MVPA and 10-min increments of MVPA are in separate models.

Specifically, those in the highest tertile of short spurts of MVPA had 31% reduced risk of developing hypertension. However, increased time spent in short spurts of MVPA did not materially change the risk of becoming obese. These findings provide longitudinal evidence that short spurts of activity in adults may provide protection over and above that which is associated with bouted MVPA against the onset of hypertension, although not against obesity. These findings partially support the notion that MVPA does not need to be performed in bouts of 10 continuous minutes to have health benefits (20).

Short spurts of MVPA may elicit enough of a physiologic response from the cardiovascular system to reduce the risk of developing hypertension. Previous studies have used total time in MVPA and did not differentiate between bouted versus short spurts of MVPA in children (13) and adults (2). For instance, Camhi et al. (2) reported a trend for an additional 30 min of objectively measured total MVPA to reduce the risk of prevalent hypertension by 10% in adults (odds ratio, 0.90 (0.77–1.04)). Likewise, a published study using data from CARDIA showed that more time in self-reported MVPA was associated with less risk of developing hypertension 15 yr later (18). Our findings add that short spurts of MVPA may elicit enough of a physiologic response

TABLE 4. Combined association of tertiles of short spurts of MVPA (columns) and bouted MVPA (rows) with incident hypertension.

MVPA Tertile (Range) (min·d^{-1})	1: Lowest Short Spurts (3.0–17.9)	2: Middle Short Spurts (18.0–30.6)	3: Highest Short Spurts (30.7–116.8)
1: Lowest bouted (0–1.5)	22.2% (51/230) 1.00 (Reference)	18.5% (27/146) 0.78 (0.51–1.17)	16.2% (12/74) 0.68 (0.37–1.24)
2: Middle bouted (1.6–12.1)	17.0% (24/141) 0.86 (0.56–1.32)	15.4% (29/188) 0.81 (0.54–1.22)	10.3% (20/195) 0.49 (0.29–0.80)
3: Highest bouted (12.3–287.9)	11.5% (12/104) 0.60 (0.34–1.05)	10.8% (22/204) 0.58 (0.37–0.92)	11.7% (29/249) 0.56 (0.36–0.87)

Data are presented as adjusted RR (95% CI); data were adjusted for age, BMI, sex, race, and income.
%, incident hypertension/no hypertension at baseline.

TABLE 6. Combined association of tertiles of short spurts of MVPA (columns) and bouted MVPA (rows) with incident obesity.

MVPA Tertile (Range) (min·d^{-1})	1: Lowest Short Spurts (3.0–17.9)	2: Middle Short Spurts (18.0–30.6)	3: Highest Short Spurts (30.7–116.8)
1: Lowest bouted (0–1.5)	13.1% (23/175) 1.00 (Reference)	18.8% (19/101) 1.53 (0.88–2.67)	21.4% (12/56) 1.66 (0.88–3.13)
2: Middle bouted (1.6–12.1)	12.1% (14/116) 0.97 (0.52–1.81)	11.2% (17/152) 0.91 (0.50–1.65)	13.5% (23/171) 1.08 (0.62–1.89)
3: Highest bouted (12.3–287.9)	5.9% (5/85) 0.52 (0.20–1.34)	9.6% (17/178) 0.82 (0.45–1.53)	9.7% (21/217) 0.81 (0.46–1.43)

%, incident obesity/no obesity at baseline.
Data are presented as adjusted RR (95% CI); data were adjusted for age, sex, race, and income.

independent of bouted MVPA from the cardiovascular system to reduce the risk of developing hypertension.

Although evidence supports the notion that sustained MVPA promotes weight stability (20), we did not find the same to be true for short spurts of MVPA. We hypothesize that there may not have been enough energy expenditure from short spurts of MVPA to overcome weight gain and development of obesity among study participants. Despite this finding, it is important to consider that there may be nonphysiologic benefits to such short spurts of physical activity. For instance, taking the stairs or parking further away may help facilitate positive changes in self-efficacy to perform physical activity (1) and ultimately may lead to adoption of an active lifestyle (19).

The limitations of our study should be acknowledged. First, a clinical trial should ideally be used to examine whether an increase in short spurts of MVPA protects against the development of hypertension and obesity in adults. However, the incidence of hypertension and obesity over 5 yr was low, i.e., <16%. Hence, it would likely be somewhat impractical from a cost perspective to test an adequately powered clinical trial with appropriate follow-up. Second, there is no definitive count cut point threshold to define for MVPA from an ActiGraph monitor. However, our selected method, using the Freedson criteria, is a well-established and validated (8) method commonly used in the physical activity literature. Third, we only adjusted for a limited number of potential confounders, which did not include dietary factors, smoking, alcohol use, and monitor wear time. Our study findings should be interpreted considering the exclusion of these behavioral risk factors as potential covariates in analyses. Fourth, we did not distinguish primary hypertension from secondary hypertension. Hence, some cases of hypertension may be due to sources unrelated to physical activity. Nevertheless, we found increased short spurts of MVPA to have a moderate effect with preventing the development of hypertension in our sample.

Our study has several strengths. First, we used a prospective study design, which is an advance over previous cross-sectional studies (4,10,21). Second, we analyzed data from a large, well-characterized cohort with standardized measures of CVD risk factors in middle-age adults with close to equal proportions people who are White and Black. Lastly, we were able to examine short spurts of MVPA from a well-validated and objective measure of physical activity, the ActiGraph monitor.

In summary, we found increasing time spent in short spurts of MPVA to be associated with more protection against the development of hypertension but not obesity over 5 yr. The implication of these findings is that participation in short spurts of MVPA, such as climbing the stairs, may protect against the development of hypertension, but not obesity, in middle-age adults.

Dr. White was funded by a Rheumatology Research Foundation Bridge Funding Award and the Boston Rehabilitation Outcomes Center, R24HD0065688. The Coronary Artery Risk Development in Young Adults study is supported by contracts HHSN268201300025C, HHSN268201300026C, HHSN268201300027C, HHSN268201300028C, HHSN268201300029C, and HHSN268200900041C from the National Heart, Lung, and Blood Institute, the Intramural Research Program of the National Institute on Aging, and an intraagency agreement between the National Institute on Aging and the National Heart, Lung, and Blood Institute (AG0005).

The authors declare no conflicts of interest.

The authors' contributions were as follows: D. W. conceived and designed the study, interpreted the data, and drafted the article; D. W. is the guarantor of the study; K. P. G. interpreted the data and revised and approved of the final version of the article; Y. K. analyzed and interpreted the data and revised and approved of the final version of the article; C. E. L. collected the data, interpreted the data, and revised and approved of the final version of the article; B. S. conceived and designed the study, interpreted the data, and revised and approved of the final version of the article.

The results of the present study do not constitute endorsement by the American College of Sports Medicine.

REFERENCES

1. Bandura A. *Self-Efficacy: The Exercise of Control*. New York (NY): Worth Publishers; 1997.
2. Camhi SM, Sisson SB, Johnson WD, Katzmarzyk PT, Tudor-Locke C. Accelerometer-determined moderate intensity lifestyle activity and cardiometabolic health. *Prev Med*. 2011;52(5):358–60.
3. Carson AP, Lewis CE, Jacobs DR Jr., et al. Evaluating the Framingham hypertension risk prediction model in young adults: the Coronary Artery Risk Development in Young Adults (CARDIA) study. *Hypertension*. 2013;62(6):1015–20.
4. Clarke J, Janssen I. Sporadic and bouted physical activity and the metabolic syndrome in adults. *Med Sci Sports Exerc*. 2014;46(1):76–83.
5. Cutter GR, Burke GL, Dyer AR, et al. Cardiovascular risk factors in young adults. The CARDIA baseline monograph. *Control Clin Trials*. 1991;12(1 Suppl):1S–77S.
6. Dinger MK, Oman RF, Taylor EL, Vesely SK, Able J. Stability and convergent validity of the Physical Activity Scale for the Elderly (PASE). *J Sports Med Phys Fitness*. 2004;44(2):186–92.
7. Dwyer T, Hosmer D, Hosmer T, et al. The inverse relationship between number of steps per day and obesity in a population-based sample: the AusDiab study. *Int J Obes (Lond)*. 2007;31(5):797–804.
8. Freedson PS, Melanson E, Sirard J. Calibration of the Computer Science and Applications, Inc. accelerometer. *Med Sci Sports Exerc*. 1998;30(5):777–81.
9. Friedman GD, Cutter GR, Donahue RP, et al. CARDIA: study design, recruitment, and some characteristics of the examined subjects. *J Clin Epidemiol*. 1988;41(11):1105–16.
10. 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):109–15.
11. Glymour MM, Weuve J, Berkman LF, Kawachi I, Robins JM. When is baseline adjustment useful in analyses of change? An example with education and cognitive change. *Am J Epidemiol*. 2005;162(3):267–78.
12. Haskell WL, Lee IM, Pate RR, et al. Physical activity and public health: updated recommendation for adults from the American

College of Sports Medicine and the American Heart Association. *Med Sci Sports Exerc*. 2007;39(8):1423–34.
13. Holman RM, Carson V, Janssen I. Does the fractionalization of daily physical activity (sporadic vs. bouts) impact cardiometabolic risk factors in children and youth? *PLoS One*. 2011;6(10):e25733.
14. Hughes GH, Cutter G, Donahue R, et al. Recruitment in the Coronary Artery Disease Risk Development in Young Adults (Cardia) study. *Control Clin Trials*. 1987;8(4 Suppl):68S–73S.
15. Hyytinen A, Lahtonen J. The effect of physical activity on long-term income. *Soc Sci Med*. 2013;96:129–37.
16. Lee DC, Sui X, Church TS, Lavie CJ, Jackson AS, Blair SN. Changes in fitness and fatness on the development of cardiovascular disease risk factors hypertension, metabolic syndrome, and hypercholesterolemia. *J Am Coll Cardiol*. 2012;59(7):665–72.
17. Murphy MH, Blair SN, Murtagh EM. Accumulated versus continuous exercise for health benefit: a review of empirical studies. *Sports Med*. 2009;39(1):29–43.
18. Parker ED, Schmitz KH, Jacobs DR Jr., Dengel DR, Schreiner PJ. Physical activity in young adults and incident hypertension over 15 years of follow-up: the CARDIA study. *Am J Public Health*. 2007;97(4):703–9.
19. Prochaska JO, Velicer WF. The transtheoretical model of health behavior change. *Am J Health Promot*. 1997;12(1):38–48.
20. Office of Disease Prevention and Health Promotion [Internet]. Physical activity guidelines [cited 2014 Oct 1]. Available from: http://www.health.gov/PAGuidelines.
21. 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.
22. Troiano RP, Berrigan D, Dodd KW, Mâsse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc*. 2008;40(1):181–8.
23. Tudor-Locke C, Schuna JM Jr., Barreira TV, et al. Normative steps/day values for older adults: NHANES 2005–2006. *J Gerontol A Biol Sci Med Sci*. 2013;68(11):1426–32.
24. van der Ploeg HP, Chey T, Korda RJ, Banks E, Bauman A. Sitting time and all-cause mortality risk in 222 497 Australian adults. *Arch Intern Med*. 2012;172(6):494–500.
25. Voelker R. Few adults with knee osteoarthritis meet national guidelines for physical activity. *JAMA*. 2011;306(13):1428, 30.
26. White DK, Neogi T, King WC, et al. Can change in prolonged walking be inferred from a short test of gait speed among older adults who are initially well-functioning? *Phys Ther*. 2014;94(9):1285–93.
27. Zou G. A modified poisson regression approach to prospective studies with binary data. *Am J Epidemiol*. 2004;159(7):702–6.