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Moderate to Vigorous Physical Activity and Weight Outcomes: Does Every Minute Count?

Jessie X. Fan, Ph.D. [Professor],
Department of Family and Consumer Studies, University of Utah, 225 South 1400 East, AEB 228. Salt Lake City, Utah 84112-0080, United States. Tel.: 1 801 581 4170; fax: 1 801581 5156

Barbara B. Brown, Ph.D. [Professor],
Department of Family and Consumer Studies, University of Utah, 225 South 1400 East, AEB 228. Salt Lake City, Utah 84112-0080, United States. Tel.: 1 801 581 4170; fax: 1 801581 5156

Heidi Hanson, B.S. [Doctoral student],
Department of Sociology, University of Utah. 380 S 1530 E Rm 301, Salt Lake City, UT 84112-0250

Lori Kowaleski-Jones, Ph.D. [Associate Professor],
Department of Family and Consumer Studies, University of Utah, 225 South 1400 East, AEB 228. Salt Lake City, Utah 84112-0080, United States. Tel.: 1 801 581 4170; fax: 1 801581 5156

Ken R. Smith, Ph.D. [Professor], and
Department of Family and Consumer Studies, University of Utah, 225 South 1400 East, AEB 228. Salt Lake City, Utah 84112-0080, United States. Tel.: 1 801 581 4170; fax: 1 801581 5156

Cathleen D. Zick, Ph.D. [Professor]
Department of Family and Consumer Studies, University of Utah, 225 South 1400 East, AEB 228. Salt Lake City, Utah 84112-0080, United States. Tel.: 1 801 581 4170; fax: 1 801581 5156

Abstract

Purpose—To test whether moderate-to-vigorous physical activity (MVPA) in less than the recommended 10+ minute bouts relates to weight outcomes.

Design—Secondary data analysis.

Setting—Random sample from the U.S. civilian non-institutionalized population included in the National Health and Nutrition Examination Survey (NHANES).

Participants—4,511 adults age 18–64 from the 2003–2006 NHANES.

Method—Clinically measured body mass index (BMI) and overweight/obese status were regressed on accelerometer measures of minutes/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, between 760–2019 CPM) and lower-intensity short bouts (<10 minutes, between 760–2019 CPM). Socioeconomic and demographic characteristics were controlled.

Results—Both higher-intensity short bouts and long bouts of physical activity 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 show that for weight gain prevention, accumulated higher-intensity PA bouts of less than 10 minutes are highly beneficial, supporting the public health promotion message that "every minute counts."

Keywords

body mass index (BMI); physical activity; MVPA bouts; obesity; exercise intensity

1. Introduction

As physical activity (PA) recommendations for health have changed over time from more vigorous to more lifestyle PA recommendations, the evidence for whether "every minute counts" is sparser than the evidence for more sustained high intensity activity. [1, p. 8] The 1970s "exercise" prescription of 20+ minutes of sustained vigorous physical activity was replaced by broader recommendations that included lifestyle activities, such as brisk walks. Specifically, on most days of the week, individuals should achieve at least 30 minutes of moderate-to-vigorous physical activity (MVPA), accumulated in "bouts as short as 8 to 10 minutes." [2, p. 405] In the health promotion field, many recommendations likely yield even shorter bouts. For example, common recommendations to take the stairs when possible or to walk to the corner store likely yield bouts that are shorter than 10 minutes. Such short duration physical activities are commonly reported by participants in programs to increase PA.[3]

The 10-minute minimum MVPA bout recommendation was based on randomized trials that compared interventions that consisted of longer bouts, such as 30-minute continuous bouts, or shorter bouts, with total MVPA minutes held constant. For example, studies might compare two treatments: one daily 30-minute walking bout versus three daily 10-minute walking bouts.[4] Such studies served as the foundation for the 2008 recommendations of 150 moderate physical activity (MPA) minutes/week, to be accumulated in 10-minute bouts.[5] Specifically, the review underlying the 2008 MPA guideline judged there was sufficient evidence to support cardiovascular and fitness benefits from accumulated 8–10+ minute MPA bouts, but insufficient evidence to recommend 8–10+ minute bouts to favorably modify body mass index (BMI; kg/m^2).[6] This left two questions untested: do 10-minute MVPA bouts relate to BMI and do even shorter, less than 10-minute bouts, relate to BMI?

A review of eight short-versus-long-bout studies showed that MVPA training related to lower BMI, with four studies favoring accumulated 10-minute bouts and only one study favoring a longer 30-minute bout.[7] Evidence for the health benefits related to <10 minute bouts has been sparse but promising. Some clinical trials showed cardiovascular health benefits of shorter bouts of six minutes [8] or 5–10 minutes.[9, 10] Past reviews also found evidence that health benefits may accrue from any additional MVPA.[11, 12] One small clinical intervention study showed that 5+ minute bouts were related to lower BMI.[10] Most relevant to the present research is a study by Strath et al.,[13] who used 2003–2004 National Health and Nutrition Examination Survey (NHANES) data. The investigators tested whether MVPA "nonbouts," defined as <10 minute MVPA bouts, would predict BMI after controlling for ≥10-minute MVPA bouts as well as age, race/ethnicity, smoking status, gender, and self-reported health status. Nonbout MVPA minutes/day related to lower BMI but the associations were about one-fourth as powerful as bout minutes/day.

Since the publication of Strath et al.,[13] new research has suggested different standards for both bouts and MVPA thresholds. Strath et al.[13] required ≥10-minute continuous MVPA to define an MVPA bout. More recently, there has been consideration of "modified 10-minute bouts" that permit 1–2 minutes below MVPA threshold in a 10-minute bout to allow for interruptions common in lifestyle physical activities, such as pausing for traffic before walking across streets.[14] In addition, most recent MVPA definitions[15] require higher accelerometer counts per minute (CPM) thresholds than the 760 CPM used by Strath et al.[13] Troiano et al.[14] computed from a sample-weighted average of prior accelerometer validation studies a MVPA threshold of ≥2,020 CPM, equivalent to 3 metabolic equivalents (METs; 1 MET=3.5ml O_2.$kg^{-1}min^{-1}$). As noted by Metzger,[16] these prior studies used MVPA CPM cut points ranging from ≥1,267 to ≥2,743.[17–20] Accordingly, an activity like child care (equivalent to 2.4 METs) would register about 760 CPM, while a brisk walk would register slightly more than 2020 CPM.[15] These new standards and definitions suggest the need to revisit and extend Strath et al.'s research. [13]

To test whether physical activity accumulated in shorter than the recommended 10+ minute bouts relate to BMI, this study amplified Strath et al.'s[13] work in several important ways. First, we used the recently developed modified 10+ minute bouts definition that allows for 1–2 minutes below MVPA threshold in a 10-minute bout.[14] Second, we used Troiano et al's[14] 2,020 CPM cutoff point as intensity thresholds for MVPA. However, because the literature is not in complete agreement as to what intensity threshold should be used for MVPA, we created additional lower-intensity PA measures to capture PA minutes between Strath's 760 CPM cutoff point and Trioano et al's 2020 CPM cutoff point. Third, we combined NHANES years 2003–2006 to create a larger, more updated sample. Fourth, we expanded on Strath et al.'s control variables to include additional important covariates that have been found to predict BMI: age,[13] marital status,[21] education,[22] race/ethnicity,[13] family size,[23] household income below the poverty level,[24] caloric intake,[25] self-reported current smoking status,[26] and self-reported poor or fair health.[13]

From an energy-balance perspective, compared to no activity, both short and long bouts of MVPA activity should generate higher energy output, resulting in lower weight. Thus we hypothesized that short bouts of MVPA would be associated with lower BMI, after controlling for long bouts of MVPA and other socio-demographic and health-related covariates. Further, we hypothesized that higher-intensity bouts would be associated with lower BMIs, compared to lower-intensity bouts.

Although it is important to base population health guidelines on a broad array of health indicators, not just normal BMI, considerable literature indicates a reduction in health risk associates with a reduction in weight. Thus, investigations into the relationship between

BMI and MVPA bout durations typical of everyday PA would be informative to the health promotion community.

2. Methods

The National Health and Nutrition Examination Survey (NHANES) is a program of studies designed to assess the health and nutritional status of adults and children in the United States. NHANES is a major program of the National Center for Health Statistics (NCHS), which is part of the Centers for Disease Control and Prevention (CDC). Since 1999, the survey has been a continuous program that examines a nationally representative sample of about 5,000 persons each year. A complex, multistage, probability sampling design is used to select participants who are representative of the civilian, non-institutionalized U.S. population. These persons are located in counties across the country, 15 of which are visited each year. The NHANES survey is unique in that it combines interviews and physical examinations. The interview component includes demographic, socioeconomic, dietary, and health-related questions. The examination component consists of medical, dental, and physiological measurements, as well as laboratory tests administered by highly trained medical personnel. [27]

In 2003–2006 the NHANES participants 6 years of age and over received accelerometers (Actigraph 7164, LLC, Ft. Walton Beach, FL) to wear at home for 7 consecutive days. Those who used wheelchairs and those with other impairments that prevented them from walking or wearing the accelerometers were not given a device.[28] For this study, adults aged 18–64 (n=8,500) were selected. Individuals over the age of 64 were excluded because of the more complicated relationship between BMI and health in older populations.[29] Also excluded were those with pregnancies (n=634), missing BMIs (n=469) BMIs <18.5 or >60 (n=184), or those who did not meet accelerometer data standards (n=3,617), described below. Some excluded participants met multiple exclusion criteria. The final sample size was 4,511, comprised of 2,202 women and 2,309 men.

Variables and Measures

Outcome measures included clinically measured BMI and a categorical measure of overweight/obesity. For physical activity measures, Troiano et al.'s[14] SAS macro for processing NHANES accelerometer data was utilized. Four days of 10+ hours of accelerometer wear were required for the accelerometer data to be considered valid.[14] Non-wear time was defined by ≥ 60 consecutive minutes of zero activity intensity counts, allowing for 1–2 minutes of <100 CPM. Wear time was defined by 24 hours minus non-wear time. Accelerometer data were discarded if units were out of calibration when returned or measured unlikely levels (i.e., 32,767 CPM) of activity.[28]

Combining both bout length and intensity cutoff points, four physical activity measures were created: higher-intensity long bouts (≥10 minute bouts and ≥2020 CPM), higher-intensity short bouts (<10 minute bouts and ≥2020 CPM), lower-intensity long bouts (≥10 minute bouts and between 760–2019 CPM), and lower-intensity short bouts (<10 minute bouts and between 760–2019 CPM). Higher-intensity long bouts represented the CDC recommended 10+ minute MVPA bouts, allowing for 1–2 minute interruptions within any 10-miniute window. The average daily minutes for each category were calculated across all valid days. Note that these four measures were mutually exclusive. Depending on the intensity threshold and bout length requirement, some or all of these four measures could be added up to form various measures of total MVPA minutes per day.

As defined in Table 1, covariates based on past research included age (log transformed to account for possible nonlinearity and heteroscadesticity),[13] marital status,[21] education,[22] race/ethnicity,[13] family size,[23] household income below the poverty level, [24] average caloric intake per day based on two one-day dietary recalls,[25] self-reported current smoking status, [26] and self-reported poor or fair health.[13] Total accelerometer wear time across all valid days was also controlled.[30]

Statistical Analyses

Analyses were conducted with SAS 9.2, including descriptive analyses (Surveymeans and Surveyfreq), least square regressions for BMI (Surveyreg), and multinomial logistic regressions for the categorical variable of normal weight, overweight and obese (Surveylogistic). These procedures corrected for the complex sampling design of NHANES as recommended.[31] Sampling weights were adjusted for combining 2003–2004 and 2005–2006 data. Past research found significant gender differences in BMI determinants.[32] Accordingly, statistical analyses were conducted for men and women separately using domain analysis. In addition, domain analyses were also utilized to account for the sample selection criteria of four days of valid accelerometer wear. While four domains were included in the analysis by gender and accelerometer data validity, only the results for two of these domains were relevant for this study: women with four days of valid accelerometer data, and men with four days of valid accelerometer data. Diagnostic tests revealed no problematic levels of multicollinearity.

3. Results

Table 1 shows that average BMIs were in the overweight range. Compared to women, men were more likely to be overweight (41% versus 27%) but less likely to be obese (32% versus 34%), to smoke (27% versus 20%) and to consume more calories per day (2,679 versus 1,850).

Figure 1 reveals that individuals achieved substantially more higher-intensity MVPA minutes in short bouts than the recommended long bouts, with very short 1–2 minute bouts especially prevalent. Note that in Figure 1, the apparent jump from 7-minutes to 8+ minute bout length is an artifact of combing all higher-intensity long bouts together.

For both men and women, most PA minutes were accumulated in lower-intensity short bouts, followed by higher-intensity short bouts, lower-intensity long bouts, and higher-intensity long bouts. Men were more physically active than women (Table 1), accruing longer mean daily minutes in all four measures of physical activity. Converting the average daily minutes to weekly minutes, women on average accumulated 46 minutes higher-intensity long bout minutes per week, compared to men’s 61 minutes. Both were much less than the 150 minutes per week recommendation. However, if higher-intensity short bout minutes were added, women on average accumulated 144 minutes per week, almost at the 150 minutes per week recommendation in terms of MVPA minutes, while men accumulated 246 minutes per week, exceeding the recommendation in terms of weekly MVPA minutes.

Additional analyses (not shown in tables) by age showed that higher-intensity PA decreased steadily with age, while lower-intensity PA had an inverse-U pattern, peaking between ages 25–44. About 48% women and 61% men spent some time in higher-intensity long bouts, while 83% women and 89% men spent some time in lower-intensity long bouts. Almost all individuals spent some time in short bouts of either higher- or lower-intensity.

For women, the regression results in Table 2 show that each average daily minute spent in higher-intensity long bouts was related to −0.04 BMI, after adjusting for confounding variables. Each average daily minute spent in higher-intensity short bouts was associated with −0.07 BMI. However, Wald's F test showed that the difference between the coefficients for short and long higher-intensity bouts was statistically insignificant ($p = 0.35$). The two lower-intensity measures had no statistically significant relationship with BMI.

Applying the BMI formula of weight in kilogram (kg)/height in meter(m)^2 or weight in pounds (lb)/height in inches^2*703, each average daily minute spent in higher-intensity MVPA had the equivalent calorie offset of 0.19kg (0.41lb) for short bouts and 0.12kg (0.26lb) for long bouts, for a 165cm (5′5″) woman. This means when two 165cm (5′5″) women are compared, after adjusting for confounding variables, the woman who regularly engages in one more minute of short-bout MVPA each day weighs 0.19kg (0.41lb) less than the other woman, while one more minute of long-bout MVPA is related to an additional 0.12kg (0.26lb) less.

For men, the results were similar, but with smaller effect sizes. The coefficients were −0.04 for higher-intensity short-bout minutes/day and −0.03 for higher-intensity long-bout minutes/day. Wald's F test showed that the difference between the coefficients for higher-intensity short and long bouts was statistically insignificant (p=0.42). The two lower-intensity measures had no statistically significant relationship with BMI.

Applying the BMI formulas again, each average daily minute spent in MVPA had the equivalent calorie offset of 0.12kg (0.27lb) for higher-intensity short bouts and 0.09kg (0.20lb) for higher-intensity long bouts, for a 178cm (5′10″) man. This means when two 178cm (5′10″) men are compared, after adjusting for confounding variables, the man who regularly engages in one more minute of higher-intensity short-bout MVPA each day weighs 0.12kg (0.27lb) less, while one more minute of long-bout MVPA each day is related to an additional 0.09kg (0.20lb) less.

The results for the multinomial logistic regression on the categorical variable of normal weight, overweight, and obese are presented in Tables 3 (for women) and 4 (for men). Normal weight was used as the reference group. For both men and women, none of the four physical activity variables were statistically significantly associated with the risk of being overweight. In addition, lower-intensity physical activity minutes, short-bout or long-bout, were not significantly related to the risk of either overweight or obese. Where physical activity did matter was in the risk of obesity. Both higher-intensity long-bout and short bout minutes were associated with lower risk of obesity, although the coefficient for higher-intensity short-bout minutes did not reach the conventionally accepted statistical significance level for women. After adjusting for confounding variables, each daily minute higher-intensity short-bout minute was associated with 2% lower odds of being obese for men. Each daily minute in higher-intensity long bouts was associated with 5% and 2% lower odds of obesity for women and men, respectively.

The effects of covariates confirm known patterns, albeit with some significance levels that vary by gender and weight measures. Tables 2, 3 and 4 show that older age and poorer health related consistently to higher BMI and higher risk of overweight or obesity. Both smoking and having a college degree were associated with lower BMI and lower risk of overweight or obesity. Less consistent effects emerged for marital status, other education categories, family size, poverty, ethnicity/race, calories, and total hours of accelerometer wear across valid days.

4. Discussion

As hypothesized, short bouts of higher-intensity MVPA related to lower BMI, even after controlling for the longer recommended bout lengths and many covariates. However, lower-intensity bouts, long or short, were not significantly related to BMI or the risk of overweight or obese, after adjusting for confounding variables, supporting our second hypothesis that higher-intensity bouts related to BMI more than lower-intensity bouts.

As compared with the data reported by Strath et al.,[13] our BMI results were similar for long bouts but more powerful for short bouts. We found higher-intensity long bouts to have regression coefficients of −0.04 and −0.03 for women and men, respectively, while Strath et al. found long bouts had coefficients of −0.04 for their combined gender data set. For the long bouts, Strath et al's stricter definition with no allowance for 1–2 minute interruption led to a higher coefficient than ours, but the inclusion of lower-intensity bouts between 760 CPM to 2012 CPM led to a lower coefficient than ours, leaving the combined effect comparable.

For the short bouts, we found regression coefficients of −0.07 and −0.04 for women and men, respectively, compared to −0.01 for Strath et al.'s [13] MVPA "nonbouts" (1–9 minutes) for their combined gender data set. Note that Strath et al.'s "nonbouts" variable included both higher-intensity and lower-intensity short bouts. Our findings show that higher-intensity short bouts were significantly related to BMI but lower-intensity short bouts were not. As such, Strath et al.'s inclusion of lower-intensity minutes greatly reduced the overall size of their "nonbouts" coefficient on BMI compared to ours, especially given that people accumulated so many more lower-intensity short-bout minutes (77 minutes/day for women and 90 minutes/day for men, Table 1) than higher-intensity short-bout minutes (14 minutes/day for women and 27 minutes/day for men, Table 1).

Our data support the notion that every daily MVPA minute counts, in that every daily minute spent engaging in MVPA, in either short or long bouts, was associated with lower BMI for both men and women. However, such MVPA minutes have to be in higher-intensity, defined as accelerometer intensity counts greater than 2020 CPM. Moreover, our results show that every minute in higher-intensity short bouts was just as beneficial to BMI as every minute in higher-intensity long bouts. Every minute of short bouts also related to lower obesity risk for men, but the negative coefficient for women was statistically insignificant.

The underlying explanatory mechanism for the lack of association between low intensity PA and BMI is not well understood. Past research has suggested that higher-intensity PA induces secretion of lipolytic hormones including growth hormone and epinephrine, [33, 34] which may facilitate greater post-exercise energy expenditure and fat oxidation, while lower-intensity PA does not have the same effect.[35, 36] Further research efforts are needed for a better understanding of this issue.

The cross-sectional data limited our ability to determine cause and effect. It could be argued that individuals with higher BMIs may be less likely to engage in higher-intensity MVPA than individuals with lower BMIs. In addition, although objective accelerometer measures of MVPA are better than self-report, they do not measure the intensities of some activities, such as swimming and activities involving upper-body actions. Use of single cut points for all adults may lead to an underestimate of moderate intensity activity for individuals with certain chronic diseases by not accounting for the decline in exercise capacity with illness. Also, we focused only on BMI-related measures, not other health outcomes. Nevertheless, our study utilized a nationally representative sample and updated MVPA thresholds, with an extensive list of appropriate control variables. As such, out data strongly suggested that physical activity in bouts shorter than 10 minutes is related to lower BMI.

The question of whether short bouts relate to health is important for health promotion and obesity prevention efforts. Long bouts take more deliberate efforts. Although the current MVPA guideline of accruing 8–10+ minute bouts to total 150 or more MVPA minutes per week has demonstrable health benefits,[5] the reality is that less than 4% of U.S. adults aged 20–59 achieve this guideline.[14] Short bouts of exercise, on the other hand, may enhance adherence.[37] If individuals understand that short bouts also support healthier BMI, they may be encouraged to weave them into their daily routines.

These results support current health promotion campaigns and programs. For example, New York City has adopted design guidelines that encourage planners and builders to design attractive stairs, to create short walks from workspaces to lunchrooms, mail rooms, and bathrooms, based upon the assumption that short bouts of walking are healthy.[38] Such short daily walks may be fairly accessible; for example, 93% of workers in one study noted that stairs were accessible to them at work. [39] Although this study did not examine health outcomes beyond BMI and overweight/obesity, the evidence suggests that current campaigns that encourage bouts shorter than the 10-minute traditional bout may be consistent with healthy weight.

5. Conclusions

The health promotion implication from our research is: “Every minute counts!” The results support public health and clinical recommendations to make small lifestyle changes such as taking stairs instead of elevators, or parking further for a longer brisk walk to and from work or shopping. If done on a regular basis, such MVPA activities are consistent with lower BMI. Although long durations of exercise are beneficial to health, our results show that brief and brisk bouts are just as beneficial to BMI.

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So-What?

What is already known on this topic?

Few U.S. adults achieve the recommended 150+ minutes of moderate-to-vigorous physical activity (MVPA) per week in the recommended 10-minute minimum bouts. Few studies have investigated the relationship between bouts less than 10 minutes and weight outcomes.

What does this article add?

Using 2003–2006 NHANES accelerometer data, we relate weight outcomes to MVPA thresholds (760 vs. 2020 counts per minute (CPM)), bout durations (<10, 10+), and an extensive list of control variables. We find that bout duration does not matter for weight outcomes when intensity exceeds 2020 accelerometer CPM. Lower intensity bouts of either length are unrelated to weight.

What are the implications for health promotion practice or research?

This evidence supports current health promotions that urge individuals to add short bouts of MVPA to their day by using the stairs, walking to the store, or parking at the far end of the lot. For maintaining healthy weight, the health promotion message should be, “Every (brisk) minute counts!”

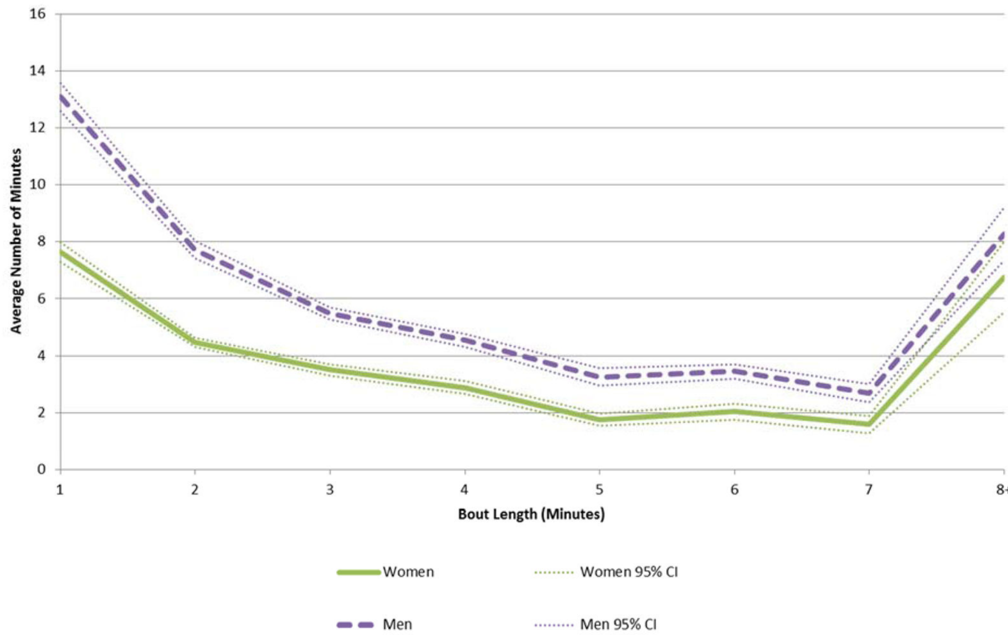

Figure 1.

Mean and 95% confidence interval (CI) of high-intensity moderate-to-vigorous physical activity (MVPA) minutes per day by bout length and gender, National Health and Nutrition Examination Survey (NHANES) 2003–2006

Table 1

Weighted descriptive statistics by gender: National Health and Nutrition Examination Survey (NHANES) 2003–2006

Variable	Definition	Women (n=2,202)		Men (n=2,309)	
		Mean	SE	Mean	SE
BMI	(Weight in kg)/(height in meters)^2, clinically measured	28.56	0.25	28.34	0.19
Normal weight (%)	BMI between 18.5 and 24.9	38.19	1.71	27.72	1.41
Overweight (%)	BMI between 25 and 29.9	27.47	1.33	40.51	1.39
Obese (%)	BMI between 30 and 60	34.33	1.51	31.76	1.77
Higher-intensity long bouts minutes/day	Bouts with 10+ consecutive minutes ≥2020 accelerometer counts per minute (CPM), with allowance for interruptions of 1 or 2 min below threshold. Mean daily time in bouts calculated across all valid days.	6.56	0.47	8.76	0.46
Higher-intensity short bouts minutes/day	Bouts with 1+ minute ≥ 2020 CPM but less than the higher- intensity long-bout definition. Mean daily time calculated across all valid days.	14.07	0.37	26.36	0.49
Lower-intensity long bouts minutes/day	Bouts with 10+ consecutive minutes between 760–2019 CPM, with allowance for interruptions of 1 or 2 min below threshold. Mean daily time in bouts calculated across all valid days.	13.90	0.70	21.40	0.80
Lower-intensity short bouts minutes/day	Bouts with 1+ minute between 760–2019 CPM but less than the lower-intensity long bout definition. Mean daily time calculated across all valid days.	76.04	1.02	89.49	1.15
Age (year)	Continuously measured	42.71	0.37	41.63	0.40
Married (%)	Married or cohabitating	64.98	1.38	70.98	1.64
Less high school (%)	Education: Less than high school	12.12	1.03	15.18	1.12
High school (%)	Education: High school graduate	23.81	0.98	26.07	1.11
Some college (%)	Education: Some college education	36.47	1.44	31.98	1.18
College graduate (%)	Education: College graduate or more education	27.59	1.75	26.75	1.84
White (%)	Race/ethnicity: Non-Hispanic White	70.85	2.46	71.99	2.20
Black (%)	Race/ethnicity: Non-Hispanic Black	11.38	1.45	9.84	1.27
Hispanic (%)	Race/ethnicity: Hispanic	11.91	1.34	13.08	1.51
Other race (%)	Race/ethnicity: Other race/ethnicity	5.86	0.84	5.10	0.69
Family size	Number of people in the family	3.07	0.04	3.18	0.04
Below poverty (%)	Household income below poverty threshold	10.38	0.79	9.66	0.64
Daily calories (100 kcal)	Average caloric intake per day (continuous) based on 2-day dietary recalls	18.50	0.14	26.79	0.19
Smoker (%)	Current smoker	20.36	1.02	26.77	1.12
Poor/fair health (%)	Poor or fair self-assessed general health	13.91	0.99	12.32	0.73

Variable	Definition	Women (n=2,202)		Men (n=2,309)	
		Mean	SE	Mean	SE
Hours of wear	Total hours of accelerometer wear	84.57	0.50	86.92	0.53

Table 2

Relationship of short and long moderate-to-vigorous physical activity (MVPA) bouts with different intensity to BMI in the National Health and Nutrition Examination Survey (NHANES) 2003–2006: Regression results by gender

	Women (n=2,202)			Men (n=2,309)		
Parameter	**Coefficient**	**SE**		**Coefficient**	**SE**	
Intercept	19.25	2.43	***	24.23	1.37	***
Higher-intensity long bouts minutes/day	−0.04	0.01	***	−0.03	0.01	***
Higher-intensity short bouts minutes/day	−0.07	0.02	***	−0.04	0.01	***
Lower-intensity long bouts minutes/day	0.01	0.01		0.00	0.00	
Lower-intensity short bouts minutes/day	0.00	0.01		0.00	0.01	
Log (Age)	2.83	0.51	***	1.84	0.40	***
Married	−0.55	0.55		0.61	0.35	***
Less than high school[a]	−0.07	0.62		−0.70	0.56	
Some college[a]	−0.16	0.42		−0.34	0.38	
College graduate[a]	−1.77	0.43	***	−1.08	0.38	***
Black[b]	2.41	0.44	***	0.59	0.41	
Hispanic[b]	−0.34	0.52		−0.01	0.35	
Other race[b]	−2.98	0.61	***	−1.16	0.67	
Family size	−0.06	0.13		0.18	0.08	**
Below poverty	0.89	0.57		−1.55	0.33	***
Daily calories (100 kcal)	0.06	0.03	*	0.00	0.02	
Smoker	−1.31	0.41	***	−1.59	0.26	***
Poor/fair health	2.17	0.58	***	2.23	0.43	***
Hours of wear	−0.01	0.01		−0.02	0.01	***
Adj. R-squared	0.11			0.12		

[a] The reference group in this sequence of dummy variables is “high school graduate.”

[b] The reference group in this sequence of dummy variables is “non-Hispanic whites.”

*** $p < .01$

** $p < .05$

* $p < .10$.

Table 3

Relationship of short and long moderate-to-vigorous physical activity (MVPA) bouts with different intensity to overweight and obesity risk in the National Health and Nutrition Examination Survey (NHANES) 2003–2006: Multinomial logistic regression results for women (n=2,202)

	Overweight vs. normal weight				Obese vs. normal weight			
Parameter	**Odds-Ratio**	**95% CI**			**Odds-Ratio**	**95% CI**		
Higher-intensity long bouts minutes/day	0.994	0.983	1.006		0.950	0.934	0.966	***
Higher-intensity short bouts minutes/day	0.995	0.976	1.014		0.987	0.969	1.005	
Lower-intensity long bouts minutes/day	1.001	0.993	1.008		1.001	0.994	1.009	
Lower-intensity short bouts minutes/day	0.998	0.991	1.006		1.000	0.994	1.006	
Log (Age)	2.213	1.545	3.460	***	2.850	1.974	4.116	***
Married	1.186	0.911	1.544		0.951	0.684	1.321	
Less than high school[a]	1.169	0.778	1.757		1.085	0.663	1.776	
Some college[a]	0.879	0.598	1.293		0.867	0.618	1.216	
College graduate[a]	0.556	0.394	0.785	***	0.539	0.411	0.708	***
Black[b]	2.363	1.711	3.264	***	3.031	2.212	4.153	***
Hispanic[b]	1.454	0.977	2.164	*	1.055	0.671	1.658	
Other race[b]	0.480	0.273	0.843	***	0.269	0.136	0.529	***
Family size	0.934	0.866	1.008	*	1.024	0.934	1.123	
Below poverty	0.977	0.663	1.439		1.093	0.759	1.574	
Daily calories (100 kcal)	0.985	0.964	1.006		1.013	0.996	1.031	
Smoker	0.702	0.452	1.089		0.545	0.412	0.722	***
Poor/fair health	0.934	0.701	1.246		1.615	1.215	2.146	***
Hours of wear	1.006	1.000	1.012	**	0.998	0.991	1.004	

[a] The reference group in this sequence of dummy variables is “high school graduate.”

[b] The reference group in this sequence of dummy variables is “non-Hispanic whites.”

*** $p < .01$

** $p < .05$

* $p < .10$.

Table 4

Relationship of short and long moderate-to-vigorous physical activity (MVPA) bouts with different intensity to overweight and obesity risk in the National Health and Nutrition Examination Survey (NHANES) 2003–2006: Multinomial logistic regression results for men (n=2,309)

	Overweight vs. normal weight				Obese vs. normal weight			
Parameter	**Odds-Ratio**	**95% CI**			**Odds-Ratio**	**95% CI**		
Higher-intensity long bouts minutes/day	0.998	0.991	1.006		0.979	0.964	0.993	***
Higher-intensity short bouts minutes/day	0.995	0.986	1.004		0.975	0.963	0.987	***
Lower-intensity long bouts minutes/day	0.997	0.991	1.002		1.000	0.993	1.008	
Lower-intensity short bouts minutes/day	1.003	0.998	1.009		1.004	0.997	1.012	
Log (Age)	4.847	2.990	7.858	***	3.398	2.189	5.275	***
Married	1.260	0.925	1.715		1.187	0.794	1.773	
Less high school[a]	0.642	0.440	0.938	**	0.627	0.348	1.131	
Some college[a]	0.927	0.658	1.306		0.906	0.608	1.351	
College graduate[a]	0.765	0.536	1.093		0.580	0.364	0.923	**
Black[b]	1.224	0.879	1.704		1.243	0.828	1.865	
Hispanic[b]	1.596	1.104	2.307	***	1.041	0.682	1.590	
Other race[b]	0.722	0.408	1.278		0.615	0.264	1.434	
Family size	1.105	1.008	1.212	**	1.139	1.033	1.257	***
Below poverty	0.677	0.483	0.950	**	0.506	0.356	0.720	***
Daily calories (100 kcal)	0.991	0.976	1.005		0.996	0.979	1.013	
Smoker	0.561	0.449	0.700	***	0.390	0.279	0.545	***
Poor/fair health	0.933	0.589	1.478		2.020	1.293	3.155	***
Hours of wear	0.995	0.988	1.003		0.992	0.985	0.999	**

[a]The reference group in this sequence of dummy variables is “high school graduate.”

[b]The reference group in this sequence of dummy variables is “non-Hispanic whites.”

*** $p < .01$

** $p < .05$

* $p < .10$.