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Length of Moderate-to-Vigorous Physical Activity Bouts and Cardio-metabolic Risk Factors in Elementary School Children

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Abstract

Background—Accumulating moderate-to-vigorous physical activity (MVPA) in bouts of 10 min is associated with improved cardio-metabolic risk factors (CMRF) in adults.

Purpose—To assess the association between the lengths of MVPA bouts and CMRF in elementary school age children.

Methods—The sample included 396, 2nd and 3rd grade students from eastern Kansas (182 boys, 214 girls; age 7.6±0.6 yrs.; Body Mass Index Percentile [BMI%ile]: 61.6±9.3) in the fall of 2011. Analyses were conducted in 2014. MVPA bouts were defined as sporadic (<5 min.), short (5–<10min.) or medium-to-long (≥10min.). Latent profile analysis was used to identify distinct subgroups (classes) based on the composition of MVPA bouts. Bayesian probability-based Wald chi-square test was used to compare CMRF between classes controlling for age, sex, BMI%ile, and total moderate and total vigorous PA.

Results—Three classes of accumulated physical activity were identified: A (n=78); 97% sporadic, 2% short, 1% medium-to-long bouts; B (n=174); 93% sporadic, 5% short, 2% medium-to-long; C (n=144); 86% sporadic, 9% short, 5% medium-to-long bouts. Class C had significantly lower BMI%ile (57.3±2.3 (SE)), waist circumference (WC; 55.8±0.5 cm) compared with Class A (BMI%ile=70.9±0.5, $p < 0.01$, WC=61.0±1.0 cm, $p = 0.001$). Class B had significantly lower WC (56.6±0.6 cm, $p < 0.01$ than Class A. No significant differences between classes were shown in other outcomes.

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Conflict of Interest

The authors report no conflict of interest

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Conclusion—Children who accumulated MVPA with a higher percentage of short (5–<10 min) and medium-to-long bouts (≥10 min.) had lower BMI%ile, and WC compared with children who accumulated MVPA with a lower percentage short and medium-to-long bouts.

INTRODUCTION

The prevalence of overweight (≥85th percentile of Body Mass Index) and obesity (≥95th percentile of Body Mass Index) among children in the United States is 32% and 17%, respectively (1). Childhood obesity is associated with increased cardio-metabolic risk including reduced cardiovascular fitness and increased risk of metabolic syndrome (2) defined as the presence of three of five risk factors including central obesity, elevated blood pressure, elevated triglycerides, reduced high-density lipoprotein cholesterol, and hyperglycemia (3). It is estimated that 5–10% of children and adolescents in the U.S. have metabolic syndrome, while over 60% have at least 1 metabolic syndrome risk factor (4, 5).

Physical activity is an integral component in reducing cardio-metabolic risk (6–9). Currently, the American College of Sports Medicine (ACSM) and the Centers for Disease Control (CDC) recommend that children participate in 60 minutes or more of moderate-to-vigorous intensity physical activity (MVPA) each day (10). However, there are no guidelines regarding how the 60 min of MVPA should be accumulated. Previous research in adults has suggested that when the total volume of physical activity is equivalent, bouts of physical activity as short as 10 min are associated with similar health benefits to physical activity accumulated in longer bouts (11, 12). The limited data on the effect of MVPA bout length on cardio-metabolic risk factors in children suggests longer bouts of MVPA may be associated with lower body weight (13, 14) and waist circumference (15). However, studies on MVPA bout length and other cardio-metabolic risk factors have shown no association (16, 17). The primary aim of this analysis was to examine the independent association between MVPA bout length assessed by accelerometry, and cardio-metabolic risk factors including body mass index (BMI), waist circumference, blood pressure, total and HDL-cholesterol, triglycerides, glucose, insulin and cardiovascular fitness in a sample of elementary school age children.

METHODS

Participant recruitment

Baseline data from participants in the Academic Achievement and Physical Activity Across the Curriculum (A+PAAC) trial were used for this analysis. Briefly, A+PAAC was a 3 year cluster-randomized trial designed to compare changes in academic achievement between elementary schools randomized to intervention (n=9) or control (n=8). The A+PAAC intervention involved 100 min/wk. of academic lessons delivered by classroom teachers using MVPA). The study was approved by the Human Subjects Committee at the University of Kansas. Details regarding the design and methods of the A+PAAC trial have been published (18). The parents/guardians of students in 2nd and 3rd grades of participating schools received a flyer describing the study, including exclusion criteria and assessment procedures. Those interested in participation returned a portion of the flyer providing contact information to the school. An informational meeting was then held at the school to describe

the study and obtain written parental consent and student assent. The number of volunteers exceeded the study requirements, thus a random sample of 2nd and 3rd grade students (stratified by grade and sex) in each school was selected to participate. Baseline assessments were obtained in the fall of 2011.

Assessments

Physical activity—Children wore an ActiGraph GT3X+ portable accelerometer (ActiGraph LLC, Pensacola, FL) on a belt over the non-dominant hip for 4 consecutive days (including 1 week-end day) (19). The model GT3X+ accelerometer (3.8 × 3.7 × 1.8 cm; 27 g) is a solid-state digital device that measures accelerations by generating an electrical signal proportional to the force acting along three axes. Data were collected in 1 minute epochs. Non-wear time was defined by an interval of at least 20 consecutive min of activity counts of zero with an allowance for 1–2 min of counts between 0 and 100 (20). A valid day was defined as 10 hours of valid data time (21). A minimum of three valid days (1-week-end day) were required to be included in analysis (22). Three hundred and ninety-six children met these criteria (valid days = 3.49 ± 0.52). Age specific cut-points were applied for MVPA as described by Freedson et al. (23) and used in the National Health and Nutrition Examination Survey (NHANES) (24). MVPA bouts, as described by Mark and Jenssen (14), were identified as sporadic sessions of activity (< 5 minutes); short bouts of activity (5–< 10 minutes); and medium-to-long bouts of activity (≥ 10 minutes) were considered. Bouts were terminated when accelerometer counts/min dropped below the MVPA threshold. Accelerometer data was processed using a custom SAS program.

Anthropometrics (Height/weight/waist circumference)—Body weight to the nearest 0.1 kg was assessed on a calibrated scale (Model #PS6600, Befour, Saukville, WI) during the first period of the school day with children wearing school clothes without shoes. Standing height was measured with a portable stadiometer (Model #IP0955, Invicta Plastics Limited, Leicester, UK). BMI was calculated as weight (kg)/height (m²). BMI percentile was calculated using the CDC growth charts (25). Waist circumference, which served as a surrogate for central obesity, was assessed using the procedures described by Lohman et al (26). Three measurements were taken with the outcome recorded as the average of the closest 2 measures.

Cardiovascular fitness—Cardiovascular fitness was assessed using the Progressive Aerobic Cardiovascular Endurance Run (PACER); a multi-stage test based on the 20-meter shuttle run that has been used as part of the FITNESSGRAM®s since 1992 (27). Children were instructed to run back-and-forth between two lines, 20-meters apart, paced by a beep recorded on a CD to indicate when they should reach each end of the 20-meter course. The pace increased as the test progressed. All tests were observed by a group of trained research assistants to ensure that the test was completed as designed. The test was terminated when students failed to traverse the 20-meter distance in the time allotted on two (not necessarily consecutive) occasions.

Cardiovascular fitness was estimated as the total number PACER laps completed, with a higher number of laps indicating a higher level of cardiovascular fitness (27). Reliability of

the PACER has been demonstrated in children ages 6 to 16 yrs. (27), while validity has been shown in children ages 8 to 19 yrs. (27, 28).

Blood Pressure and Blood Chemistry—Blood pressure was assessed with a Dinamap automated sphygmomanometer (Pro Care 100, GE HealthCare, Madison, WI) between 8 a.m. and 10 a.m., subsequent to the measurement of height, weight, and waist circumference and following 5 min of quiet rest. Participants were seated with the arm bared, supported, and positioned at the heart level during assessments. Two measures were obtained and averaged. Additional measures were obtained if the initial 2 measures differed by more than 5 mmHg.

Fasting blood samples (12 hour overnight) were obtained by a certified phlebotomist subsequent to the measurement of blood pressure, for the assessment of blood lipids, glucose, and insulin. Blood samples were separated by centrifugation for 15 min at 2,000 g. Plasma was transferred to cryogenic vials and stored at -70°C for later analysis. Total serum cholesterol and triglycerides were measured using an automated analyzer, using standard enzymatic techniques. High-density lipoprotein (HDL) was measured after removal of very-low-density lipoprotein and low-density lipoprotein by precipitation with phosphotungstate (29). Glucose was measured using an autoanalyzer while insulin was measured using a double-label antibody technique(30).

Statistical Analysis

Latent profile analysis (31) was conducted to identify distinct subgroups (classes) of participants based on their composition of bouts of MVPA : sporadic (<5 min), short ($5\text{--}10$ min), medium-to-long (>10 min). A series of mixture models (1- to 4-class models) were fitted to the percent of sporadic, short, and medium-to-long bouts. The fitted models were compared by adjusted Bayesian Information Criterion (ABIC) (32), entropy (33), Vuong–Lo–Mendell–Rubin (VLMR) (34) likelihood ratio test and adjusted Lo–Mendell–Rubin (aLMR) likelihood ratio test (35) to determine the optimal number of classes. Both likelihood ratio tests compare a k -class model with a $k-1$ -class model—a significant p value suggests that a $k-1$ -class model should be rejected in favor of a k -class model. Membership in one of the identified classes was based on the Bayesian posterior probabilities. The marginal means of the following variables were then compared between the identified classes using Wald chi-square test (36): waist circumference, BMI percentile, blood pressure, total and HDL cholesterol, triglycerides, glucose, insulin, PACER laps, and total volume of both moderate and vigorous PA. Missing data were handled by posterior probability based multiple imputation. The same variables were also compared after controlling for age, sex, BMI percentile, and total moderate and vigorous PA in follow-up regression analysis. Participants with missing observations on any of the covariates were excluded from the analysis. All the comparisons were Bonferroni-corrected for inflation in Type I error. Statistical significance was determined at 0.05 alpha level, and all analyses were performed in mid-2014 using *Mplus* version 7 (Muthén & Muthén, Los Angeles, CA) and SAS version 9.4 (SAS Institute Inc., Cary, NC).

RESULTS

Baseline descriptive characteristics of the 396 children with valid accelerometer data that were included in this analysis are presented in Table 1. The sample age ranged from 6–9 yrs., and was 54 percent female and 16 percent minority. Twenty nine percent of the sample had BMI at the 85th percentile. Due to technical problems or failure to comply with the assessment protocols, this report includes waist circumference and BMI percentile, blood pressure and blood chemistry data from 391, 386 and 111 participants, respectively. The model fit values and likelihood ratio test results from each of the 1–4 class models are shown in Table 2. The 3-class and 4-class models produced the highest entropy value thus smallest classification errors. VLMR and aLMR likelihood ratio tests further suggested that three classes were optimal, with significant *p* values for the 2- and 3-class, but not the 4 class model. AIC and ABIC both indicated better fit for the models with more classes. However, both AIC and ABIC tend to overestimate the number of classes (37, 38); and the fit improvement (i.e., decreases in AIC and ABIC) was marginal for the 4-class model compared to the 3-class model. Therefore, the latent profile results, except AIC and ABIC that are well known for the tendency to overestimate the optimal number of classes, generally supported three classes as optimal.

A description of physical activity distribution of sporadic, short and medium-to-long bouts of MVPA, and demographic characteristics of participants in the three classes identified by latent profile analysis are presented in Table 3. Classes A, B and C comprised 20%, 44% and 36% of the study sample, respectively. Both total MVPA and vigorous PA were significantly different across the 3 classes. Total MVPA ranged from 52 min/day in Class A to 103 min/day in Class C, while vigorous PA ranged from 3.3 min/day in Class A to 15.9 min/day in Class C. Likewise, the percentage of children who met the current physical activity recommendations (60 min/day MVPA) was significantly different across classes: Class A = 32%, Class B = 74%, Class C = 93% (all *p* < 0.001). The percentage of MVPA accumulated in sporadic bouts (<5 min) was progressively lower, while the percentage MVPA in both short (5–<10 min) and medium-to-long bouts (≥10 min) was progressively higher moving from Class A to Classes B and C. The percentage of girls in Class C was significantly lower than both Classes A and B (all *p* < 0.001).

A comparison of cardio-metabolic risk factors between the three classes, using posterior probability based multiple imputation, controlling for age, sex BMI percentile, and moderate and vigorous PA are presented in Table 4. BMI percentile and waist circumference were significantly lower in Class C compared with Class A, while waist circumference in Class B was significantly lower than Class A. There were no significant between Class differences in blood pressure, total or HDL-cholesterol, triglycerides, glucose, insulin or cardiovascular fitness. However, when the comparison was analyzed without imputation triglycerides were significantly lower in Class C (60.4 ± 17.1 mg/dL) compared with Class A (81.3 ± 46.5 mg/dL, *p* < 0.05).

DISCUSSION

Using latent profile analysis, three distinct classes were identified based on the percentage of MVPA that was accumulated in sporadic (<5 min), short (5-<10 min) or medium-to-long bouts (≥10 min) in a sample of elementary school-age children. After controlling for potential confounders, we found children in Class C, which was characterized by a higher percentage of short and medium-to-long bouts of MVPA (14.1%) had significantly lower BMI percentile and waist circumference compared to children in Class A, where the percentage of short and medium-to-long bouts of MVPA was lower (3.2%). Additionally, waist circumference was significantly lower among children in Class B, where the percentage of short and medium-to-long bouts of MVPA was 7.3%, compared with Class A.

These results regarding bout length and body weight associated variables are in general agreement with those from the available literature (14, 15, 39). For example, Marks and Janssen (14), using accelerometer data from 2,498 NHANES participants (age 8–17yrs.), reported that MVPA accumulated in bouts ≥5 min was associated with a reduced risk of being classified as overweight or obese, independent of total MVPA. Additionally, medium-to-long bouts of MVPA (≥10 min) were more strongly associated with reduced risk of overweight and obesity than short bouts (5–9 min) (14). Stone *et al.* (39) reported that 8–10 year old overweight boys ($n=15$) accumulated significantly ($p=0.02$) fewer longer bouts (≥5 min) of moderate intensity physical activity than normal weight boys ($n=32$). In a sample of 74 children, mean age 9 yrs., Dorsey *et al.* (13) reported that BMI-z-score was associated with daily minutes of vigorous physical activity performed in sustained bouts (≥2 min) but not when vigorous physical activity was accumulated in short (<60 sec) or intermediate length bouts (60 sec and <2 min). Holman *et al.* (15) using accelerometer data from 2754 participants (age 6–19 yrs.) in NHANES reported a significant association between waist circumference and MVPA accumulated in bouts (≥5 min) but not for sporadic MVPA (1–4 min).

We found no association between MVPA bout length and cardio-metabolic risk factors including blood pressure, total and HDL-cholesterol, triglycerides, glucose, insulin and cardiovascular fitness. These results are in agreement with those of Holman *et al.* (15) who found no association between MVPA bout length and systolic blood pressure, non-HDL cholesterol, or C-reactive protein in children and adolescent participants in NHANES as previously described. Additionally, Stone *et al.* (17) found no difference in the association between short (4 sec) or longer activity bouts (≥5 min), regardless of intensity, with waist circumference, blood pressure, cardiovascular fitness and endothelial function in a sample of 47, 8–10 year old boys. Andersen *et al.* (16) evaluated the effect MVPA bout length on a composite metabolic risk score composed of systolic blood pressure, triglycerides, total cholesterol/HDL ratio, aerobic fitness, sum of 4 skinfolds, and insulin resistance, in a random sample of 1732, 9 and 15 year old children. No significant difference in metabolic risk score were noted between MVPA bouts of at least 5 min or at least 10 min in duration. The observation that longer, but not shorter bouts of MVPA have an differential impact on weight and waist circumference, but not on other risk factors, e.g. blood pressure, cholesterol, triglycerides, etc. is interesting and worthy of further investigation. However,

the lack of an association between MVPA bout length with blood pressure and blood chemistry parameters may be at function of the health status of study samples.

Latent profile analysis identified three distinct patterns of MVPA based on the distribution of sporadic, short and medium-to-long bouts. Class C, which was characterized by the lowest percentage of sporadic, and the highest percentage of short and medium-to-long bouts of MVPA, had a higher percentage of boys (67%) compared with Classes A (31%) or B (35%). This observation is in agreement with Rowland *et al.* (40) who assessed physical activity by accelerometer over 6 days in 45 boys and 39 girls, approximately 9 years of age. Irrespective of intensity, boys accumulated a greater number of activity bouts ≥ 5 min in length compared with girls.

Strengths of the current investigation were the sample of elementary school children which included both boys and girls, inclusion of a range of cardio-metabolic risk factors, the use of an objective measure of daily physical activity, and the identification of patterns of MVPA using latent profile analysis. A major limitation of the current study, as well as other studies on this topic, is the use of a cross-sectional design which precludes conclusions regarding cause and effect. Physical activity was assessed over a minimum of 2 week days and 1-week-end day which has been shown to provide a valid estimate of habitual physical activity (22). However, the number of monitored days required to provide a valid estimate of the pattern of physical activity is undetermined. Additionally, the bout lengths that were chosen for investigation were arbitrary as the optimal bout length associated with decreased cardio-metabolic risk in children has not been established.

In summary, using latent profile analysis 3 patterns of MVPA were identified based on the distribution of sporadic (< 5 min), short or medium-to-long (≥ 10 min) bouts. The percentage of MVPA accumulated in sporadic bouts (< 5 min) was progressively lower, while the percentage MVPA in both short ($5\text{--}<10$ min) and medium-to-long bouts (≥ 10 min) was progressively higher moving from Class A to Classes B and C. Participants with the highest proportion of short and medium-to-long MVPA bouts had lower BMI percentile and waist circumference compared with those with the lowest proportion of MVPA in short and medium-to-long bouts. There were no significant between Class differences in blood pressure, total or HDL-cholesterol, triglycerides, glucose, insulin, or cardiovascular fitness. Taken together, the results of the current study, and those in the literature, suggest that longer rather than shorter bouts of MVPA are associated with decreased cardio-metabolic risk factors specifically lower BMI percentile and waist circumference in children. Confirmation of these results in randomized trials will be required prior to recommending changes in existing physical activity guidelines for children.

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Highlights

- We examined associations among physical activity bouts and cardio-metabolic risk factors
- We report longer bouts are associated with decreased risk factors in children
- We observed boys accumulate a greater number of bouts ≥ 5 min compared with girls

Table 1

Baseline characteristics of study sample

Variable	Total			Male			Female			p
	N	M	SD	N	M	SD	N	M	SD	
Age (yrs.)	395	7.6	0.6	181	7.6	0.6	214	7.5	0.6	0.26
Female (%)	395	54.2%		179	0%		214	100%		
Minority (%)	393	16.0%		179	17.3%		214	15.0%		0.18
Height (cm)	392	129.6	6.7	180	130.8	6.5	212	128.6	6.8	<0.01
Weight (kg)	392	29.5	7.0	180	30.1	7.0	212	29.0	7.0	0.12
Waist circumference (cm)	391	57.2	7.2	179	58.1	7.1	212	56.5	7.1	0.03
BMI percentile	391	61.6	29.3	179	64.7	27.2	212	58.9	30.8	0.05
MPA (min/day)	395	71.1	26.5	181	79.6	28.1	214	63.9	22.8	<0.01
VPA (min/day)	395	9.6	9.4	181	11.1	10.6	214	8.4	8.1	<0.01
MVPA (min/day)	395	80.8	32.4	181	90.6	34.7	214	72.4	27.7	<0.01
% MVPA bouts per day										
<i>Sporadic (<5 min)</i>	395	91.0	4.9	181	89.3	5.3	214	92.4	4.0	<0.01
<i>Short (5-<10 min)</i>	395	6.4	3.2	181	7.2	3.4	214	5.6	2.8	<0.01
<i>Medium-long (10 min)</i>	395	2.7	2.6	181	3.5	3.0	214	2.0	2.0	<0.01
Systolic blood pressure (mmHg)	386	99.7	8.5	179	99.6	8.5	207	99.7	8.5	0.90
Diastolic blood pressure (mmHg)	386	57.2	4.8	179	56.9	4.4	207	57.4	5.1	0.40
Total cholesterol (mg/dL)	111	153.2	20.8	48	149.0	18.2	63	156.4	22.2	0.07
HDL-cholesterol (mg/dL)	111	53.0	8.6	48	54.6	7.1	63	51.8	9.4	0.08
Glucose (mg/dL)	111	88.7	10.6	48	88.2	7.6	63	89.0	12.5	0.66
Insulin (N/uIU/mL)	111	10.6	6.6	48	8.8	2.4	63	11.9	8.3	<0.01
Triglycerides (mg/dL)	111	65.7	27.5	48	57.7	16.1	63	71.8	32.6	<0.01
Cardiovascular fitness (PACER laps)	394	16.7	8.7	181	18.9	9.9	213	14.9	7.0	<0.01

Note. M=raw mean, SD=standard deviation, p=p-value for gender difference, MPA=moderate intensity physical activity, VPA=vigorous intensity physical activity, MVPA=moderate-to-vigorous intensity physical activity, PACER=Progressive Aerobic Cardiovascular Endurance Run

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Table 2

Latent profile model fit values and likelihood-ratio test results

Model	AIC	ABIC	Entropy	VLMR (p)	aLMR (p)
1-class	6325.7	6329.5	NA	NA	NA
2-class	5672.1	5682.6	0.847	0.000	0.000
3-class	5430.1	5446.2	0.880	0.001	0.001
4-class	5260.0	5281.8	0.879	0.069	0.072

Note. AIC=Akaike Information Criteria, ABIC=adjusted Bayesian Information Criterion, VLMR=Vuong-Lo-Mendell-Rubin likelihood ratio test, aLMR=adjusted Lo-Mendell-Rubin likelihood ratio test, NA=not applicable

Table 3

Physical activity and demographic characteristics among 3 classes identified based on the composition of bouts of moderate-to vigorous physical activity

Variable	Class A (n=78)		Class B (n=174)		Class C (n=144)	
	M	SE	M	SE	M	SE
MPA (min/day) <i>a,b,c</i>	48.7	1.9	67.9	1.7	86.8	2.3
VPA (min/day) <i>a,b,c</i>	3.3	0.3	7.1	0.4	15.9	1.0
MVPA (min/day) <i>a,b,c</i>	51.9	2.0	75.0	1.9	102.7	2.8
% MVPA bouts per day						
<i>Sporadic (<5 min)</i>	96.8	0.3	92.7	2.2	85.9	0.5
<i>Short (5-<10 min)</i>	2.6	0.2	5.6	1.1	9.3	0.3
<i>Medium-to-long (≥ 10 min)</i>	0.6	0.1	1.7	1.6	4.8	0.3
Age (yrs.)	7.7	0.1	7.5	0.0	7.6	0.1
Female (%) <i>d,e</i>	68.5	5.4	65.4	3.8	33.4	4.1

^aClass A < Class B, $p<0.0001$

^bClass A < Class C, $p<0.0001$

^cClass B < Class C, $p<0.0001$

^dClass A > Class C, $p<0.0001$

^eClass B > Class C, $p<0.0001$

Note. M=marginal mean from latent profile analysis, SE=standard error, MPA=moderate intensity physical activity, VPA=vigorous intensity physical activity, MVPA=moderate-to-vigorous intensity physical activity

Cardio-metabolic risk factors among 3 classes identified based on the composition of bouts of moderate-to-vigorous physical activity

Table 4

Variable	Class A (n=78)		Class B (n=174)		Class C (n=144)	
	M	SE	M	SE	M	SE
BMI percentile ^a	70.9	3.5	61.1	2.4	57.3	2.3
Waist circumference (cm) ^{b,c}	61.0	1.0	56.6	0.6	55.8	0.5
Systolic blood pressure (mmHg)	100.7	1.1	100.00	0.7	98.8	0.7
Diastolic blood pressure (mmHg)	57.3	0.6	57.2	0.4	57.0	0.4
Total cholesterol (mg/dL)	159.1	6.8	153.4	2.8	150.2	2.8
HDL-cholesterol (mg/dL)	50.7	1.9	52.8	1.2	54.3	1.4
Glucose (mg/dL)	87.6	1.3	89.6	1.9	87.9	1.3
Insulin (N/uIU/mL)	10.9	1.0	11.1	1.2	9.8	0.7
Triglycerides (mg/dL)	78.1	10.4	65.1	3.9	60.7	2.8
Cardiovascular fitness (PACER laps)	12.9	0.7	15.8	0.6	19.7	0.8

Note. M=marginal mean from latent profile analysis, SE=standard error, PACER=Progressive Aerobic Cardiovascular Endurance Run

Comparison of marginal means from regression analysis which accounted for age, sex, BMI percentile, and total moderate and total vigorous physical activity, except for the comparison in BMI percentile which accounted for age, sex, and total moderate and total vigorous physical activity:

^a Class C (n=142) < Class A (n=78), $p<0.05$

^b Class C (n=142) < Class A (n=77), $p<0.01$

^c Class B (n=171) < Class A (n=77), $p<0.01$