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Associations between Physical Fitness and Obesity Related Measures in South Asian Schoolchildren

Lesser IA[1,*], Fowokan AO[1], Punthakee Z[2], Lear SA[1,3,4]

[1]Department of Biomedical Physiology and Kinesiology, Simon Fraser University, Vancouver, BC, Canada
[2]Department of Medicine, McMaster University, Hamilton, ON, Canada
[3]Faculty of Health Sciences, Simon Fraser University, Burnaby, BC, Canada
[4]Division of Cardiology, Providence Health Care, Vancouver, BC, Canada
*Corresponding author: ilesser86@gmail.com

Abstract Childhood obesity is associated with many health complications. In the South Asian population this may have an especially devastating impact due to the unique obesity phenotype of high abdominal fat and low lean body mass at a given body size which lends itself to greater disease risk at a younger age. OBJECTIVES: It is unknown what is responsible for this high risk phenotype but physical fitness levels are associated with body fatness and South Asian children report lower levels of physical fitness than their European peers. Therefore, the purpose of this descriptive study is to assess the associations between obesity related measures and physical fitness in South Asian children. METHODS: Forty-five boys and girls between the ages of 7 and 10 completed measures of physical fitness for the assessment of upper and lower body strength and aerobic capacity as well as obesity related measures. RESULTS: South Asian boys and girls showed positive associations between obesity related measures and grip strength and negative associations with standing long jump and aerobic fitness. CONCLUSION: Physical fitness and specifically aerobic fitness should be emphasized among South Asian children. This is especially relevant as South Asian children report objectively lower levels of physical activity than their European peers.

Keywords: *South Asian, children, physical fitness, body composition*

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1. Introduction

Adults of South Asian background have a unique obesity phenotype of high abdominal fat and low lean body mass at a given body size [1], which lends itself to greater disease risk at a younger age [2]. This is also evident in South Asian children who tend to have an elevated body fat despite a lower body mass index (BMI) [3] with greater body fat in the trunk region. It is unclear what may account for this difference in body composition, but low physical activity and physical fitness levels are associated with greater fat mass and lower lean mass [4].

There is a large public health concern over the upwards trend in childhood overweight and obesity [5]. Childhood obesity is associated with many medical complications such as hypertension, dyslipidemia, insulin resistance and non-alcoholic fatty liver disease [6]. Participating in regular physical activity and having a high cardiorespiratory (physical) fitness level are associated with improved health, greater well-being, less obesity and less chronic disease [7]. As a result, the Canadian Physical Activity Guidelines recommend that children get 60 minutes of daily moderate to vigorous physical activity [8]. Children who participate in a greater amount of vigorous physical activity score better on measures of physical fitness than children who are more sedentary [9].

South Asian children in the United Kingdom have been reported to have lower levels of objective physical activity compared to Europeans with greater amounts of time spent in sedentary pursuits than their European peers [10]. Most recently, this lower level of objective physical activity is associated with a lower aerobic fitness level in South Asian children compared to their European counterparts [11]. In addition, physical fitness levels are also correlated with resting metabolic rate [12], therefore, putatively low levels of physical activity and physical fitness may be a possible determinant of the thin-fat body type in South Asians and this association may be established in childhood.

The associations between physical fitness and levels of obesity related measures have been well documented in a number of ethnic groups [13,14,15] but there is a paucity of data regarding South Asian children. Therefore, the purpose of this study was to provide a descriptive analysis of the associations between measures of physical fitness and obesity related measures in South Asian children aged 7 to 10 years. It is hypothesized that there will be significant associations between obesity related measures and physical fitness in South Asian children.

2. Methods

2.1. Study Population

This was a sub-study of a child health study entitled Research in International Cardiovascular Health – Lifestyles, Environments and Genetic Attributes in Children and Youth (RICH LEGACY). Participants who were recruited for the RICH LEGACY project who chose to return for a follow-up visit were asked if they were interested in participating in the current sub-study. From March 2013 to December 2015, 45 children were recruited at local elementary schools and community events through the RICH LEGACY project in the Surrey community. Children were eligible to participate if they were of South Asian origin, were between 7 to 10 years of age and were comfortable performing three physical fitness tests. The study was approved by the Simon Fraser University Research Ethics Board. Parental consent and child verbal assent were obtained from all participants.

2.2. Measurements

All measurements took place at Simon Fraser University and parents were given the option of remaining with their child during all measurements.

2.2.1. Physical Fitness Measures

Aerobic capacity was assessed through the completion of a 20 metre shuttle test which has shown a correlation of 0.71 with direct maximal aerobic capacity testing [16]. This test involved having children run between two lines spaced 2 metres apart at a pace set by signals on a pre-recorded audio file. The starting speed was 8.5 km/hour and the frequency of the signals increased 0.5 km/hour each minute [16]. The child was encouraged to run back and forth until they could not longer maintain the desired pace. The last completed stage was used to predict maximal aerobic capacity based on the multiple regression prediction equation developed for children aged 8-19 years of age [16].

Handgrip dynamometry and standing long jump have been shown to be valid field tests for assessing upper and lower body strength respectively in youth [17]. For the handgrip dynamometry test children were told to grip the handgrip dynamometer, hold it parallel to the body at a 45 degree angle and to squeeze as hard as possible for 2 seconds. This was repeated twice on each side and the highest score was counted. For the standing long jump test children were asked to jump as far as possible horizontally from a marked starting line. The average of two scores was used for statistical analyses.

2.2.2. Obesity Related Measures

Mass in kilograms and height in metres were assessed with participants in light clothing, footwear removed and pockets emptied. Body mass index (BMI) was assessed as mass in kilograms over height in metres squared. Waist circumference (WC) was measured as the midway point between the lower anterior ribs and the top of the iliac crest and recorded in centimetres as the average of two measures taken against the skin at the point of maximal narrowing from the anterior view following a normal expiration. A sub set of children (n=22) completed whole body scans using a dual energy x-ray absorptiometry (DXA) scanner (Hologic Discovery QDR 4500w, Bedford, Massachusetts) to determine lean mass (kg), fat mass and percent body fat. The percentage of total body fat was calculated by dividing fat mass by total body mass.

2.3. Statistical Analysis

The following data were non-normally distributed and natural log transformed: resting heart rate, body mass index, waist circumference (WC), lean mass, fat mass and body fat percentage. Data were natural log transformed are presented as geometric means with 95% confidence intervals while all remaining data are presented as means and standard deviations.

An independent t-test was used to compare cardiovascular, obesity related measures and physical fitness data between boys and girls. Given that there were no significant differences between sexes, data were combined for all additional analyses. Pearson correlations were used to assess the linear associations between physical fitness measures (grip strength, long jump and aerobic capacity) and obesity related measures (WC, BMI, body fat, lean mass, body fat percentage). Linear regression analyses were used to model the association between physical fitness measures and obesity related measures. Separate multiple linear regression models were constructed with, physical fitness measures as the predictor variables of interest and obesity related measures as the outcome variable. For each predictor, models were additionally adjusted for age and sex. Statistical analysis was completed using SPSS v. 23.0 and significance was set at $p<0.05$.

3. Results

There were 17 boys and 28 girls between the ages of 7 and 10 with a mean age of 8 who participated in this study (Table 1). There were no significant differences in cardiovascular, obesity related measures or physical fitness characteristics between South Asian boys and girls. Of those, 11 boys and 11 girls completed a body scan for further assessment of body composition (Table 2). There were no significant differences in obesity related measures or physical fitness measures among children who completed the body scan and those who opted not to (Appendix – Table 1a).

There were significant linear associations between a number of obesity related measures and physical fitness measures (Table 3 and Table 4). In the larger sample of 45 South Asian children, upper body strength as assessed by grip strength was positively associated with BMI and WC in unadjusted analyses. Analyses remained significant after further adjustment for age, sexand household income with BMI (Table 3-Model 1c). Lower body strength as assessed by horizontal jump was not significantly associated with BMI or WC (Table 3). Completion of shuttle run stage was used to predict VO_2max and there were significant negative associations between VO_2max and obesity related measures (Figure 1). These associations remained significant after further adjustment for age, sex and household income (Table 3).

Table 1. Comparison of cardiovascular, anthropometric and fitness characteristics between South Asian boys and girls

	Boys (n=17)	Girls (n=28)	p-value
Age (yrs)	8.0 ± 0.8	8.3 ± 0.9	0.346
Mother Tongue			
Punjabi	14 (82.4%)	23 (82.1%)	
Hindi	1 (5.9%)	5 (17.9%)	0.109
Urdu	2 (11.8%)	0 (0%)	
Family Income			
<$25,000	2 (11.8%)	3 (10.7%)	
$25,000 – $45,000	3 (17.6%)	9 (32.1%)	0.430
$45,000- $70,000	7 (41.2%)	4 (14.3%)	
>$70 000	2 (11.8%)	5 (17.9%)	
Resting HR (bpm)	82 (76, 87)	83 (78, 87)	0.770
BMI (kg/m^2)	18.3 (16.5, 20.3)	17.3 (15.9, 18.7)	0.388
WC (cm)	62.5 (57.4, 68.1)	58.6 (54.6, 62.9)	0.245
Horizontal Jump (cm)	110.7 ± 19.2	103.6 ± 24.9	0.320
Grip strength (kg)	18.5 ± 4.2	16.7 ± 4.2	0.176
Shuttle Run (stage)	1.7 ± 0.6	1.8 ± 0.7	0.736
VO_2max (mL/kg/min)	44.6 ± 1.7	44.3 ± 1.9	0.590

Heart rate (HR), body mass index (BMI), waist circumference (WC), maximal oxygen consumption (VO_2max)
Resting HR, BMI and WC were natural log transformed prior to analysis and are presented as geometric means and 95% confidence intervals. All remaining data are presented as means and standard deviations.

Table 2. Comparison of body composition characteristics between South Asian boys and girls

	Boys (n=11)	Girls (n=11)	p-value
Bone Mineral Content (kg)	1.07 (0.98, 1.18)	1.09 (0.99, 1.20)	0.821
Fat Mass (kg)	9.60 (7.30, 12.54)	12.71 (9.70, 16.66)	0.137
Lean Mass (kg)	20.10 (18.53, 23.79)	22.70 (20.03, 25.72)	0.364
Body Fat (%)	30.0 (26.8, 33.5)	34.6 (30.9, 38.7)	0.077

Variables were natural log transformed prior to analysis and are presented as geometric means and 95% confidence intervals.

Table 3. Regression models showing associations between physical fitness measures and anthropometric data (n=45)

	Grip Strength (kg)	Horizontal Jump (cm)	Shuttle Run (stage)	VO_2max (mL/kg/min)
BMI (kg/m^2)				
Model 1a	0.389 ‡	-0.210	-0.416 †	-0.542 *
Model 1b	0.334 ‡	-0.229	-0.514 *	-0.643 *
Model 1c	0.395 ‡	-0.141	-0.519 †	-0.612 †
WC (cm)				
Model 2a	0.385‡	-0.184	-0.307‡	-0.556 *
Model 2b	0.291	-0.207	-0.442†	-0.543†
Model 2c	0.351	-0.096	-0.510 †	-0.577 †

Body mass index (BMI), Waist circumference (WC), Maximal oxygen consumption (VO_2max)
Model a: unadjusted regression models, Model b: regression models adjusted for age and sex, Model c: regression models additional adjusted for income level
* p <0.001, † p<0.01, ‡ p<0.05
BMI, WC were natural log transformed prior to analysis.

Table 4. Regression models showing associations between physical fitness measures and obesity related measures (n=22)

	Grip Strength (kg)	Horizontal Jump (cm)	Shuttle Run (stage)	VO_2max (mL/kg/min)
Fat Mass (kg)				
Model 1a	0.321	-0.535 ‡	-0.544†	-0.742 *
Model 1b	0.339	-0.493 ‡	-0.871 *	-0.831 *
Model 1c	0.391	-0.293	-0.756 *	-0.758 *
Lean Mass (kg)				
Model 2a	0.524 ‡	-0.343	-0.405	-0.741 *
Model 2b	0.480 ‡	-0.324	-0.816 *	-0.775 *
Model 2c	0.536 ‡	-0.112	-0.694 †	-0.693 †
Body Fat (%)				
Model 3a	0.161	-0.582†	-0.593†	-0.653†
Model 3b	0.227	-0.525†	-0.775 *	-0.778 *
Model 3c	0.246	-0.352	-0.689 †	-0.695 †

Maximal oxygen consumption (VO_2max)
Model a: unadjusted regression models, Model b: regression models adjusted for age and sex, Model c: regression models additional adjusted for income level
* p <0.001, † p<0.01, ‡ p<0.05
Fat mass, lean mass and body fat percentage were natural log transformed prior to analysis.

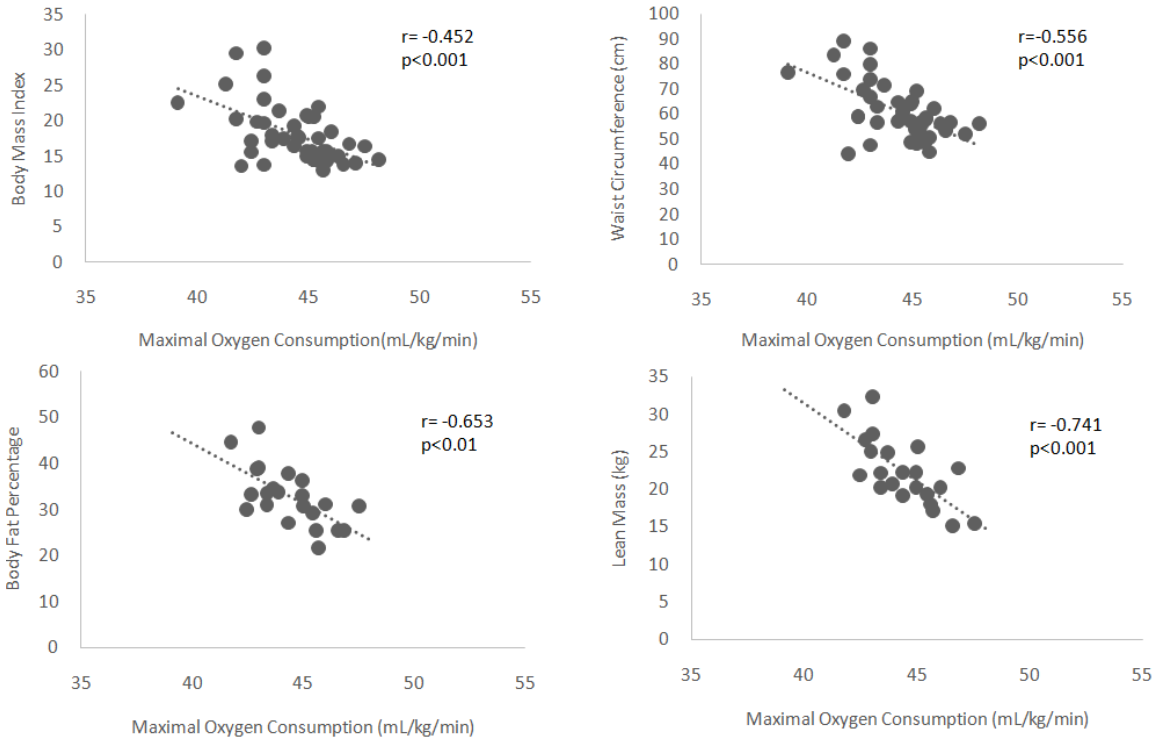

Figure 1. Pearson correlations between obesity related measures and maximal oxygen consumption

In the smaller sample of 22 South Asian children which completed body scans, upper body strength as assessed by grip strength was positively associated with lean massand remained significant after further adjustment for age, sex and household income (Table 4 - Model 2c). Lower body strength as assessed by horizontal jump was negatively associated with fat mass and body fat percentage in unadjusted analyses (Table 4 – Model 1a and Model 3a) and remained significant after further adjustment for age and sex (Table 4- Model 1b and 3b) but not household income (Table 4- Model 1c and 3c). Shuttle run stage and VO_2max were negatively associated with fat mass, lean mass and body fat percentage after adjustment for age, sex and household income (Table 4).

4. Discussion

South Asian boys and girls showed significant associations between obesity related measures and physical fitness variables after adjustment for age and sex thus supporting our hypothesis. Given the paucity of data regarding South Asian children and the association between obesity related measures and physical fitness measures this study is of importance as it provides further context for the impact of physical activity and fitness on the health of South Asian children. Specifically, upper body strength as measured by maximal grip strength was positively associated with BMI, WC and lean body mass while lower body strength as measured by horizontal long jump was negatively associated with fat mass and body fat percentage. Aerobic fitness was negatively associated with all obesity related measures.

We found upper body strength as measured by maximal grip strength was positively associated with BMI which suggests that larger children score better on upper body strength. This was also found when physical fitness was assessed among children 7 to 11 years of age in Europe [14] and Mexican and Canadian children 9 to 13 years of age [15]. In addition, in a subset of our population that completed body scans and we found lean body mass to also be positively associated with maximal grip strength. This suggests that it is muscle mass rather than body fat that is resulting in the positive association with BMI. This is logical given than muscle mass tends to increase with body mass [18]. This was also suggested by Heroux et al., to explain the positive associations between BMI and grip strength in Mexican and Canadian children [15]. Comparatively, measures of lower body strength as measured by horizontal long jump were negatively associated with fat mass and body fat percentage. Thus children with greater leg strength tended to have a lower amount of body fat.

We found significant negative associations between aerobic capacity and obesity related measures in our population of South Asian children. This finding parallels results seen in Iranian children 11 to 13 years of age [13], European children 7 to 11 years of age [14] as well as Kenyan, Mexican and Canadian children 9 to 13 years of age [15]. We have also previously shown significant negative associations between aerobic capacity (using direct metabolic assessment) and abdominal fat in older South Asian women [19]. Given the known association between physical activity levels and physical fitness in children [20], one could conclude that low levels of physical activity in South Asian children [10] may be associated with the unique obesity phenotypeof high abdominal fat and low lean body mass at a given body size in South Asian adults [6]. Further research is necessary to directly measure this association in South Asian children.

Limitations of this study include the small and non random sample which may not be representative of South Asian children in Canada, however, this was a community

based sample in a Canadian city with a large South Asian population. In addition, in order to improve the feasibility of the study, we used a number of field tests to assess measures of physical fitness. The field tests were chosen due to their reported validity in school aged children. Specifically, the 20 meter shuttle run test has a moderate validity (r=0.71) in school aged children with indirect calorimetry and is consistently used to measure physical fitness in this population [16]. Furthermore, we were able to have a sub set of children complete body scans for direct assessment of body composition and were therefore able to add to the body of literature with a strong measure of body composition.

In conclusion, we found significant associations between measures of physical fitness and obesity related measures in South Asian children 7 to 10 years of age. This is especially relevant as South Asian children report objectively lower levels of physical activity than Europeans in the United Kingdom with greater amounts of time spent in sedentary pursuits than their European peers [10]. Given the unique obesity phenotype in the South Asian population [1] and its association with greater disease risk at a younger age [2] improving physical fitness and specifically aerobic fitness may be a useful and inexpensive modality for reducing disease risk in South Asian children. Further research is necessary to assess whether low levels of physical activity and fitness in South Asian children explains the unique obesity phenotype seen in the South Asian population.

References

[1] Lear SA, Kohli S, Bondy GP, Tchernof A, Sniderman AD. Ethnic variation in fat and lean body mass and the association with insulin resistance. *J. Clin. Endocrinol. Metab*. 2009; 94 (12): 4696-702.

[2] Joshi P, Islam S, Pais P, Reddy S, Dorairaj P, Kazmi K, et al. Risk factors for early myocardial infarction in south asians compared with individuals in other countries. *JAMA*. 2007; 297(3):286-94.

[3] Nightingale CM, Rudnicka AR, Owen CG, Cook DG, Whincup PH. Patterns of body size and adiposity among UK children of South Asian, black African-Caribbean and white European origin: Child Heart and Health Study in England (CHASE Study). *Int. J. Epidemiol*. 2011; 40 (1): 33-44.

[4] Ness AR, Leary SD, Mattocks C, Blair SN, Reilly JJ, Wells J, et al. *PLoS Med*. 2007; 4(3):e97.

[5] Han JC, Lawlor DA, Kimm SY. Childhood obesity. *Lancet* 2010; 375 (9727): 1737-48.

[6] Daniels SR. Complications of obesity in children and adolescents. *Int. J. Obes. (Lond)* 2009; 33 (Suppl 1): S60 – 5.

[7] Warburton DE, Nicol CW,Bredin SS. Health benefits of physical activity: the evidence. *CMAJ*. 2006; 174 (6): 801-9.

[8] Colley RC, Garriguet D, Janssen I, Craig CL, Clarke J, Tremblay MS. Physical activity of Canadian children and youth: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Rep.* 2011; 22 (1):7-14.

[9] Denton SJ, Trenell MI, Plotz T, Savory LA, Bailey DP, Kerr CJ. Cardiorespiratory Fitness is Associated with Hard and Light Intensity Physical Activity but Not Time Spent Sedentary in 10-14 Year Old Schoolchildren: The HAPPY Study. *PLoS One.* 2013; 8 (4): e61073.

[10] Owen CG, Nightingale CM, Rudnicka AR, Cook DG, Ekelund U and Whincup PH. Ethnic and gender differences in physical activity levels among 9-10 year old children of white European, South Asian and African- Caribbean origin: the Child Heart Health Study in England (CHASE study). *Int. J. Epidemiol*. 2009; 38(4): 1082-93.

[11] Nightingale et al. Cross-sectional study of ethnic differences in physical fitness among children of South Asian, black African-Caribbean and white European origin: the Child Heart and Health Study in England (CHASE). *BMJ Open*. 2016; 6 e011131.

[12] Zurlo F, Larson K, Bogardus C, Ravussin E. Skeletal muscle metabolism is a major determinant of resting energy expenditure. *J. Clin. Invest.* 1990; 86 (5): 1423-7.

[13] Minasian V, Marandi SM, Kelishadi R, Abolhassani H. Correlation between aerobic fitness and body composition in middle-school students. *Int. J. Prev. Med.* 2014; 5 (Suppl 2): S102-7.

[14] Ceschia A Giacomini S, Santarossa S, Rugo M, Salvadego D, Da Ponte A, et al. Deleterious effects of obesity on physical fitness in pre-pubertal children. *Eur. J. Sport Sci.* 2016; 16 (2): 271-8.

[15] Heroux M, Onywera V, Tremblay MS, Adamo KB, Lopez Taylor J, Jaregui Ulloa E, et al. The relation between aerobic fitness, muscular fitness, and obesity in children from thress countries at different stages of the physical activity transition. *ISRN Obes.* 2013; 20: 134835.

[16] Leger LA, Mercier D, Gadoury C and Lambert J. The multistage 20 metre shuttle run test for aerobic fitness. J. Sports Sci. 1988; 6(2):93-101.

[17] Artero EG, Espana-Romero V, Castro-Pinero J, Ruiz J, Jimenez-Pavon D, Aparicio V, et al. Criterion-related validity of field-based muscular fitness tests in youth. *J. Sports Med. Phys. Fitness.* 2012; 52 (3): 263-72.

[18] Forbes GB. Lean body mass – body fat interrelationships in humans. *Nutr. Rev*. 1987; 45 (8): 225-31.

[19] Lesser IA, Dick TJM, Guenette JA, Hoogbruin A, Mackey DC, Singer, Lear SA. The association between cardiorespiratory fitness and abdominal adiposity in postmenopausal, physically inactive South Asian women. *Prev. Med. Rep.* 2015; 2:783-7.

[20] Sallis JF, Patterson TL, Buono MJ, Nader PR. Relation of cardiovascular fitness and physical activity to cardiovascular disease risk factors in children and adults. *Am. J. Epidemiol.* 1988; 127(5): 933-41.

Appendix

Table 1a. Comparison of participants who opted to complete the body scan vs. those who opted not to

	Body scan (n= 22)	No body scan (n=23)	p-value
Age (yrs)	8.2 ± 0.9	8.1 ± 0.9	0.586
Resting HR (bpm)	82 (77, 87)	83 (78, 88)	0.813
BMI (kg/m^2)	18.4 (16.8, 20.2)	17.0 (15.6, 18.5)	0.205
WC (cm)	67.4 (59.1, 76.9)	58.1 (51.1, 66.2)	0.113
Horizontal Jump (cm)	111.0 ± 20.3	101.9 ± 24.8	0.188
Grip strength (kg)	18.0 ± 4.2	16.8 ± 4.4	0.381
Shuttle Run (stage)	1.82 ± 0.72	1.68 ± 0.60	0.494
VO_2max (mL/kg/min)	44.4 ± 1.6	44.4 ± 2.1	0.908

Heart rate (HR), body mass index (BMI), waist circumference (WC), maximal oxygen consumption (VO_2max)
Resting HR, BMI and WC were natural log transformed prior to analysis and are presented as geometric means and 95% confidence intervals. All remaining data are presented as means and standard deviations.