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The association between different types of exercise and energy expenditure in young nonoverweight and overweight adults

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Abstract

With decades of trends for decreasing activity during work and travel, exercise becomes an important contributor to total physical activity (PA) and energy expenditure. The purpose of this study was to examine the contribution of different types of exercise to the variability in energy expenditure and time spent at different PA intensities in young adults. Four hundred and seventeen adults (49.9% male; 46.2 overweight/obese) between 21 and 36 years of age provided valid objective PA and energy expenditure data, assessed via the SenseWear Armband (BodyMedia Inc.). Frequency and duration of participation in various exercise types was self-reported. Weight status was based on body mass index (BMI) (kg/m^2) with body weight and height being measured

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according to standard procedures. Eighty-four percent of the participants reported regular exercise engagement with no difference in participation rate by sex or BMI category. Exercise time along with sex and ethnicity explained roughly 60% of the variability in total daily energy expenditure (TDEE) while the association between exercise and time spent in moderate to vigorous PA or being sedentary was low or nonsignificant. Engagement in endurance exercise and sports contributed predominantly to the variability in energy expenditure and PA in nonoverweight participants. In overweight/obese participants engagement in resistance exercise and swimming contributed significantly to variability in TDEE. Current exercise recommendations focus primarily on aerobic exercise, but results of the present study suggest that nonweight-bearing exercises, such as resistance exercise and swimming, contribute significantly to the variability in TDEE in overweight/obese adults, which would make these types of activities viable options for exercise interventions.

Keywords

sports; endurance exercise; resistance exercise; sedentary time; physical activity

Introduction

Low energy expenditure, because of an increasingly sedentary lifestyle, has been suggested as a key component contributing to the high prevalence of overweight/obesity (Peters et al. 2002; Wareham et al. 2005). The most variable components of energy expenditure are physical activity (PA), including exercise. PA has been defined as any bodily movement that results in increased energy expenditure while exercise consists of planned and structured PA (Caspersen et al. 1985). Insufficient PA has been shown to increase the risk for several chronic diseases, such as cardiovascular disease and type 2 diabetes (Warburton et al. 2006; Löllgen 2013). With a reduction in the requirement of PA at work and for activities of daily living over the past several decades (Church et al. 2011; Archer et al. 2013), exercise during leisure time becomes an important component of total PA and total daily energy expenditure (TDEE), particularly in younger subjects (Westerterp 2003). A recent meta-analysis also showed that exercise and sport have a stronger association with mortality than do occupational PA or transport-related PA (Samitz et al. 2011).

There is, however, limited research on potential differences of various types of exercise on energy expenditure and time spent at different intensities. Most research has focused on aerobic exercise, which has been associated with an increase in energy expenditure in young adults (Westerterp 2008), but there is a lack of research on the contribution of other types of exercise to energy expenditure. Differences in exercise type should be considered both in terms of energy expenditure during exercise and the differential effect on energy expenditure during nonexercise time. Aerobic exercise has been shown to increase resting energy expenditure for up to 19 h postexercise (Hunter et al. 2006), while resistance exercise has been associated with an increase in functional capacity, which could affect TDEE by an increase in total PA (Hunter et al. 2000; Levinger et al. 2007). The effects of exercise on energy expenditure may also differ between normal weight and overweight or obese adults. While aerobic exercise can be performed safely and effectively in various populations, it has been argued that resistance exercise may be more applicable to at-risk populations, such as the elderly and obese, who may have difficulties performing aerobic exercises (Willey and Singh 2003). In college students, on the other hand, participation in sports was associated with a higher intrinsic motivation compared with other types of exercise (Kilpatrick et al. 2005), and, therefore, sports participation may be a key component in an attempt to increase energy expenditure in young adults.

No previous research examined potential differences in the effects of various types of self-selected exercise on energy expenditure, total PA levels, time spent at different intensities, and whether effects differ across body mass index (BMI) categories and by sex. The purpose of this study, therefore, was to determine the contribution of various self-selected exercise types to the variability in TDEE, energy expenditure in moderate to vigorous physical activity (MVPA), and time spent at different intensities in young nonoverweight and overweight/obese adults. Further, potential differential effects of exercise on TDEE, total PA, and sedentary time between male and female participants were examined.

Materials and methods

Participants

A total of 430 young adults (age, 27.7 ± 3.8 years) provided baseline data for an ongoing observational study. Specifics of the study have been described previously (Hand et al. 2013). Recruitment occurred via press releases, e-mail listservs (automatic e-mailing list server), Web site postings, posters, and flyers, and was balanced by sex and age (≥21 to <28 years and ≥28 to <35 years). Only adults with a BMI between 20 and 35 kg/m^2, no major acute or chronic conditions and no large changes in health behaviors in the previous 3 months were considered eligible for participation in the study. To ensure accurate estimations of energy expenditure, participants needed to provide at least 7 days of objective PA data, resulting in a final sample size of 417 (49.9% male). All participants signed informed consent prior to data collection and the study protocol was approved by the University of South Carolina Institutional Review Board.

Anthropometric measurements

Anthropometric measurements were taken after an overnight fast with the participants dressed in surgical scrubs and in bare feet, according to standard procedures. Body weight was measured to the nearest 0.1 kg using an electronic scale (Healthometer model 500KL, McCook, Ill., USA) and height was measured to the nearest 0.1 cm using a wall-mounted stadiometer (Model S100, Ayrton Corp., Prior Lake, Minn., USA). BMI (kg/m^2) was calculated based on the average of 3 measurements and used to differentiate between nonoverweight (18.5 kg/m^2 < BMI < 25 kg/m^2) and overweight/obese subjects (BMI ≥ 25 kg/m^2) (National Institutes of Health 1998).

Energy expenditure

TDEE, energy expenditure, and time spent in MVPA as well as sedentary time were determined with the SenseWear Mini Armband (SWA; BodyMedia Inc., Pittsburgh, Pa., USA). Using a propriatory algorithm (SenseWear Professional 7.0), the SWA incorporates measurements of tri-axial accelerometry, galvanic skin response, heat flux, skin temperature, and near body temperature to estimate minute-by-minute energy expenditure. The SWA has been shown to provide accurate estimations of total energy expenditure in free-living adults (St-Onge et al. 2007; Johannsen et al. 2010). Participants were asked to wear the SWA for 24 h, except during water-based activities, over a period of 10 days. At least 7 days (including 2 weekend days) with a minimum of 18.4 h of SWA wear-time per day was required for a participant's inclusion in the analysis. Participants recorded their activities during periods of nonwear time. Specifically, participants reported the time when the SWA was taken off and subsequently reported the start and end times of specific activities during the periods that the SWA was not worn. These activities were matched with metabolic equivalents (METs) using the 2011 Compendium of Physical Activity (Ainsworth et al. 2011). Subsequently, minute-by-minute MET values of the reported activities were multiplied with the participant's resting metabolic rate (RMR) to fill in the gaps of objectively measured data (i.e., periods when the SWA was not worn) to obtain energy expenditure for the entire day. RMR was measured in all participants via indirect calorimetry (True One 2400, Parvo Medics, Sandy, Utah, USA) after a 12-h overnight fast and abstention from exercise for at least 24 h. Previous research did not show significant differences in RMR between the SWA and indirect calorimetry (Fruin and Rankin 2004; Casiraghi et al. 2013). Minute-by-minute MET values were used to determine the time participants spent being sedentary, including rest (≤1.5 METs), in light PA (>1.5 METs and <3.0 METs), and in MVPA (≥3.0 METs). Energy expenditure in MVPA was also determined via SWA and self-reported activities of sufficient intensity. To obtain sedentary time during waking hours, sleep time, determined via the SWA, were subtracted from total sedentary time.

Exercise engagement

In addition to the objective assessment of PA and energy expenditure, participants were asked to report their habitual, self-selected engagement in different types of exercise or other structured activities. Specifically, participants reported frequency (days/week) and time (min/session) spent doing sports, endurance exercise (cycling and running), resistance exercise, swimming (including other water-based activities), aerobics/group exercise, brisk walking, and other structured forms of PA. Only exercise sessions lasting at least 30 min were included when calculating exercise time per week (min/week). Participants also reported frequency and time spent travelling by bike or walking (active travel) and household PA. There were no specific cutpoints for time spent in active travel and household PA when calculating time spent in these activities.

Participants also provided information on various demographic characteristics including their ethnicity. Specifically, participants self-reported their ethnic background as white/ European, African American, Hispanic, Asian, mixed, or other.

Statistical analysis

Descriptive statistics were calculated for the total sample and separately for nonoverweight and overweight/obese adults as well as separately for male and female participants. Time spent in different types of exercise and structured PA was initially correlated with TDEE, energy expenditure in MVPA, time spent sedentary, in light PA and in MVPA, adjusting for sex and ethnicity. Exercise types significantly correlated with energy expenditure or time spent at different intensities were subsequently entered into linear regression models using best subset modelling to determine the exercise types predominantly contributing to variability in absolute (kcal/day) and relative (kcal/(kg·day)$^{-1}$) TDEE, energy expenditure in MVPA, as well as time spent sedentary, in light PA and in MVPA. Model selection was based on adjusted R^2 starting with a total of 6 different exercise types (endurance exercise, resistance exercise, sports, swimming, other structured PA, walking) entering the model in addition to the covariates of age and ethnicity. These analyses were performed for the total sample and separately for nonoverweight and overweight/obese as well as male and female participants. All analyses were carried out with IBM SPSS Statistics for Windows (version 21.0; IBM Corp., Armonk, N.Y., USA). Statistical significance was set at $\alpha = 0.05$ (2-tailed).

Results

There was no difference in ethnicity and anthropometric characteristics between noncompliant participants and those included in the analysis. The prevalence of overweight/obesity was 46.3% (49.0% in males, 43.7% in females). Two-thirds of the study population was white/European, with the majority having a college degree (Table 1). There was no sex-difference in ethnicity but the prevalence of white/European participants was higher in non-overweight compared with overweight/obese (71.4% vs. 61.7%). Education level did not differ between BMI categories but the rate of participants with a college degree was higher in females compared with males (90.1% vs. 77.5%).

Exercise participation and energy expenditure in nonoverweight and overweight/obese

In the total sample 84.2% (84.8% male, 83.6% female) reported engagement in some type of exercise. Participation rates in various types of exercise did not differ between nonoverweight and overweight/obese participants (Table 2). More nonoverweight participants, however, reported active travel compared with overweight/obese participants. Controlling for participation rate, sex and ethnicity, time spent (min/week) in various types of exercise did not differ between BMI categories, except for resistance exercise ($F_{[1,412]} = 4.07$, $p = 0.044$). Overweight/obese participants reported a higher amount (min/week) of resistance exercise compared with nonoverweight participants. Nevertheless, non-overweight participants spent more time in MVPA and less time in light PA or being sedentary compared with overweight/obese ($F_{MVPA}[1,413] = 118.49$, $p < 0.001$; $F_{Light}[1,413] = 22.85$, $p < 0.001$; $F_{Sedentary}[1,413] = 28.39$, $p < 0.001$). Absolute and relative (per kilogram body weight) energy expenditure in MVPA was higher in nonoverweight compared with overweight/obese ($F_{MVPA}[1,413] = 45.78$, $p < 0.001$; $F_{MVPA/kg}[1,413] = 105.99$, $p < .001$). Accordingly, relative TDEE was higher in nonoverweight participants ($F_{[1,413]} = 166.93$, $p < 0.001$), while absolute TDEE was higher in overweight/obese ($F_{[1,413]} = 34.17$, $p < 0.001$).

Exercise participation and energy expenditure in males and females

Participation rates for sports, resistance exercise, and other PA were higher in males compared with females and males spent more time in these exercises, adjusting for participation rate and ethnicity ($F_{Sport}[1,413] = 5.06$, $p = 0.025$; $F_{Resistance}[1,413] = 11.71$, $p = 0.001$; $F_{PA}[1,413] = 4.50$, $p = 0.034$) (Table 2). Participation in aerobics and brisk walking was higher in females compared with males but there was no sex difference in average time committed to these exercises. Female participants, however, reported more time in household activities ($F_{[1,380]} = 8.84$, $p = 0.003$). Absolute and relative energy expenditure were higher in males compared with females ($F_{TDEE/kg}[1,414] = 50.99$, $p < .001$; $F_{TDEE}[1,414] = 461.42$, $p < 0.001$; $F_{MVPA/kg}[1,414] = 41.82$, $p < .001$; $F_{MVPA}[1,414] = 114.83$, $p < 0.001$). Male participants spent more time in MVPA and less time in light PA compared with female participants ($F_{MVPA}[1,414] = 44.39$, $p < 0.001$; $F_{Light}[1,414] = 53.38$, $p < 0.001$) but there was no sexdifference in sedentary time.

Correlation between exercise and energy expenditure

Partial correlations, adjusted for sex and ethnicity, between energy expenditure or time spent at different intensities were generally low (Supplementary Table S1[1]); however, except for aerobics, all exercise types were significantly correlated with energy expenditure or time spent at different intensities. Household PA and active travel were not significantly correlated with either energy expenditure or time spent in different intensities. Therefore, these variables were not included in the multiple linear regression analysis.

Contribution of exercise to variability in energy expenditure in normal weight and overweight/obese

Partial correlations between total exercise time and energy expenditure were between $r = 0.21$ and $r = 0.27$ for TDEE and between $r = 0.20$ and $r = 0.29$ for energy expenditure in MVPA (Supplementary Table S2[1]). Endurance exercise and sports were the dominant parameters affecting energy expenditure and time spent in MVPA in nonoverweight participants (Table 3). In overweight/obese, resistance exercise and swimming were the main variables with endurance exercise contributing only to energy expenditure in MVPA and time spent in MVPA. Additionally adjusting for BMI or using relative energy expenditure ($kcal/(kg{\cdot}day)^{-1}$) affected model strength but there was essentially no change in the exercise types significantly contributing to TDEE except for endurance exercise being a significant contributor in overweight/obese (Supplementary Table S4[1]). Exercise types contributing to TDEE and MVPA were inversely associated with sedentary time in overweight/ obese. In nonoverweight participants, only walking was inversely associated with sedentary time, while it was positively associated with time spent in light PA.

Contribution of exercise to variability in energy expenditure in males and females

Sex-specific analyses, adjusting for ethnicity, indicated a stronger association between exercise and absolute energy expenditure in females compared with males (Supplementary Table S3[1]). Endurance and resistance exercise were the most common contributors to absolute energy expenditure in men (Table 4). In females, endurance exercise and swimming were associated with variability in energy expenditure. Additionally adjusting for

BMI did not affect these results. Sports, however, became a significant contributor when using relative energy expenditure, while resistance exercise was no longer significant (Supplementary Table S5[1]). Endurance exercise and sports were also associated with time spent in MVPA in males and females. Walking was positively associated with time spent in light PA and inversely associated with sedentary time in males. There was no significant association between light PA and specific exercise types in females but swimming and endurance exercise were inversely associated with sedentary time.

Discussion

To our knowledge this was the first study that explored the association between different types of exercise and energy expenditure or time spent at different intensities in a sample of non-overweight and overweight/obese young adults. Because of the decreasing physical demands in everyday life (Church et al. 2011), exercise becomes an important component in ensuring adequate levels of PA for health. The key finding of this study was that the proportional contribution of different types of exercise to energy expenditure differed between BMI categories even though self-reported participation rate and duration of exercise engagement did not differ between nonoverweight and overweight/obese participants. Endurance exercise and sports were the dominant exercise types contributing to energy expenditure in nonoverweight participants. Resistance exercise and swimming or other water-based activities along with endurance exercise were the major contributors to the variability in energy expenditure and time spent in MVPA in overweight/obese adults. These results suggest that the facilitation of nonweight-bearing exercises (i.e., swimming and resistance exercise) could be a key component to increase PA and energy expenditure in overweight/obese individuals. These exercise types have also been shown to be more enjoyable and better tolerated in overweight adults (Willey and Singh 2003; Nagle et al. 2007), which would positively affect adherence to exercise interventions in this population. The popularity of resistance training in overweight/ obese individuals has further been indicated in the National Weight Control Registry, as it was the second most reported exercise following walking (Catenacci et al. 2008).

Coping with high-intensity endurance training, on the other hand, has been shown to be difficult in adults with a BMI above 24 kg/m^2 (Westerterp 1999) and greater postexercise fatigue could negatively affect nonexercise activity thermogenesis or habitual PA during the rest of the day. This problem may also be present with participation in sports as overweight women have been shown to achieve lower average intensities during sports compared with nonoverweight women (Scheers et al. 2012). The higher energy expenditure in MVPA in nonoverweight compared with overweight/obese participants, despite a similar duration of reported exercise, also indicates higher exercise intensities in nonoverweight adults. Besides the intensity while performing exercises, breaks during exercise sessions need to be considered as well. Overweight/obese children have been shown to take more breaks and spend more time sedentary during a soccer game than their nonoverweight peers (Sacheck et al. 2011). No such research exists for adults but it seems plausible that overweight/obese adults require a higher amount of rest during sports participation. The present study showed that overweight/obese spend more time in sedentary pursuits during waking hours compared with nonoverweight participants, which is consistent with previous research (Scheers et al.

2012; DeLany et al. 2013). The association between exercise and sedentary time in the present study, however, was low. Large-scale studies also reported low correlations between PA and sedentary time (Healy et al. 2008; Schuna et al. 2013), suggesting that sedentary behaviors need to be considered separately from PA (Rhodes et al. 2012). The lack of a sex difference in time spent sedentary despite significantly higher amounts of exercise and time spent in MVPA of males compared with females further supports this argument.

In contrast with the observed differences in the contribution of various exercise types to energy expenditure between nonover-weight and overweight/obese adults, differences in the effect of various types of exercise on energy expenditure were less pronounced between male and female participants. Endurance exercise and sports, along with swimming in females, emerged as predominant contributors to the variability in relative energy expenditure in both males and females, even though female participants reported lower amounts of exercise compared with male participants. Resistance exercise was a significant contributor to absolute energy expenditure in males and females, despite a significantly lower participation rate in female participants. Given the benefits of resistance training (Westcott 2012), this type of exercise may be of particular interest in the promotion of a healthy lifestyle in women. Even though energy expenditure is lower during resistance exercise compared with endurance exercise (Strasser and Schobersberger 2011), resistance exercise could positively affect TDEE because of greater functional capacity, which may facilitate higher nonexercise PA. The effect of sports participation on MVPA in males and females is of interest as participation rates and exercise time reported for sports were lower compared with other types of exercise. The fact that the impact of various exercise types on energy expenditure and PA was not determined by time spent in specific exercises supports the argument of a differential effect of various exercise types on energy expenditure.

Results of the present study further indicate that activities of daily living, such as household PA or active travel, do not significantly contribute to the variability in energy expenditure or PA. In Canadian adults, the contribution of active transportation to total energy expenditure was considered to be negligible (Csizmadi et al. 2011) and it has been argued that the level of locomotive activities needed to affect energy expenditure are unlikely to be achieved in the general population (Ohkawara et al. 2011). Along the same line, Wareham et al. (2005) suggested that weight maintenance is more achievable with activities of higher intensity. As participants of the current study reported similar duration for active travel, household PA, and exercise time (results not shown), it can be assumed that activities consisting of higher intensities (i.e., exercise) affect energy expenditure more strongly than less intense activities of daily living. The lack of an effect of brisk walking on energy expenditure and time spent in MVPA could also be explained by the lower intensity compared with other types of exercise. Nevertheless, walking was inversely associated with sedentary time. Walking has also been shown to reduce chronic disease risk (Ford and Caspersen 2012), which makes it an important part of a healthy lifestyle.

Some limitations of the present study, however, need to be considered when interpreting the results of the present study. There is a potential for misrepresentation of exercise behavior because of the reliance on self-report. Overweight/obese have been shown to overestimate their levels of PA and exercise (Walsh et al. 2004). The influence of social desirability and social approval on self-reported PA, however, has been shown to be minimal (Adams et al. 2005; Motl et al. 2005) and additionally controlling for social desirability and social approval did not affect the main outcomes of the study (results not shown). The exclusion of short exercise bouts (<30 min) could lead to some misrepresentation as well. The lack of information on exercise intensity (kcal/min) is of concern, as this is a key contributor to energy expenditure. Exercise types associated with energy expenditure during MVPA, however, were associated with time spent in MVPA as well. This suggests that endurance exercise and sports along with resistance exercise and swimming in overweight/obese are the most influential contributors to energy expenditure and PA despite individual differences in exercise intensity. There are also some limitations regarding the generalizability of the results of the present study as the prevalence of obesity was lower than that observed in a representative sample of American adults between 20 and 39 years of age (Ogden et al. 2014). Further, most of the participants were European Americans with a college degree and an exercise participation rate of 84% was higher than what has been reported in the American adult population (Ham et al. 2009). Nevertheless, this study provides valuable information on the differential effects of various types of exercise on energy expenditure and time spent at different intensities in young adults.

In summary, results of the present study emphasize the contribution of resistance and endurance exercise along with sports participation to energy expenditure and PA in nonoverweight young adults. In overweight/obese adults, nonweight-bearing exercises such as swimming and resistance exercise were shown to be key contributors to energy expenditure and PA in addition to endurance exercise. It should also be considered that different exercise types may affect body composition and physiologic processes differently, which could provide additional health benefits beyond the role of exercise in weight management. This study provides a glimpse of the association between exercise and energy expenditure and PA, but more research is needed to increase the understanding of the differential effects of various types of exercise on energy expenditure and energy balance.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Sample characteristics.

	Nonoverweight		Overweight/obese		Total sample (N = 417)
	Male (N = 104)	Female (N = 120)	Male (N = 100)	Female (N = 93)	
% White/European[a,b]	67.3%	75.0%	69.0%	53.8%	66.9%
% College degree[a]	73.1%	92.5%	82.0%	87.1%	83.9%
Height (cm)[a]	179.0±7.0	165.5±6.5	177.9±7.3	164.6±6.6	171.6±9.5
Weight (kg)[a,b]	73.3±7.3	60.7±6.7	88.6±11.4	79.9±10.1	74.8±13.7
BMI (kg/m^2)[b]	22.9±1.4	22.1±1.7	27.9±2.5	29.4±2.8	25.3±3.8
TDEE (kcal/d)[a,b]	3039.9±407.1	2280.0±268.2	3178.2±405.8	2522.3±287.5	2739.0±509.3
TDEE (kcal/(kg·d)$^{-1}$)[a,b]	41.6±5.0	37.8±4.6	36.1±4.3	31.8±4.1	37.0±5.6
EE in MVPA (kcal/d)[a,b]	995.3±428.3	567.6±271.5	714.1±365.6	405.9±229.3	673.3±394.3
EE in MVPA (kcal/(kg·d)$^{-1}$)[a,b]	13.7±6.0	9.6±4.9	8.3±4.4	5.2±3.3	9.3±5.6
MVPA time (min/d)[a,b]	197.5±80.0	139.9±63.2	120.9±62.8	76.9±48.1	135.6±77.5
Light PA time (min/d)[a,b]	183.4±50.0	224.7±54.5	208.3±48.2	249.6±61.8	216.0±58.5
Sedentary time (min/d)[b]	656.8±93.0	656.2±82.9	714.3±94.3	707.5±90.7	681.7±93.8

Note: Values are means ± SD unless prevalence is reported. Moderate to vigorous PA (MVPA ≥ 3.0 METs), light PA (1.5–3.0 METs), sedentary (≤1.5 METs). BMI, body mass index; EE, energy expenditure; MVPA, moderate to vigorous physical activity; PA, physical activity; TDEE, total daily energy expenditure.

[a]Significant difference between men and women ($p < 0.05$).

[b]Significant difference between nonoverweight and overweight/obese ($p < 0.05$).

Table 2

Prevalence of reported engagement in different types of exercise.

	Nonoverweight		Overweight/obese		Total sample (%)
	Male (%)	Female (%)	Male (%)	Female (%)	
Sports[a]	51.0	20.8	37.0	19.4	31.2
Endurance exercise	58.7	52.5	59.0	46.2	54.2
Aerobics[a]	20.2	45.0	20.0	50.5	34.1
Swimming	21.2	14.2	11.0	16.1	15.6
Resistance exercise[a]	44.2	31.7	49.0	37.6	40.3
Other structured PA[a]	28.8	15.0	26.0	10.8	20.1
Brisk walking[a]	31.7	44.2	37.0	59.1	42.7
Active travel[b]	58.7	49.2	42.0	36.6	47.0
Household PA[a]	84.6	95.8	91.0	95.7	91.8

Note: PA, physical activity.

[a] Significant difference between men and women ($p < 0.05$).

[b] Significant difference between nonoverweight and overweight/obese ($p < 0.05$).

Table 3

Final model for the contribution of time spent (min/week) in various exercise types to the variability in energy expenditure and time spent at different intensities based on best linear subset modelling, separately for (*a*) nonoverweight and (*b*) overweight/obese participants.*

(*a*) Nonoverweight participants

		Endurance exercise		**Sports**		**Walking**	
Dependent variable	R^2	β	***p***	β	***p***	β	***p***
TDEE (kcal/d)	0.623	0.153	<0.001	0.083	0.056	0.082	0.063
MVPA (kcal/d)	0.347	0.231	<0.001	0.120	0.040	na	na
MVPA time (min/d)	0.180	0.155	0.014	0.130	0.046	na	na
Light PA time (min/d)	0.157	na	na	na	na	0.113	0.072
Sedentary time (min/d)	0.056	na	na	na	na	−0.055	0.040

(*b*) Overweight/obese

		Endurance exercise		**Resistance exercise**		**Swimming**	
Dependent variable	R^2	β	***p***	β	***p***	β	***p***
TDEE (kcal/d)	0.581	na	na	0.188	<0.001	0.162	0.001
MVPA (kcal/d)	0.345	0.155	0.013	0.192	0.003	0.161	0.008
MVPA time (min/d)	0.248	0.179	0.008	0.139	0.040	0.144	0.027
Light PA time (min/d)†	—	—	—	—	—	—	—
Sedentary time (min/d)	0.152	na	na	−0.114	0.102	−0.214	0.002

Note: MVPA, moderate to vigorous physical activity; na, not applicable; PA, physical activity; TDEE, total daily energy expenditure.

*Values reflect standardized regression coefficients (β) and *p* value for final model after entering time spent (min/week) in endurance exercise, resistance exercise, sports, swimming, walking, and other PA, adjusting for sex and ethnicity.

†No exercise types identified by best subset modelling.

Table 4

Final model for the contribution of time spent (min/week) in various exercise types to the variability in energy expenditure and time spent at different intensities based on best linear subset modelling, separately for (*a*) male and (*b*) female participants.*

(*a*) Male participants

		Endurance exercise		Resistance exercise		Sports		Walking	
Dependent variable	R^2	β	***p***	β	***p***	β	***p***	β	***p***
TDEE (kcal/d)	0.115	na	na	0.163	0.016	na	na	na	na
MVPA (kcal/d)	0.078	0.200	0.004	0.105	0.128	na	na	na	na
MVPA time (min/d)	0.045	0.151	0.032	na	na	0.115	0.099	na	na
Light PA time (min/d)	0.037	−0.102	0.147	na	na	na	na	0.140	0.048
Sedentary time (min/d)	0.106	na	na	na	na	na	na	−0.167	0.014

(*b*) Female participants

		Endurance exercise		Resistance exercise		Sports		Swimming	
Dependent variable	R^2	β	***p***	β	***p***	β	***p***	β	***p***
TDEE (kcal/d)	0.171	0.149	0.037	0.185	0.005	na	na	0.178	0.012
MVPA (kcal/d)	0.196	0.300	<0.001	na	na	0.158	0.013	0.137	0.049
MVPA time (min/d)	0.089	0.225	0.001	na	na	0.162	0.016	na	na
Light PA time (min/d)†	—	—	—	—	—	—	—	—	—
Sedentary time (min/d)	0.080	−0.120	0.104	na	na	na	na	−0.150	0.044

Note: MVPA, moderate to vigorous physical activity; na, not applicable; PA, physical activity; TDEE, total daily energy expenditure.

*Values reflect standardized regression coefficients (β) and *p* value for final model after entering time spent (min/week) in endurance exercise, resistance exercise, sports, swimming, walking, and other PA, adjusting for ethnicity.

†No exercise types identified by best subset modelling.