



Obese but not lean adolescents spontaneously decrease energy intake after intensive exercise[☆]



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HIGHLIGHTS

- The energy intake response to exercise depends on the adolescents' weight status.
- Obese but not lean adolescents decrease energy intake after intensive exercise.
- Energy intake and appetite feelings are dissociated in both lean and obese youth.

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ABSTRACT

Background: Acute intensive exercise has been shown to induce a decreased subsequent daily energy intake in obese adolescents without altering the subjective appetite feelings. It is however unclear whether or not those nutritional adaptations to acute exercise are affected by the adolescents' weight status. The aim of this study was to compare the energy intake and macronutrient preferences, appetite feeling and energy expenditure response to acute exercise between lean and obese adolescents.

Methods: Ten obese and nine normal weight 12–15 year old adolescents randomly completed a session with a 30 minute cycling exercise at 75% $\dot{V}O_{2max}$ and a sedentary session. During both sessions energy expenditure was assessed using Armband, ad libitum energy intake measured by weighing at both lunch and dinner time and appetite feelings assessed using visual analog scales.

Results: Daily, morning and afternoon energy expenditure were significantly higher in obese than in normal weight adolescents ($p < 0.001$). Total energy expenditure was significantly higher during EX (1086 ± 157 kcal) compared to SED (853 ± 154 kcal) in lean ($p < 0.05$) but not significantly different in obese (respectively 1865 ± 222 and 1803 ± 232 kcal). Afternoon energy expenditure was significantly lower during EX compared to SED in obese ($p < 0.05$) but not in normal weight adolescents. Lunch, dinner and total daily energy intake were significantly reduced after the exercise session in obese ($p > 0.05$) but not in lean adolescents. No group or condition effects were observed on subjective appetite feelings.

Discussion: Post exercise spontaneous energy intake and energy expenditure are reduced in obese but not in normal weight adolescents, without appetite feeling changes. Acute exercise may have a greater impact on energy balance through the induced decreased energy intake in the absence of significant change in energy expenditure in obese youth.

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Abbreviations: EI, energy intake; EE, energy expenditure; EB, energy balance; SED, sedentary condition; EX, exercise condition; $\dot{V}O_{2max}$, maximal oxygen consumption; FM, fat mass; FFM, fat-free mass; BMI, body mass index; WC, waist circumference; VAS, visual analog scale; CHO, Carbohydrates.

[☆] Clinical Trial Protocol Registration System (ClinicalTrials.Gov: NCT01036360).

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1. Introduction

The control of energy balance is no longer considered as a simple and static combination between energy intake energy expenditure, which can respectively be affected by dietary strategies and physical activity interventions or recommendations. Energy intake and expenditure are rather considered as an interrelated complex whose regulation is affected by age, physical activity level, dietary intake or weight status. The impact of daily activities (physical and sedentary) on subsequent

energy intake has mainly been demonstrated in adults [1–6]. In children and youth, the limited literature available and the heterogeneity in methods to assess energy intake and expenditure render any conclusion uncertain [7,8]. Thus far, energy intake and appetite feeling in normal-weight adolescents have been observed unchanged after acute exercise performed at intensity corresponding to the ventilatory threshold or above, whatever the exercise-induced energy expenditure [9,10]. Tamam et al. asked 9–14 year old lean and obese adolescents to complete a 15 minute treadmill exercise set at the ventilatory threshold. They did not observe a modification in energy intake in both groups after exercise compared to the resting session [10]. Although these results contradict previously published data in obese adolescents [11,12], the use of a highly palatable buffet meal (pizza) makes interpretation difficult. The non-homeostatic and hedonic pathways involved in the regulation of energy intake may have overridden the physiological effect of exercise [13]. We previously conducted a number of studies using a standardized protocol that aim to determine whether acute exercise and its characteristics have any impact on subsequent energy intake and appetite in obese youth. First, a spontaneous decrease in energy intake was observed in obese adolescents after 30 min cycling exercise bout, whereas appetite feelings remained unchanged [11,12]. Importantly the uncoupling between appetite feelings and the anorexic impact of exercise in obese youth and was reported independent of gender [1,5,6,14]. Second, we noted that exercise intensity plays a major role in post exercise dietary behavior, with subsequent energy intake being decreased after a high intensity exercise (75% VO_{2max}) but not after an isoenergetic low intensity exercise (40% VO_{2max}) [12]. Altogether these results indicate a potential anorexigenic effect of high intensity exercise (>70% VO_{2max}) in obese adolescent boys and girls. Because the latter work only involved obese participants, the purpose of the present study was to question whether changes in dietary behavior in response to acute exercise are similar between lean and obese adolescents.

2. Methods

2.1. Population

Ten obese (6 girls and 4 boys) and nine normal weight (6 girls and 3 boys) adolescents (Tanner stages 3–4) aged 12–15 years old were respectively recruited through the Pediatric Obesity Department of the Children's Medical Center (Centre Médical Infantile) of Romagnat (France) and the general population. Obesity was defined according to the international reference curves for Body Mass Index for age and sex [15]. Participants and their legal guardians received information sheets and all provided written informed consent and approval to take part in the study. The study protocol was approved by the relevant Ethical Committee (Comité de Protection des Personnes Sud Est VI, CPPAU814) and registered with the Clinical Trial Protocol Registration System (ClinicalTrials.Gov: NCT01036360).

2.2. Design

Anthropometric characteristics and body composition were measured, and children performed a maximal incremental cycling test to assess maximal oxygen uptake (VO_{2max}) during a preliminary sessions. Each participant randomly completed two experimental sessions: a sedentary day (SED); and an exercise day (EX). The adolescents arrived at the laboratory at 0730 am in the fasted state and were immediately equipped with Armband to assess their energy expenditure. At 0800 am, a standardized breakfast was offered to the adolescents. Then, the adolescents either completed a 30 minute cycling exercise bout (EX) or remained sedentary (SED) until the end of the morning. During the two experimental sessions, adolescents were offered ad libitum lunch and dinner and subjective appetite feelings were assessed by questionnaires throughout the day. The experimental sessions were

separated by at least seven days, as previously done in normal weight and overweight adults [16,17] and obese youths [12,14,18] to avoid any interference between conditions.

2.3. Anthropometric characteristics and body composition

A digital scale was used to measure body weight to the nearest 0.1 kg, and barefoot standing height was assessed to the nearest 0.1 cm by using a wall-mounted stadiometer. Body Mass Index (BMI) was calculated as body weight (kg) divided by height squared (m^2). Waist circumference was measured at a level midway between the last rib and the upper iliac crest. Fat Mass (FM), percentage FM and Fat Free Mass (FFM) were assessed using bio-impedance (Analcor T2100, Eugedia Laboratory, Chambly, France) in lean participants and dual-energy X-ray absorptiometry (QDR4500A scanner, Hologic, Waltham, MA, USA) in the obese sample.

2.4. Maximal oxygen uptake test

VO_{2max} was measured during a graded exhaustive cycling test that was performed during a preliminary session at least one week prior to the experimental sessions. The initial power was set at 30 W for 3 min and followed by 15 W increments every 1.5 min. Adolescents were strongly encouraged by experimenters throughout the test to perform a maximum effort. Criteria for reaching VO_{2max} were subjective exhaustion with heart rate above 195 $beats \cdot min^{-1}$ and/or Respiratory Exchange Ratio (RER, VCO_2/VO_2) above 1.02 and/or a plateau of VO_2 [19]. An electromagnetically-braked cycle ergometer (Ergoline, Bitz, Germany) was used to perform the test. VO_2 and VCO_2 were measured breath-by-breath through a mask connected to O_2 and CO_2 analyzers (Oxycon Pro-Delta, Jaeger, Hoechberg, Germany). Calibration of gas analyzers was performed with commercial gases of known concentration. Ventilatory parameters were averaged every 30 s. ECG was monitored for the duration of the test.

2.5. Experimental conditions

2.5.1. Sedentary session (SED)

During the sedentary session, the adolescents were asked to remain quiet, not engaging in any moderate to intensive physical activities.

2.5.2. Exercise session (EX)

At 11:00 am participants were asked to complete a cycling exercise of 3 times 10 min at 75% VO_{2max} (with 1 min and 30 s of rest between exercise bouts). The intensity was controlled based on the number of revolutions per minute and the workload (in watts) calculated from the individual data obtained during graded exhaustive cycling test. The targeted heart rate was monitored using a heart rate monitor (Polar.Inc.-RS800CX Multi). The rest of the day was similar to the SED condition.

2.6. Energy expenditure

The SenseWear Armband was used to quantify daily energy expenditure. This recent device includes a biaxial accelerometer and also measures the heart rate, altogether allowing the estimation of energy expenditure. The captor was positioned on the right arm of the participants at their arrival to the laboratory and wore them during each experimental day.

2.7. Energy intake

At 0830 h, a standardized breakfast was offered (504 kcal). Ad libitum meal: Lunch and dinner were offered ad libitum to the participants. The composition of the buffet meal was the same for all the participants and conformed to the adolescents' tastes as determined

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