Effects of exercise intensity on food intake and appetite in women[1–3]

Marjorie Pomerleau, Pascal Imbeault, Torrey Parker, and Eric Doucet

ABSTRACT

Background: Increasing exercise intensity has been shown to reduce energy intake in men.

Objective: The main objective of this study was to investigate the effects of exercise intensity on energy intake in women.

Design: Thirteen moderately active (peak oxygen uptake: 44.0 ± 4.7 $\text{mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$) women [body mass index (in kg/m^2): 22.2 ± 2.4; age: 22.2 ± 2.0 y] were subjected to 3 experimental conditions: control with no exercise and 2 equicaloric (350 kcal) low- (LIE) and high- (HIE) intensity exercise sessions at 40% and 70% of peak oxygen uptake, respectively. After each session, the participants ate ad libitum from buffet-type meals at lunch and dinner and ate snacks during the afternoon and evening. Visual analogue scales were used to rate appetite.

Results: More energy was ingested at lunchtime after the HIE session than after the control session (878 ± 309 and 751 ± 230 kcal, respectively; $P = 0.02$). Relative energy intake (postexercise energy intake corrected for the energy cost of exercise above the resting level) at lunch was lower after the LIE session than after the control session (530 ± 233 and 751 ± 230 kcal, respectively; $P < 0.001$) and was lower after the HIE session than after the control session (565 ± 301 and 751 ± 230 kcal, respectively; $P < 0.01$). Similarly, daily energy intake tended to increase during the HIE session relative to that during the control session. No treatment effect was found for appetite scores throughout the experiment.

Conclusion: The results suggest that HIE increases energy intake in women. *Am J Clin Nutr* 2004;80:1230–6.

KEY WORDS Physical activity, energy intake, energy expenditure, appetite

INTRODUCTION

Physical activity is often considered a futile form of weight control because of the possible concomitant compensation of food intake. However, it should be noted that some studies have shown that exercise induces a brief suppression of appetite (hunger) (1–3), even if this does not necessarily translate into a decrease in subsequent food intake (1, 2). Evidence shows that only 19% of the intervention studies report an increase in energy intake after exercise, and 65% show no change (4). When the physical activity level decreases, food intake does not seem to be down-regulated in the same way (5–10). In fact, compensation is observed when the deficit is created by a meal omission (5), which is not seen when the deficit is induced by exercise (5–7, 9). These observations highlight the weak coupling between energy intake and expenditure (4, 11).

Postexercise energy intake might also be influenced by exercise intensity (12). In fact, high-intensity exercise has been shown to favor a negative energy balance to a greater extent than does low-intensity exercise (12, 13). Some studies report that intense exercise of long duration reduces relative energy intake (postexercise energy intake corrected for the energy cost of exercise above the resting level) (3, 6). Also, men fail to compensate for exercise-induced energy expenditure (EE) by increasing their energy intake at the meal after exercise, during the same day (12), or during the following day (5). Even when men performed high levels of exercise during 7 consecutive d, no compensation was seen (14). Similarly, women do not seem to acutely compensate in response to a bout of high-intensity exercise (13, 15–17) but tend to show a significant but partial compensation in energy intake of ≈30% of the energy expended during exercise over longer periods (7 d) (18).

Even though some studies have already shown that intense exercise seems to reduce food intake acutely, controversy remains. Most of the previous studies only included men, whereas the food intake pattern differs for women (15). Therefore, the present study was performed to investigate acute and short-term effects of exercise intensity on energy intake, macronutrient preferences, and appetite in women. We hypothesized that high-intensity exercise would exert a brief, acute suppression of appetite and energy intake and that exercise-induced EE would trigger a partial compensation over the day, which would be more apparent after low-intensity exercise.

SUBJECTS AND METHODS

Seventeen young women were recruited through advertisements on the University of Ottawa campus. Of these participants, 13 completed all 3 experimental sessions, the results of which are presented in this study. All participants took part in a screening session to ensure that they met the following inclusion criteria: age between 18 and 30 y, not pregnant, free of any diseases or food allergies, weight stable for ≥6 mo before their enrollment in the study (±2 kg), or not following a special diet or taking any medications that could influence food intake. All women were

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[1] From the School of Human Kinetics, University of Ottawa.

[2] Supported by University of Ottawa Research grants.

[3] Reprints not available. Address correspondence to E Doucet, School of Human Kinetics, University of Ottawa, Ottawa, Ontario, Canada K1N 6N5. E-mail: edoucet@uottawa.ca.

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TABLE 1
Descriptive characteristics of subjects at baseline[1]

Variable	Value
Age (y)	22.2 ± 2.0 (19.0–26.0)
Body weight (kg)	64.5 ± 7.1 (49.3–76.3)
Height (m)	1.7 ± 0.07 (1.59–1.82)
BMI (kg/m^2)	22.2 ± 2.4 (19.5–27.2)
$\dot{V}O_2$ peak (mL · kg^{-1} · min^{-1})	44.0 ± 4.7 (35.0–52.7)
Body fat (%)	25.3 ± 5.7 (14.4–34.7)
Restraint	7.8 ± 3.9 (1–15)
Hunger	6.2 ± 3.3 (2–13)
Disinhibition	5.6 ± 4.2 (0–14)

[1] All values are $\bar{x}$ ± SD; range in parentheses. $\dot{V}O_2$ peak, peak oxygen uptake.

moderately active (30–45 min of continuous exercise performed 3–5 times/wk). The characteristics of the subjects at baseline are shown in **Table 1**. This study was approved by the University of Ottawa Ethics committee, and informed consent was obtained from all participants.

Baseline assessments

Anthropometric measurements

Body weight was determined with a standard beam scale, whereas height and waist circumference were measured with a tape. Body fat was determined at baseline by bioelectrical impedance with the use of the TBF-300A Body Composition Analyzer/Scale (Tanita, Arlington Heights, IL).

Attitude in relation to food

The Three-Factor Eating Questionnaire (TFEQ) (19) was administered at baseline. The TFEQ is a 51-item questionnaire that includes 3 scales that assess cognitive restraint, disinhibition, and hunger.

Maximal aerobic capacity

An aerobic capacity test to measure maximum oxygen consumption ($\dot{V}O_2$ max) (20) was performed to precisely determine the exercise intensities during the experimental conditions. The test consisted of 3-min stages (walking that led to running) on a treadmill with an increasing workload to the point of exhaustion. Heart rate was recorded continuously during the test, and blood pressure was monitored at the end of every stage of the test. The Borg scale (21) was used to monitor perceived exertion throughout the measurement. Expired gases were collected continuously during the test. Oxygen and carbon dioxide concentrations in expired gases were determined by using the MOXUS system, which was equipped with electrochemical gas analyzers (AMETEK model S-3A/1 and CD 3A; Applied Electrochemistry, Pittsburgh). We used specific criteria to determine whether participants had achieved $\dot{V}O_2$max: *1*) predicted maximal heart rate reached, *2*) respiratory quotient > 1.1, *3*) oxygen consumption remained stable or decreased with an increase in workload; and *4*) the Borg scale reached 19 or 20. The subjects had to meet ≥2 of the above criteria. Because a plateau of $\dot{V}O_2$ was not achieved in most subjects, $\dot{V}O_2$ peak will be used henceforth.

TABLE 2
Energy expenditure and duration of the low- and high-intensity exercise sessions[1]

Variable	Low-intensity exercise	High-intensity exercise
Energy expenditure (kcal)	351 ± 11	349 ± 10
Duration (min)	64.7 ± 7.9	37.0 ± 4.6[2]
Intensity (%$\dot{V}O_2$peak)	40.9 ± 1.4	69.4 ± 2.8[2]

[1] All values are $\bar{x}$ ± SD. $\dot{V}O_2$ peak, peak oxygen uptake.

[2] Significantly different from low-intensity exercise, $P < 0.001$ (one-factor repeated-measures ANOVA).

Experimental protocol

This was a crossover study in which subjects were randomly assigned to 1 of 3 experimental conditions: *1*) control, in which the subjects remained seated and were allowed to read or write quietly in the laboratory for a 1 h and 15 min; *2*) low-intensity exercise (LIE), in which the subjects walked on a treadmill at a target exercise intensity of 40% of $\dot{V}O_2$ peak; and *3*) high-intensity exercise (HIE), in which the subjects walked on a treadmill at a target exercise intensity of 70% of $\dot{V}O_2$ peak. For the LIE and HIE conditions, the subjects exercised for a duration that allowed an EE of ≈350 kcal. A $\dot{V}O_2$ value corresponding to these exercise intensities was determined on the basis of values obtained during the $\dot{V}O_2$max test performed at baseline. Parameters of the exercise sessions are presented in **Table 2**. Women were always tested on days 1–8 of the follicular phase of the menstrual cycle, ie, when estrogen and progesterone are at their lowest concentrations. Approximately 1 mo separated each experimental session. The diet was standardized for 3 d before each experimental session. The recommendations consisted of a consistent energy intake (≈1800 kcal) and macronutrient proportion (55% of carbohydrate, 30% of lipid, and 15% of protein). A nutritionist explained to each subject the Good Health Eating Guide (food exchange system) so that they would respect the dietary recommendations. Participants were asked to refrain from any vigorous exercise 48 h before the experimental sessions and were asked to abstain from consuming alcohol on the day before all experiments. The subjects were also told to keep their physical activities as constant as possible during the experimental days as well as during the entire course of the study. Specifically, the participants were asked to refrain from structured exercise but were allowed to continue their habitual physical activities (eg, walking to and from school and climbing stairs) on the experimental days.

A diagram detailing the experimental sessions is shown in **Figure 1**. After fasting overnight, the participants came to the laboratory at 0800. They were then weighed, and their dietary logs were reviewed to verify compliance with the preexperimental recommendations. After a 10-min resting period, a 20-min resting metabolic rate measurement was made. A standard breakfast was served at 0830. The energy content and the food quotient were 570.6 kcal and 0.89, respectively. Details are provided in **Appendix A**. At ≈1000, the participants performed exercise on a treadmill for the LIE or HIE sessions or rested for the control session. Expired air was sampled for 5 min at 15-min intervals. $\dot{V}O_2$ and maximum carbon dioxide consumption ($\dot{V}CO_2$) were measured to calculate EE with the Weir formula (22). The workload was adjusted to ensure that participants were exercising at the required intensities (40% and 70% of $\dot{V}O_2$ peak for the LIE

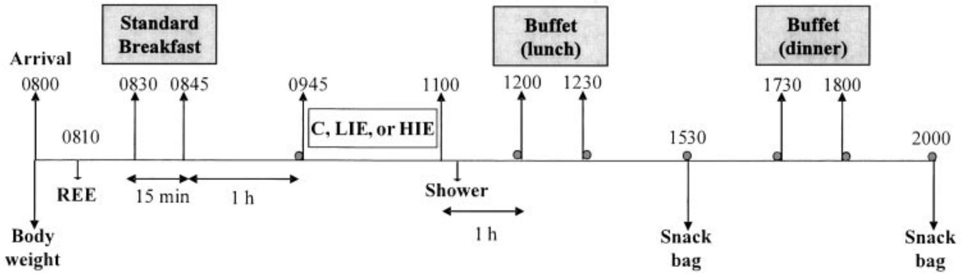

FIGURE 1. Experimental design. ●, time of administration of the visual analogue scales. C, control session; LIE, low-intensity exercise; HIE, high-intensity exercise.

and HIE sessions, respectively). Heart rate was recorded continuously during the exercise session.

After all experimental conditions, the participants took a shower (with the same water temperature across conditions) at our facilities. A buffet-type meal was then served at 1200 [modified version of the one used by Arvaniti et al (23)] (**Appendix B**). It is important to note that 1 h was allotted between the end of exercise and lunch for both exercise sessions and for the control session as well. This was done by estimating the duration of both exercise sessions from the $\dot{V}O_2$ and $\dot{V}CO_2$ values obtained during the $\dot{V}O_2$max measurement. The LIE session was thus started ≈30 min earlier than the HIE session (at ≈0945 compared with 1015). After lunch, the participants were free to leave for the afternoon with a bag containing snacks composed of a variety of foods (**Appendix C**). The participants were instructed to return at 1730 for a dinner buffet-type meal, after which time they left with a second bag of snacks for the evening. After the consumption of the meals and snacks, any remaining food was weighed to the nearest 0.1g, and this amount was subtracted from the premeal values to obtain the total amount of food ingested. Energy and macronutrient contents were assessed by using Canadian Nutrient File software (24). From the energy intake at lunch and the daily energy intake, 2 other variables were calculated: relative energy intake (REI) and compensation of exercise-induced EE. REI corresponds to the postexercise energy intake corrected for the energy cost of exercise above the resting level. REI was calculated as follows:

$$\text{REI} = \text{EI} - [350 - (\text{exercise time} \times \text{REE})] \qquad (1)$$

where EI is the ad libitum energy intake (food consumed either for lunch or for the entire day), 350 is the total energy cost of the exercise session, and REE refers to the resting EE (kcal/min) measured before each session. Compensation of the exercise-induced EE was calculated as follows:

$$\begin{aligned} \text{Compensation} = \{[&\text{energy intake (HIE or LIE session)} \\ &- \text{energy intake control session}]/\text{exercise cost of exercise} \\ &\text{(HIE or LIE session) above resting EE}\} \times 100 \qquad (2) \end{aligned}$$

Adapted versions of visual analogue scales (25) were administered throughout the day, ie, immediately before exercise (time 0), before (1200) and after (1230) lunch, between lunch and dinner (1530), before (1730) and after (1800) dinner, and during the evening (2000). After all experimental sessions, the subjects were required to fill out a 3-d dietary record (26). A nutritionist explained to each subject how to complete the record, and it was reviewed on collection.

Statistical analyses

SPSS Software 11.5 (SPSS Inc, Chicago) was used for all analyses. A one-factor repeated-measures ANOVA (control, LIE, and HIE) was used to assess the effects of exercise intensity on food intake and macronutrient intake. A repeated-measures ANOVA with 2 within-subject factors [effects of intervention (control, LIE, HIE) and effects of time] was used for appetite scores. Paired *t* tests were used for post hoc comparisons with a Bonferroni adjustment of the α level for multiple comparisons (3 comparisons). Spearman's ρ rank-order correlations were performed between TFEQ scores (restraint and disinhibition) and energy intake (lunch and daily energy intake) for all experimental conditions. For the post hoc comparisons, differences were considered significant at $P \leq 0.02$. All other effects were considered significant at $P \leq 0.05$. Data are presented as means ± SDs. All variables were normally distributed.

RESULTS

Experimental conditions

Although ≥1 mo had elapsed between each experimental session, body weight remained stable across conditions (control: 64.4 ± 6.6 kg; LIE: 64.9 ± 7.3 kg; HIE: 64.9 ± 7.6 kg; NS). As shown in Table 2, exercise modalities were carefully respected, considering that exercise protocols were designed to induce an EE of 350 kcal at intensities of 40% of $\dot{V}O_2$ peak for LIE and 70% of $\dot{V}O_2$ peak for HIE. EE during the LIE and HIE sessions was essentially the same (350.6 ± 11.1 and 348.6 ± 10.3 kcal, respectively; NS). As expected, the LIE session was longer than the HIE session (64.7 ± 7.9 and 37.0 ± 4.6 min; $P < 0.001$). The mean intensities of the LIE and HIE sessions were 40.9 ± 1.4% and 69.4 ± 2.8% of $\dot{V}O_2$ peak, respectively ($P < 0.001$).

Energy intake

A significant effect of the intervention was noted for energy intake at lunch ($P < 0.05$; **Figure 2**). Post hoc analysis showed that energy intake was significantly greater at lunchtime after the HIE session than after the control session (878 ± 309 and 751 ± 230 kcal, respectively; Δ127 ± 174 kcal). Food intake after the LIE session was not significantly different from that after the control session (819 ± 236 and 751 ± 230 kcal, respectively; Δ68 ± 154 kcal). No significant differences in food intake were

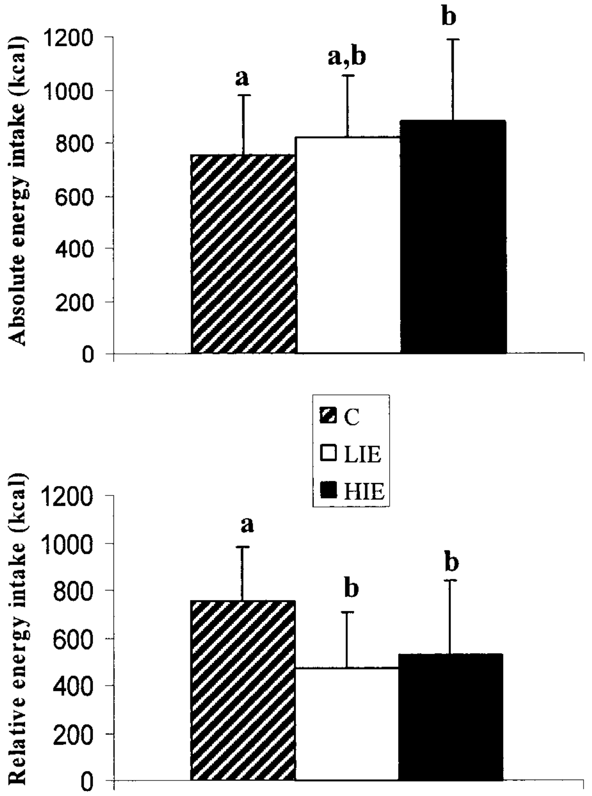

FIGURE 2. Mean (±SD) absolute and relative energy intakes at lunchtime after the control session (C) and the low-intensity (LIE) and high-intensity (HIE) exercise sessions. $n = 13$. The main effects of the model were assessed with repeated-measures ANOVA ($P \leq 0.05$). Post hoc testing was followed by paired t tests (Bonferonni corrections were applied for multiple comparisons). Means with different letters are significantly different, $P \leq 0.02$. Relative energy intake = energy intake − [350 − (exercise time × resting energy expenditure)].

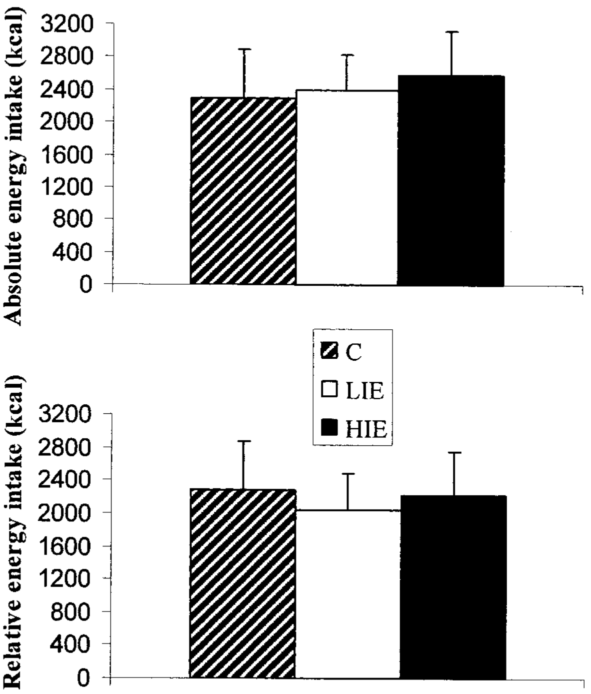

FIGURE 3. Mean (±SD) absolute and daily relative energy intakes after the control session (C) and the low-intensity (LIE) and high-intensity (HIE) exercise sessions. $n = 13$. The main effects of the model were assessed with repeated-measures ANOVA ($P \leq 0.05$). Post hoc testing was followed by paired t tests (Bonferonni corrections were applied for multiple comparisons). No significant differences between conditions were noted. Relative energy intake = energy intake − [350 − (exercise time × resting energy expenditure)].

noted at dinner (control: 660 ± 199 kcal; LIE: 671 ± 283 kcal; HIE: 649 ± 339 kcal). Although more energy from snacks tended to be ingested during the HIE session than during the control session, this difference was not significant (1044 ± 431 and 870 ± 443 kcal, respectively; Δ174 ± 482 kcal). Daily energy intake also tended to be higher during the HIE day than during the control day (2580 ± 529 and 2285 ± 596 kcal, respectively; Δ295 ± 490 kcal; NS), whereas daily energy intake on the LIE day was not significantly different from that observed on the control day (2397 ± 432 and 2285 ± 596 kcal, respectively; Δ112 ± 334 kcal; **Figure 3**). Of note is the fact that no significant difference were noted for water consumption across all 3 conditions (control: 2442 ± 890 mL; LIE: 2695 ± 1050 mL; HIE: 2531 ± 553 mL). Finally, energy intake derived from the dietary records for the 3 d after each experimental session was not significantly different across conditions (control: 2210 ± 266 kcal; LIE: 2138 ± 500 kcal; HIE: 2194 ± 428 kcal).

Relative energy intake

To further investigate the effects of exercise on energy intake, we calculated the REI. A significant effect of the intervention was observed for REI at lunch ($P < 0.001$). Post hoc analyses showed a significantly lower REI at lunch during the HIE session than during the control session (565 ± 307 and 751 ± 230 kcal, respectively; Δ−186 ± 175 kcal). Similarly, REI at lunch during the LIE session was significantly lower than that during the control session (530 ± 233 and 751 ± 230 kcal, respectively; Δ−220 ± 159 kcal; Figure 2). No difference in the REI at lunch was observed between LIE and HIE sessions. As shown in Figure 3, no significant differences were observed for daily REI across conditions (2266 ± 528, 2108 ± 435, and 2285 ± 596 kcal for the HIE, LIE, and control sessions, respectively).

Macronutrient preferences

A significant effect of the intervention was observed for both lipid ($P < 0.05$) and protein ($P < 0.05$) intakes at lunch. Follow-up of this main effect (post hoc) showed that participants ate significantly more lipids during the HIE than during the control session (30.7 ± 13.1 and 24.0 ± 10.8 g, respectively). A trend was also noted for the comparison of the LIE with the control session (28.5 ± 12.4 and 24.0 ± 10.8 g, respectively; NS). As for lipids, a higher protein consumption was observed at lunch during the HIE than during the control session (41.8 ± 11.1 and 34.2 ± 9.7 g, respectively). A trend was also seen for the comparison of the LIE with the control session (38.7 ± 10.3 and 34.2 ± 9.2 g, respectively; NS). There was a significant effect of the intervention for daily absolute carbohydrate intake ($P < 0.05$), and a post hoc analysis showed that carbohydrate consumption was significantly higher after the HIE than after the control session (318.6 ± 87.0 and 274.9 ± 80.5 g, respectively), whereas lipid and protein intakes were not significantly different across conditions (**Table 3**).

TABLE 3
Daily macronutrient intake[1]

	Control	Low-intensity exercise	High-intensity exercise
Carbohydrate (g)	274.9 ± 80.5[a]	288.5 ± 78.8[a]	318.6 ± 87.0[b]
Lipid (g)	94.1 ± 25.5	97.9 ± 17.0	102.3 ± 25.4
Protein (g)	84.5 ± 23.3	90.5 ± 22.0	96.2 ± 18.7

[1] All values are $\bar{x}$ ± SD. The main effects of the model were assessed with repeated-measures ANOVA ($P < 0.05$). Post hoc testing was followed by paired *t* tests (Bonferonni corrections were applied for multiple comparisons.) Means in a row with different superscript letters are significantly different ($P \leq 0.05$).

Appetite

Daily visual analogue scale measurements are presented in **Figure 4**. As expected, we observed a significant effect of time during the day across conditions ($P < 0.01$). However, no effect of the intervention was noted.

Attitude in relation to food

According to the cutoff criteria proposed by Stunkard and Messick (19), 5 of the 13 women in this study were found to show restraint (TFEQ score > 10). No significant differences in energy intake were observed between the restraint and nonrestraint groups across conditions (data not shown). Furthermore, no significant associations were observed between restraint or disinhibition with energy intake (lunch and daily energy intake) under all conditions (data not shown).

DISCUSSION

Recent studies reported that HIE induces a greater acute negative energy balance by exerting a suppression of energy intake (4, 5, 7, 9, 12, 15–17, 27). The present study was performed to investigate acute and short-term effects of exercise intensity on energy intake, macronutrient preferences, and appetite in women. The main hypothesis of this study was that HIE would exert brief appetite suppression as reflected by a decrease in energy intake acutely. We also hypothesized that this effect would be short-lived because a partial compensation of energy intake would be noted over the day, an effect that would be more apparent after the LIE session. Experimental conditions were rigorously respected as reflected by the subjects' adherence to the preexperimental diet, by a stable body weight across conditions, and by the achievement of targeted exercise EE and intensities. The findings of this study were 2-fold. First, energy intake at lunch after the HIE session was greater than that observed during the control session. Second, exercise-induced EE was almost entirely compensated by the subsequent energy intake during the HIE day.

Over the past decade, importance has been given to the intensity component of exercise as a way to facilitate the regulation of energy balance (4, 5, 7, 9, 12, 15–17, 27). Indeed, increasing exercise intensity enhances its energy cost, promotes greater postexercise EE and fat oxidation (28, 29), increases the potential of skeletal muscle to utilize lipids (30), and favors a decrease in energy intake (30). Among others, Tremblay et al (31) and Imbeault et al (12) reported that for a given EE, HIE could contribute to a more important negative energy balance and fat loss. In contrast, our results showed that acute energy intake (lunch) after intense exercise was significantly greater than after the control session, an effect that was not observed with the LIE session. This prompted us to calculate the REI, which is a better proxy of energy balance under such conditions. REI at lunchtime after both the LIE and HIE sessions was significantly lower than after the control session, which brings into light the potential of exercise to induce a negative energy balance acutely in women, with LIE being seemingly better at this. Interestingly, most of the studies conducted in men observed a greater acute negative energy balance after HIE (7, 9, 12, 27). Other researchers (15–17) also observed the absence of compensation at the meal after an HIE bout in women. According to the literature, it would seem that both women and men do not seem to compensate for the exercise-induced EE acutely. In contrast, we observed a

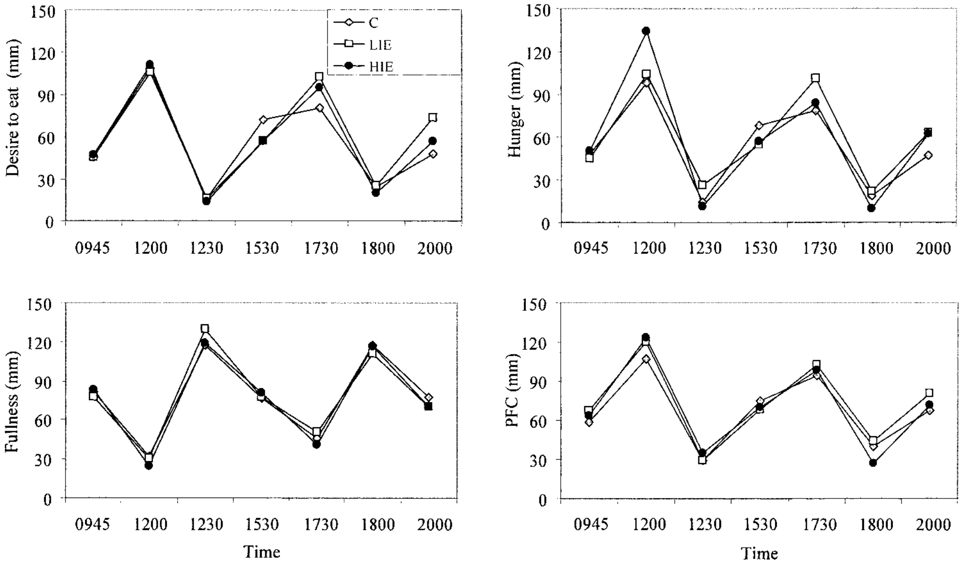

FIGURE 4. Mean (±SD) appetite scores for the desire to eat, hunger, fullness, and prospective food consumption (PFC) derived with the use of visual analogue scales throughout the day for the control session (C) and the low-intensity (LIE) and high-intensity (HIE) exercise sessions. $n = 13$. The effects were assessed with repeated-measures ANOVA. There was a significant effect of time across conditions but no significant effect of intervention.

partial compensation of 25% and 41% shortly after the LIE and HIE sessions, respectively.

Even though several studies conducted in women used methods similar to ours, some of them used only 2 conditions (one control and one exercise session) (15–17) and used different types (15, 16) and intensities (17) of exercise. Some studies focused on exercise duration (15–17) instead of energy costs and did not perform actual EE measurements during exercise, which led to an estimation of the caloric cost of exercise (17). Moreover, the allotted time between the end of the exercise sessions and food intakes varied between 15 (15, 17) and 30 (17) min compared with 1 h in the current study. These factors complicate the comparison of our results with those of the aforementioned studies.

Five decades ago, Edholm et al (32) found a correlation between EE and energy intake 2 d after exercise. This observation raises the possibility of the existence of a delay in the compensatory augmentation of energy intake in response to exercise. To investigate the effect of an exercise session over a longer term, we assessed energy intake throughout the whole day as well as over 3 d after the experimental sessions. A trend toward greater daily energy intake was noted after the HIE session than after the control session. In addition, we observed that daily REI after LIE tended to be lower than after the control session, whereas REI after the HIE session was not significantly different from that after the control session. The energy deficit observed acutely was no longer apparent at the end of the day with the HIE condition. Indeed, a more important compensation of exercise EE occurred after the HIE day (91%) than after the LIE day (40%), even if this difference was not significant. Conversely, it was found previously that high levels of exercise did not increase EI in men, neither on the day of the exercise or on the day after (5). Stubbs et al (14, 18) investigated the short-term effects of high levels of exercise on EI over 7 d. Men maintained a significant negative energy balance over this period of time without showing any compensation. Women showed a slight compensation (30%) under similar conditions (18). The mean 7-d compensation observed in women by Stubbs et al (18) after high levels of exercise (30%) was still lower than what we observed with both of our exercise protocols over 1 d (40% for LIE and 91% for HIE). However, Woo and Pi-Sunyer (33) also found that nonobese women had hyperphagic responses after a 19-d treatment of either mild or moderate nonconstant caloric exercise periods performed at a constant intensity. As stated previously, study differences could be explained by such factors as the length of time over which energy intake was measured (7 d or 19 d compared with 1 d), varying exercise intensities, and the nonconstant caloric cost of exercise. In addition, despite the fact that participants in the study by Stubbs et al (18) showed characteristics similar to ours, we note that exercise was performed by using an ergocycle and that meals were taken at home and reported in food diaries as opposed to the laboratory setting used in the current study. These dissimilarities may also have contributed to the different results between these studies.

Some sex differences seem to pertain to the ability to tolerate a considerable negative energy balance. Exercise does not suppress hunger the same way for women as for men, and in women it increases the sensory attractiveness of food (15). These observations might explain the differences in energy intake between the sexes in response to exercise. As stated by King et al (15), this might contribute to the observation that exercise often fails to induce weight loss in women. If we assume that EI during the control condition was representative of usual EI and because these women maintained their weight, we can present that the LIE session induced a negative energy balance of ≈177 kcal. As such, it could be postulated that LIE could be better at favoring negative energy balance in young women and that HIE could be an exercise modality better suited for men.

In summary, the results from this study show that increasing exercise intensity in young women leads to an increase in energy intake during the meal that follows the exercise session. Also, the increase in energy intake on the day of the HIE bout is sufficient to almost completely compensate for the exercise-induced EE.

MP and ED were involved in the conception of the study. MP, ED, and TP conducted the experiment. MP, ED, and PI analyzed and interpreted the data and wrote the paper. None of the authors of this work had any financial interests linked to this paper.

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APPENDIX A

Composition of the breakfast test meal

Food	Weight	Protein	Carbohydrate	Fat	Energy
	g	*g*	*g*	*g*	*kcal*
Whole-wheat bread	80	7.4	32	2.6	192
Smooth peanut butter	20	4.4	4.1	10.7	122.9
Strawberry jam	20	0	17.3	0	66.7
Mozzarella cheese, 27% milk fat	20	5.2	0.2	5.53	72
Orange juice	250[1]	1.8	28	0.2	117
Total	—	—	—	—	570.6

[1] Value is in mL.

APPENDIX B

Energy content and macronutrient composition of the food items served in the buffet-type meal[1]

Food item	Weight	Fat	Protein	Carbohydrate	Energy
	g	*g*	*g*	*g*	*kcal*
Sliced turkey	130	1.0	39.0	0.0	176
Liver pâté	70	19.6	10.0	1.0	223
Mozzarella cheese	100	24.6	22.0	2.5	318
Cottage cheese	100	1.9	14.0	3.6	90
Butter	40	32.4	0.0	0.0	287
Mayonnaise	60	29.3	0.0	7.7	297
Italian dressing	60	41.4	0.0	3.1	374
Ranch dressing	60	21.1	1.0	10.4	239
Mustard	30	1.3	1.0	1.9	23
Ketchup	40	0.1	1.0	10.9	42
Kaiser white bread	75	2.7	6.0	37.1	200
Kaiser wheat bread	75	3.1	7.0	34.6	185
Soda crackers	75	8.9	7.0	53.6	326
Lettuce	60	0.1	1.0	1.4	10
Tomato	100	0.3	1.0	4.6	21
Carrot	150	0.3	2.0	15.2	65
Orange	100	0.2	1.0	11.5	46
Apple	100	0.4	0.0	15.3	59
Chocolate-chip cookies	100	15.4	6.0	73.3	453
Yogurt	400	6.2	16.0	70.4	404
Skim milk[2]	1000	1.8	34.0	48.5	349
Milk, 2% fat[2]	1000	19.2	33.0	48.0	497
Orange juice[2]	1000	1.4	6.0	98.5	420
Cola[2]	355	0.0	0.0	36.9	146
Lemon soft drink[2]	355	0.0	0.0	36.9	142
Potato chips, regular	60	21.3	4.0	29.1	323
Water	1000	0.0	0.0	0.0	0

[1] Adapted from the following reference: Arvaniti K, Richard D, Tremblay A. Reproducibility of energy and macronutrient intake and related substrate oxidation rates in a buffet-type meal. Br J Nutr 2000;83:489–95.

[2] Values are in mL.

APPENDIX C

Composition of the snacks

Food	Weight	Protein	Carbohydrate	Fat	Energy
	g	*g*	*g*	*g*	*kcal*
Crackers	15	1.0	10.7	1.8	65
Chocolate-chip cookies	60	3.0	44.0	9.2	272
Apple	80	0.0	12.2	0.3	47
Orange	120	1.0	13.8	0.3	55
Peanuts	75	18.0	16.1	37.2	439
Orange juice	250[1]	1.8	28	0.2	117
Cola	355[1]	0.0	36.9	0.0	146
Water	2000[1]	0.0	0.0	0.0	0
Total	—	—	—	—	1134

[1] Values are in mL.