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Consistency in Compensatory Eating Responses Following Acute Exercise in Inactive, Overweight and Obese Women

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Abstract

It is often assumed that some individuals reliably increase energy intake (EI) post-exercise ('compensators') and some do not ('non-compensators'), leading researchers to examine characteristics which distinguish these two groups. However, it is unclear whether EI post-exercise is stable over time. This study examined whether compensatory eating responses to a single exercise bout are consistent within individuals across 3 pairs of trials. Twenty-eight physically inactive, overweight/obese women (BMI: 30.3±2.9kg/m^2) participated in 3 pairs of testing sessions, with each pair consisting of an exercise (30 min of moderate-intensity walking) and resting testing day. EI was measured using a buffet meal 1 hour post-exercise/rest. For each pair, the difference in EI ($EI_{diff}=EI_{ex}-EI_{rest}$) was calculated and women were classified as a 'compensator' ($EI_{ex}>EI_{rest}$) or 'non-compensator' ($EI_{ex} \leq EI_{rest}$). The average EI on exercise days (3328.0±1686.2 kJ) was similar to rest days (3269.4±1582.4 kJ; p=0.67). While EI was reliable within individuals across the 3 rest (ICC = 0.75; 95% CI: 0.60–0.87; p<0.001) and 3 exercise days (ICC=0.83; CI: 0.70–0.91; p<0.001), the ICC for EI_{diff} across the 3 pairs of trials was low (ICC=0.20; CI: −0.02–0.45; p=0.04), suggesting that compensatory eating post-exercise is not a stable construct. Moreover, the classification of 'compensators'/'non-compensators' was not reliable (K= −0.048; p=0.66). Results were unaltered when 'relative' EI was used, which considers the energy expenditure of the exercise/rest sessions. Acute compensatory EI following an exercise bout is not reliable in overweight women. Seeking to understand what distinguishes 'compensators' from 'non-compensators' based upon a single eating episode post-exercise is not justified.

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Conflict of Interest
None

Authorship
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Keywords

Exercise; physical activity; energy expenditure; compensation; obesity

INTRODUCTION

Previous studies have demonstrated that the variability in weight loss produced by exercise training programs is large, such that some individuals lose weight while others maintain or even gain weight following months of supervised exercise[1; 2; 3; 4]. This heterogeneity in weight loss suggests that some individuals may be compensating or increasing energy intake (EI) in response to exercise. Engagement in compensatory eating behaviors in response to exercise could undermine the beneficial effect of exercise on energy balance, and possible lead to weight gain over time. A greater understanding of why compensation occurs could have important clinical implications for weight control.

One approach to understanding compensatory eating post-exercise is to examine it acutely, within a laboratory setting. Similar to exercise training trials, findings from acute laboratory-based studies reveal a large degree of variability in compensatory eating post-exercise with approximately half of participants increasing EI ('compensators') and the other half not altering or decreasing EI post-exercise ('non-compensators'), when compared to a resting, control condition[5; 6; 7]. This has led researchers to begin to try to distinguish 'compensators' from 'non-compensators', examining whether these two groups differ in their physiological or affective responses to exercise [7; 8; 9; 10].

However, a significant concern with this research is that we have yet to establish whether the acute compensatory response to exercise is consistent over time. That is, before we begin to examine behavioral and physiological characteristics of compensators and non-compensators using a laboratory paradigm, we must first determine whether the difference between an individual's EI post-exercise, versus EI post-rest, is similar across occasions. If compensatory eating is not reliable, it would suggest that trying to identify variables that distinguish compensators from non-compensators based upon this laboratory paradigm may not be appropriate.

Prior studies have examined the consistency in EI in a resting condition following the administration of a dietary preload. These studies reveal that EI is highly reliable when measured on multiple resting occasions in healthy males (Intra class correlations (ICCs) ranging from 0.89–0.97)[11; 12] and overweight/obese males (correlation coefficient = 0.76 or 0.90 when an outlier was excluded) [13], indicating that in controlled settings there is little fluctuation in EI on a daily basis in these populations. Moreover, Laan and colleagues[14] reported that EI 35 minutes post-exercise is highly reproducible (ICC=0.90) when measured on two separate days among physically active men and women with a BMI between 18 and 29 kg/m^2. However, with the exception of one smaller study by Brown et al. (n=14)[15], the consistency in 'compensation' (e.g., EI measured on the exercise day minus EI measured on the resting day), has not been examined. Further, the majority of studies which examine the effect of exercise on appetite control have utilized trained, normal weight males. However, research suggests that trained individuals may be better able to regulate their energy needs, compared to those who are untrained, possibly due to deficient homeostatic feedback control of hunger and satiety in sedentary individuals [16; 17; 18; 19]. In addition, women and overweight individuals may be more likely to compensate in response to exercise compared to men and those who are normal weight[20; 21]. For example, there may be differences in appetite, cognitive factors, motivation to eat, eating behavior characteristics such as dietary restraint or disinhibition, and gut peptides (e.g., ghrelin) between overweight/obese and normal weight individuals [18; 19; 22; 23].While it still remains unclear how training status, gender, or BMI influence EI following exercise, it is plausible to hypothesize that energy compensation in response to exercise is most likely to occur in untrained, overweight/obese women.

The purpose of this study was to examine whether the difference in EI following a period of exercise and a period of rest is reliable across 3 separate pairs of exercise/resting trials in physically inactive, overweight/obese women. A secondary aim was to determine whether classification of an individual as a 'compensator' versus 'non-compensator' is consistent over time. We specifically focused our investigation on women, given their large variability in EI post-exercise [5; 6]. We also utilized a physically inactive sample, given that the majority of overweight/obese individuals do not exercise regularly. Further, exercise is a recommended weight loss strategy for overweight/obese individuals and thus this research question may be the most clinically relevant in this population.

METHODS

Subjects

Subjects were overweight and obese women (BMI: 25 to <35 kg/m^2) between the ages of 18 and 45. All reported being physically inactive (<60 min/wk of moderate-intensity exercise), weight stable (± 10 lbs over past 6 months), relatively healthy (e.g., free of heart disease and diabetes, not taking any medications that would alter heart rate (HR) or metabolism, and no reported orthopedic conditions that would impact exercise), and sleeping an average of >6 hours/night. Subjects ate breakfast regularly and reported liking and being willing to eat at least 75% of the foods that were provided as part of the buffet meal, which was used to measure EI during the experimental testing sessions. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by The Miriam Hospital's Institutional Review Board. Written informed consent was obtained from all subjects/patients.

Study Protocol

After undergoing an initial assessment visit, in which subjects underwent initial anthropometric testing and were oriented to study procedures, subjects participated in 3 pairs of testing visits, with each pair consisting of an exercise and resting testing day (6 visits total), using a randomized, counter-balanced design. Thus, the order of the testing visits differed for each participant; however all participants had two pairs of testing visits in which the order was identical and one pair in which the order was reversed (e.g., Pair 1: exercise first, Pair 2: exercise first, Pair 3: rest first). Visits within a pair were separated by 48–96 hours, while pairs of testing sessions were separated by at least 7 days (see Figure 1). All testing visits lasted approximately 3 hours, were performed at the same time of day (±30 min), and were conducted in the morning (starting between 07:30–09:30). Both exercise and resting testing days were identical, with the exception of a 30-minute, moderate-intensity treadmill bout on the exercise day and 30-minute period of seated rest, on the resting day. Prior to each testing session, participants were instructed to: 1) not consume any food or caloric beverages past midnight, 2) refrain from exercising 24 hours prior to their visit, 3) abstain from any caffeine or alcohol use 12 hours prior to their visit, and 4) maintain regular sleeping habits. Research staff queried participants at the beginning of each testing visit to confirm compliance. Participants were asked to report the last time that they ate, exercised, or had caffeine or alcohol and how many hours of sleep they had the previous night. If participants were non-compliant to the pre-testing recommendations, their testing visit was rescheduled. Following the completion of all 6 testing visits, participants completed the Three-Factor Eating Questionnaire[24] which was used to assess dietary restraint and disinhibition.

Assessment visit

Height and weight were measured using standard procedures and body composition was assessed using bioelectrical impedance (RJL Systems, Clinton Township, MI). Subjects completed a submaximal graded exercise test (GXT) to 75% of age-predicted maximal HR. This GXT allowed participants to become familiar with walking on a treadmill, provided a surrogate measure of fitness, and assisted in determining the starting treadmill grade for the initial exercise testing session (see below).

Experimental testing session

Figure 2 provides an overview of the experimental testing sessions. Upon arrival, participants were informed of whether it would be an exercise or rest day, as not to bias them prior to the testing visit. Body weight was measured to ensure that weight did not change over time and participants consumed a standardized meal replacement bar [878.6 kJ (210 kcals), 47% CHO, 26% fat, 27% protein]. Participants then completed several computer tasks and questionnaires, used to blind participants to the true purpose of the study (i.e., the measurement of EI). Forty-five minutes after arrival, participants either rested quietly or exercised for 30 minutes while watching a standardized video (from the British Broadcasting Corporation’s Planet Earth video series). Immediately following this exercise or rest period, participants again completed the same series of questionnaires and computer tasks. Following these tasks, participants sat quietly by themselves and were given the option to read or to continue watching the video until the start of the feeding session. One hour following the cessation of the exercise or seated rest, participants were provided ad-libitum access to a buffet meal (see additional detail below). The questionnaires and computer tasks were repeated following the feeding period.

Exercise session

During the first exercise visit, subjects walked on a treadmill (Spirit XT685, Jonesboro, AR) at 3.0 mph at a grade that elicited a HR between 70–75% of age predicted maximal HR for 30 minutes. Heart rate was recorded every minute using the Polar T31 HR monitor (Lake Success, NY) and the grade of the treadmill was adjusted appropriately if the subject’s HR fell outside the target HR range for two consecutive minutes. If the subject's HR was above the target HR range at a 0% treadmill grade, the speed of the treadmill was also reduced. Any adjustments made to the grade or speed of the treadmill were noted so that an identical exercise protocol could be employed during the second and third exercise testing visits (i.e., changes in speed/grade from visit 1 were duplicated in visits 2 and 3, regardless of whether the participant's HR fell out of the targeted HR range). The energy expenditure of the exercise session was calculated using the American College of Sports Medicine's (ACSM) prediction equations for the energy expenditure of walking[25]. Ratings of perceived exertion (RPE) were assessed every 5 minutes during exercise using Borg's 6–20 RPE scale[26]. Energy expenditure (EE) of the resting session was calculated using the ACSM energy expenditure prediction equation, assuming a 3.5 ml/kg/min resting value.

Measurement of energy intake and macronutrient composition

Subjects were provided with ad-libitum access to a buffet-style meal starting 1-hour post-exercise/rest and efforts were taken to blind subjects to the measurement of EI. Subjects ate alone, without any music or videos, and were given a half hour to consume as much food as desired. Energy intake was assessed by weighing all foods prior to and following the feeding session while using the manufacturer's energy values and food tables to calculate total EI. The test meal consisted of bagels, cream cheese, jelly, 3 varieties of cereal, granola, yogurt, 1% milk, donuts, and canned fruit, all of which were provided in excess of expected consumption (see Table 1).

Statistical Analysis

The difference in energy intake (EI_{diff}) between sessions was calculated as the EI of the exercise session (EI_{ex}) minus the EI of the resting session (EI_{rest}) and was calculated for each of the 3 pairs of exercise/resting trials ($EI_{diff} = EI_{ex} – EI_{rest}$). Relative energy intake (REI) was also calculated for each testing visit by subtracting the EE of the exercise or rest period from the EI on that testing day (REI = EI – EE). The difference in REI (REI_{diff}) was calculated in a similar manner ($REI_{diff} = REI_{ex} – REI_{rest}$). Intraclass correlation coefficients (ICC) were calculated to examine whether EI_{ex}, EI_{rest}, EI_{diff} and REI_{diff} were similar across the three pairs of trials. The higher the ICC value (range 0–1.0), the greater the consistency in the measure, such that ICC values <0.40 indicate "poor" agreement, values between 0.40 and 0.59 indicate "fair" agreement, values between 0.60 and 0.74 indicate "good" agreement, and values between 0.75 and 1.00 indicate "excellent" agreement[27]. A 3 × 2 (time × condition) repeated measures ANOVA was used to examine the change in EI over time on exercise, relative to resting testing days.

The classification of an individual as a 'compensator' or 'non-compensator' was performed using both absolute EI and relative EI for each of the 3 pairs. If $EI_{ex} > EI_{rest}$ an individual was classified as a 'compensator', and if $EI_{ex} < EI_{rest}$ they were classified as a 'non-compensator', when absolute EI scores were utilized. For REI, an individual was considered to be a 'compensator' if EI post-exercise exceeded the sum of their resting EI plus the net EE of the exercise bout (i.e., $REI_{ex} > REI_{rest}$). A 'non-compensator' was an individual whose EI post-exercise did *not* exceed the sum of the resting EI plus the net EE of the exercise bout (i.e., $REI_{ex} < REI_{rest}$). A modified kappa coefficient[28] was calculated to indicate the degree to which individuals tend to fall into the same category (‘compensator’ vs. ‘non-compensator’) across the three pairs of trials. A statistically significant positive kappa value would indicate that the categorization of a ‘compensator’ or ‘non-compensator’ was reliable within persons across the three pairs of trials.

Paired samples t-tests were used to examine whether there was a difference in EI or REI on rest days compared to EI or REI on exercise days within each pair. Statistical analyses were performed using SPSS for Windows (SPSS Inc., Chicago IL, version 18.0). All values are reported as means ± SD. Statistical significance was set at $p<0.05$.

RESULTS

Subjects

Thirty-four subjects participated in this study. Of those, 28 completed all 6 experimental testing visits and thus were included in the analyses. On average, participants were 33.1 ± 9.6 years of age, had a BMI of 30.3 ± 2.9 kg/m^2, had a body fat percentage of 37.9 ± 5.4%, and 61% were Caucasian. Dietary restraint and disinhibition scores were 7.9±3.7 and 9.3±3.2, respectively. The estimated MET value at 75% of age-predicted maximal HR was 5.2 ± 0.9 METs. Subjects’ weight did not change over the 6 experimental visits ($p=0.10$).

Exercise and rest periods

Each subject completed 3 identical exercise bouts in which the average speed and grade of the treadmill were 2.92 ± 0.14 mph and 2.16 ± 1.98%, respectively. Averaged across the 3 exercise sessions, subjects exercised at 70.8 ± 3.0% HR_{max} ; however HR was lower during EX_2 (70.0±3.6% HR_{max}) compared to EX_1 (72.2±1.8% HR_{max}; $p=0.001$), with no differences in HR observed between the other exercise sessions ($p>0.05$). The mean RPE throughout the 30-minute exercise period was 11.5 ± 2.0, with the RPE during EX_1 (12.0±2.0) being higher than EX_2 (11.3±2.0) or EX_3 (11.3±2.3; ps<0.05). The EE of each exercise bout was estimated to be 722.2 ± 166.5 kJ (172.6 ± 39.8 kcals), which was significantly greater than the estimated EE of the rest period [179.5 ± 27.2 kJ (42.9 ± 6.5 kcals; $p<0.001$)].

Energy intake

Table 2 displays the absolute and relative energy intake and EI_{diff} for each pair of trials. Energy intake was similar over time ($p=0.91$), indicating that there was no effect of the repeated use of the same buffet meal on EI. Further, absolute energy intake was not significantly different between exercise and rest days within each pair of trials (ps>0.19). Repeated measures ANOVA revealed no significant main effect of trial (Pair 1, Pair 2, or Pair 3; $p=0.71$), condition (exercise vs. rest; $p=0.66$), or trial × condition interaction ($p=0.27$) for absolute EI. When the EE of the exercise and rest periods was taken into consideration, the REI was lower on the exercise day compared to the rest day within each pair (p-values ranging from 0.002 to 0.08). Repeated measures ANOVA revealed that there was a significant main effect of condition such that the average REI across the 3 exercise days was significantly less than the average REI across the 3 rest days ($p=0.001$); however there was no significant main effect of trial (p=0.71) or trial × condition interaction (p=0.27).

Although there was no difference in EI between exercise and resting days at the group level (i.e., the EI_{diff} was small), there was a large degree of variability in the EI_{diff} at the individual level (shown in Figure 3). Consistent with previous reports, compensatory eating was observed in approximately half of all trials when defined using absolute EI to identify compensation. Moreover, compensation was observed in 27% of all trials, when the REI criterion was utilized.

Consistency in eating responses

Energy intake across the 3 ‘rest’ days was reliable (ICC = 0.75; 95% CI: 0.60 – 0.87). Similarly, EI measured 1-hour following exercise was also reliable across the 3 exercise days (ICC = 0.83; 95% CI: 0.70– 0.91). However the ICC for the EI_{diff}, calculated as EI_{ex} minus EI_{rest}, was very low (ICC = 0.20; 95% CI: −0.02 – 0.45), indicating only “slight agreement” in the EI_{diff} across the 3 exercise/rest trials[29]. This poor agreement in the EI_{diff} within an individual across the 3 pairs of trials is displayed graphically in Figure 4.

Classification of an individual as a ‘compensator’ or ‘non-compensator’ based upon the absolute EI_{diff} for each of the 3 pairs revealed a similar lack of consistency (Kappa = −0.048, p=0.66), meaning that if an individual was categorized as a ‘compensator’ during the first exercise/resting pair, she would not necessarily be classified as a ‘compensator’ in the remaining two exercise/rest pairs. Only 6 of the 28 participants (21%) were consistently classified as either a ‘compensator’ (n=4) or ‘non-compensator’ (n=2) in all 3 pairs of trials. There was also a lack of consistency when REI was used to classify an individual as a ‘compensator’ or ‘non-compensator’ (Kappa = 0.102, p=0.51). Although there were far fewer instances of ‘compensation’ using the REI criteria, still less than 50% of participants were consistently classified as either a ‘compensator’ (n=1) or ‘non-compensator’ (n=12) on all 3 pairs.

DISCUSSION

Laboratory paradigms, which utilize an exercise day and a rest day, have been used to identify ‘compensation’ following an acute exercise bout. The current study investigated whether the identification of an individual as a ‘compensator’ or ‘non-compensator’ during an acute laboratory paradigm is consistent across multiple time points, when measured in inactive, overweight/obese women. Findings reveal that compensatory eating post-exercise is *not* consistent within an individual over time. That is, if this methodology was used and identified an individual as a ‘compensator’ during a single exercise/rest pair, there is a high likelihood that the individual would *not* be classified as a ‘compensator’ if measured at a later time point. This suggests that the classification of a person as a ‘compensator’ and ‘non-compensator’ based on a single pair of exercise/rest trials does not identify a reliable phenotype in this particular population.

The current findings are in agreement with the only other study to date to examine the consistency in the EI_{diff} between exercise and resting days. In a small sample (n=14) of overweight and sedentary women, Brown et al.[15] reported a slightly greater ICC value for the EI_{diff} across 2 pairs of exercise/rest trials (ICC=0.37 vs. 0.20 observed in the current study), indicating a lack of consistency in compensatory eating post-exercise. The current findings not only confirm those by Brown et al. using a larger cohort, more stringent methodology (3 vs. 2 pairs of exercise/rest trials), and a much lower and more typical exercise EE for physically inactive, overweight women [(720 kJ vs. 1648.5 kJ (172 kcals vs. 394 kcals)], but they also add to the literature by examining the reliability of the dichotomous classification of an individual as a 'compensator' or 'non-compensator' across trials. Together, these two studies demonstrate that compensatory eating in response to exercise is not reliable within inactive, overweight/obese individuals when measured across multiple time points. However, it could be argued that the population used within these studies has the poorest appetite regulation; thus future studies are needed to examine whether there is also a lack of consistency observed in compensatory eating post-exercise within other populations which may have better appetite control (e.g., males, lean, or physical active individuals).

Given that prior studies examining "compensation" have utilized only a single pair of exercise/rest trials, we also wanted to compare our findings from a single exercise/rest pair to previous reports. As illustrated in Figure 3, there was a large degree of individual variability in the EI_{diff} within any given exercise/rest pair, with approximately an equal number of 'compensators' and 'non-compensators', as has been reported previously[5; 6; 7]. Moreover as with previous studies in overweight/obese women, in the current study there was no evidence of compensation at the group level [mean EI_{diff} ranging from −154.8 kJ (−37 kcals) in Pair 2 to 230.1 kJ (55 kcals) in Pair 3]. Thus, although compensatory eating was not reliable within an individual over time, it appears that at any given measurement period there will be individuals who eat more and others who eat less after exercise compared to rest, canceling out one another at the group level. Future studies should begin to examine whether there are day-to-day variations in both psychological (e.g., mood, fatigue, hedonic or non-homeostatic factors, etc.) and physiological factors (e.g., HR response to exercise, fluctuations in hormones, hunger, etc.) which may contribute to compensatory eating within an individual on one occasion but not another.

From a clinical perspective, it is also important to consider the current findings and how they may relate to the role of exercise in weight control. Although it has never been tested, there is an underlying assumption that those who compensate by increasing EI acutely post-exercise in a laboratory setting, are also the same individuals who lose less weight than expected (based upon the exercise-induced energy expenditure) when engaging in a longer term exercise training program, due to this compensatory eating mechanism. While the current study was not designed to examine this hypothesis, the lack of consistency observed suggests that other factors, besides acute compensatory eating, may likely explain why some individuals gain weight (or lose less weight than expected) while others lose significant amounts of weight with exercise training. As noted by Boutcher et al.[30], this variability in weight loss could be attributed to a variety of behavioral, physiological, or inherited characteristics. Additional research is needed to identify the mechanisms explaining this variability in response.

Although the aim of this study was to examine the consistency in the EI_{diff} across 3 exercise/rest trials, the study design also allowed for the examination of the consistency in EI following a 30-minute rest period and following a 30-minute exercise bout. Similar to previous reports, findings reveal that EI following a period of rest was reliable over time, suggesting that a buffet meal is a reliable method for assessing EI within a laboratory. However, the ICC value reported in the current study (ICC=0.75) was slightly lower than what has been reported previously following a period of rest in healthy, normal weight men (ICCs range from 0.86–0.97)[11; 12; 31], and in trained males and females with a BMI between 18–29.9 kg/m^2 (ICC = 0.86)[14]. It is possible the lower ICC value observed in the current study was due to the use of 3 testing days (vs. 2 days) or the fact that the current study used physically inactive, overweight/obese women, compared to males or trained individuals. Finally, the reliability of EI following 30 minutes of moderate-intensity treadmill walking in the current study was high (ICC = 0.83) and very similar to that reported by Laan et al. (ICC = 0.86) following a 35 minute bout of pedaling on a cycle ergometer. This suggests that there is consistency in meal consumption following exercise.

This study was strengthened by the use of a rigorous methodology which utilized 3 pairs of identical exercise/resting trials (as opposed to 2 pairs), a larger than typical sample size, a standardized breakfast administered in-person, and a buffet-meal which consisted of a wide selection of food items, versus a single dietary item. In addition, this study utilized physically inactive, overweight/obese women, a population for which the examination of compensatory eating is clinically relevant. However, this study is not without limitations. First, while efforts were taken to blind subjects to the measurement of EI, it is not possible to know whether the delivery of a buffet meal in an unnatural environment could have impacted eating behaviors. However if this were the case, it is likely that this would have equally altered EI at *all* testing visits, thereby not affecting the consistency measure. Secondly, the timing of the EI measurement in relation to one's menstrual cycle may have influenced EI. However, given that rest and exercise days within a pair were conducted within 48–96 hours of one another, it likely that individuals were within the same phase of their menstrual cycle during the exercise and rest session within a pair; thus having little influence on the EI_{diff} measure. Thirdly, while efforts were taken to ensure that the grade and speed of the treadmill remained constant across the 3 exercise trials, this resulted in the fluctuation of HR and RPE across exercise days. Some may argue that these physiological or perceptual responses to exercise could influence EI. Thus, we also examined the ICC for the EI_{diff} using only Pairs 2 and 3, given that HR and RPE were nearly identical between these pairs, and still found a lack of consistency in the EI_{diff} when measured over time (ICC=0.27). This suggests that these differences in HR and RPE likely had little effect on our findings. Fourthly, the EE of the exercise session in the current study was fairly small (173 kcals); thus future studies are needed to examine whether a similar lack of consistency in the EI_{diff} is also observed when exercise-induced EE is greater. Finally, EI was measured 1-hour post-exercise/rest; thus it is not known whether individuals altered their eating habits after leaving the laboratory and whether this differed across days. However, even if this were the case, the findings from the current study still suggest that this type of laboratory paradigm, which is used to assess compensatory eating, may not be a completely adequate method for distinguishing 'compensators' from 'non-compensators'.

In conclusion, our findings suggest that compensatory eating (EI_{diff}) in response to an exercise bout is not consistent when measured at multiple time points in physically inactive, overweight/obese women. Thus, using a laboratory paradigm with a single exercise and rest session to identify ‘compensators’ and ‘non-compensators’ and then seeking to identify other differences that distinguish these two groups, may not be appropriate in this population. Future studies should examine how differences in participants’ psychological or physiological responses on specific exercise and/or rest trials may contribute to differences in EI.

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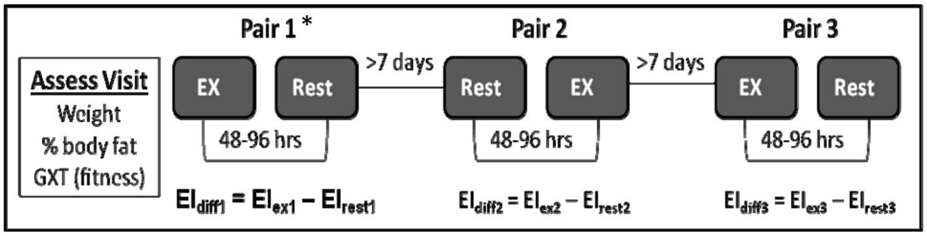


Figure 1.

Study Overview

* participants were randomized to a specific order of testing visits using a randomized, counter-balanced design

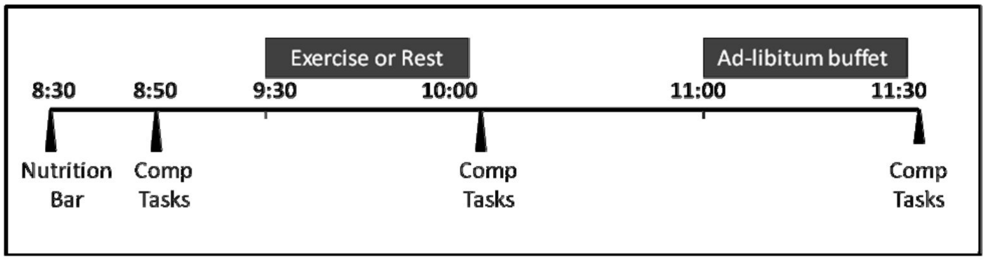
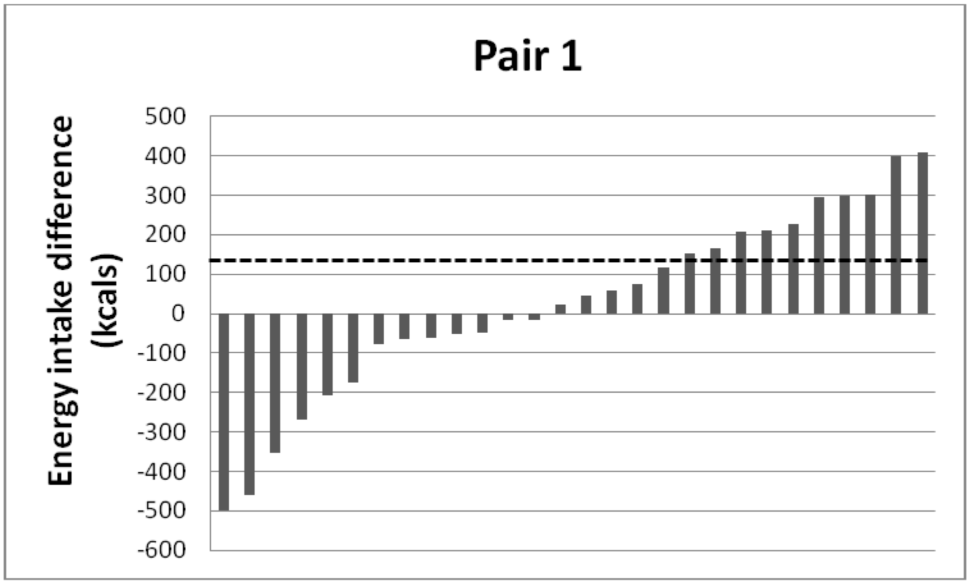


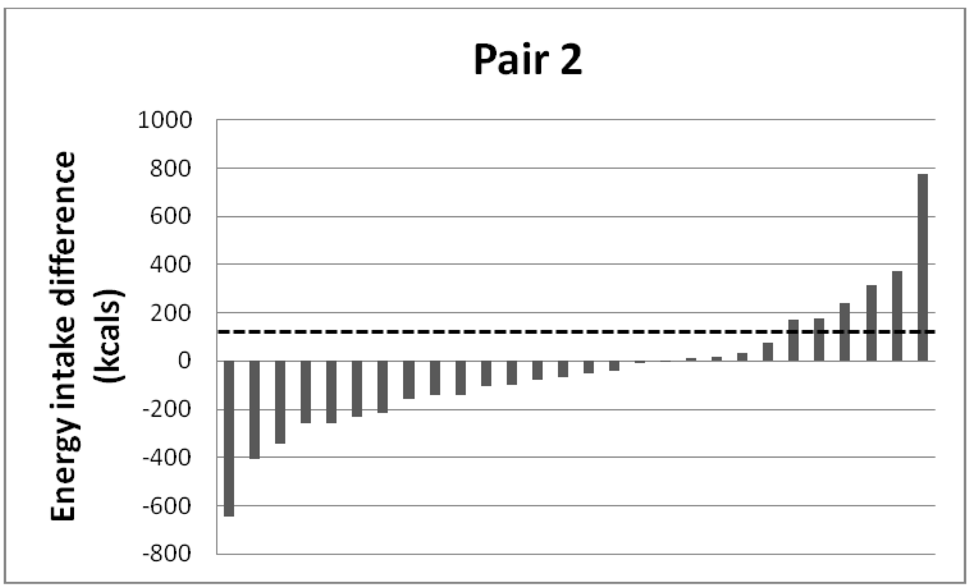
Figure 2.

Summary of Experimental Testing Visits

Comp Tasks = completion of computer tasks and questionnaires a)


Pair 1
Energy intake difference (kcals)
500
400
300
200
100
0
-100
-200
-300
-400
-500
-600

b)


Pair 2
Energy intake difference (kcals)
1000
800
600
400
200
0
-200
-400
-600
-800

c)

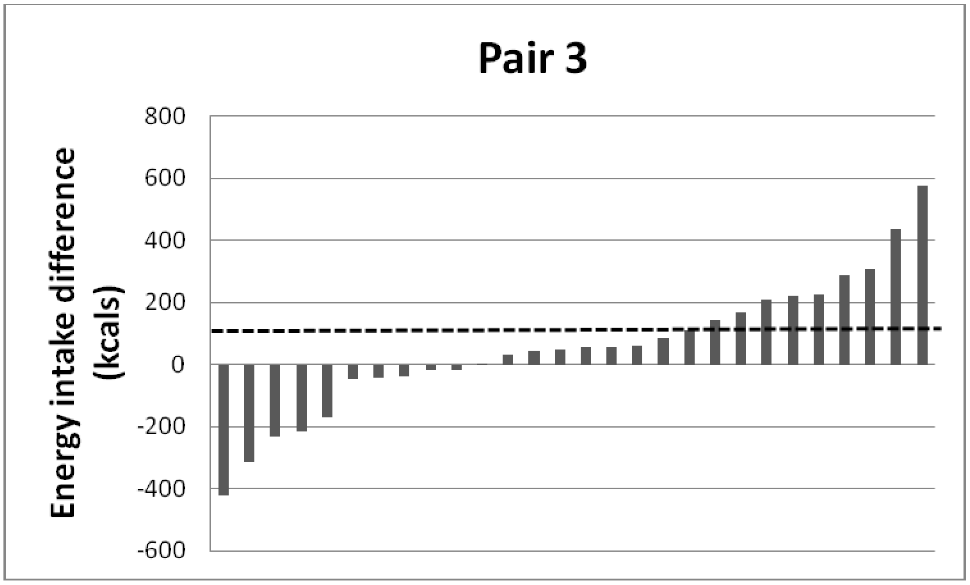


Figure 3.
Individual energy intake difference between exercise and resting sessions for each pair of trials

Energy intake difference calculated as EI_{ex} minus EI_{rest}. Positive values indicate "compensation" and negative values indicate "non-compensation." The dashed line reflects the net energy expenditure ($EE_{ex} – EE_{rest}$) of the exercise session; thus participants above the dashed line would be classified as "compensators" using the relative energy intake criteria for compensation.

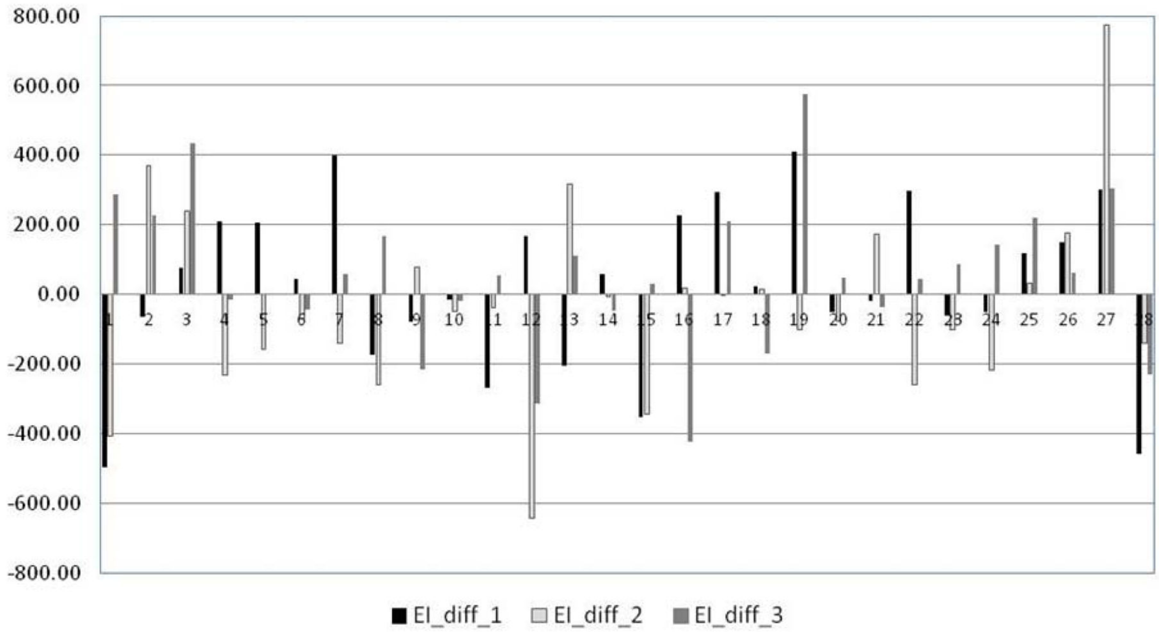


Figure 4.

The difference in energy intake between exercise and resting sessions for each individual for each of the 3 pairs of trials

Energy intake difference calculated as EI_{ex} minus EI_{rest}; thus a positive value indicates "compensation" (i.e., an individual ate more after exercise compared to rest).

Table 1

Description of foods provided during the buffet meal

Food	Energy Density (kcal/g)	Amount Provided (g)	Total Energy (kcal)
Plain Bagel	2.79	133.9	373.7
Cinnamon Raisin Bagel	2.79	135.8	379.1
Plain Cream Cheese	3.33	184.2	614.0
Strawberry Cream Cheese	3.33	206.4	688.1
Strawberry Preserves	2.50	340.0	850.0
Chocolate Donettes	4.79	129.0	618.2
Powdered Donettes	4.39	127.4	558.6
Vanilla Yogurt	0.84	825.6	691.0
Light Strawberry Yogurt	0.57	832.2	476.6
Fruit Cocktail	0.48	415.0	200.8
Granola	4.39	680.4	2984.1
Cheerios	3.57	256.2	914.9
Golden Grahams	3.87	792.2	3066.5
Rice Krispies	3.94	299.7	1180.6
1% Milk	0.46	1085.8	497.7

Table 2

Mean energy intake for exercise and resting testing days for each pair of trials

	Exercise Session		Rest Session		EI difference ($EI_{diff} = EI_{ex} - EI_{rest}$)	
Absolute Energy Intake	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Pair 1	3427.1 kJ (819.1 kcals)	1823.8 kJ (435.9 kcals)	3324.2 kJ (794.5 kcals)	1946.4 kJ (465.2 kcals)	102.5 kJ (24.5 kcals)	998.7 kJ (238.7 kcals)
Pair 2	3148.9 kJ (752.6 kcals)	1810.0 kJ (432.6 kcals)	3306.2 kJ (790.2 kcals)	1738.9 kJ (415.6 kcals)	−157.3 kJ (−37.6 kcals)	1126.3 kJ (269.2 kcals)
Pair 3	3408.3 kJ (814.6 kcals)	1752.3 kJ (418.8 kcals)	3177.3 kJ (759.4 kcals)	1487.8 kJ (355.6 kcals)	231.4 kJ (55.3 kcals)	900.4 kJ (215.2 kcals)
Relative Energy Intake						
Pair 1	2705.0 kJ (646.5 kcals)	1768.6 kJ (422.7 kcals)	3145.1 kJ (751.7 kcals)	1941.4 kJ (464.0 kcals)	−400.2 kJ (−105.2 kcals)	981.1 kJ (234.5 kcals)
Pair 2	2426.7 kJ (580.0 kcals)	1775.7 kJ (424.4 kcals)	3126.7 kJ (747.3 kcals)	1734.7 kJ 414.6 kcals)	−700.0 kJ (−167.3 kcals)	1104.2 kJ (263.9 kcals)
Pair 3	2686.1 kJ (642.0 kcals)	1717.5 kJ (410.5 kcals)	2997.8 kJ (716.5 kcals)	1482.8 kJ (354.4 kcals)	−311.7 kJ (−74.5 kcals)	900.0 kJ (215.1 kcals)