Free-Living Responses in Energy Balance to Short-Term Overfeeding in Adults Differing in Propensity for Obesity

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Objective: Free-living adaptive responses to short-term overfeeding (OF) were explored as predictors of longitudinal weight change in adults classified as having obesity resistance (OR) or obesity proneness (OP) based on self-identification and personal/family weight history.

Methods: Adults identified as OP (n = 21; BMI: 23.8 ± 2.5 kg/m²) and OR (n = 20; BMI: 20.2 ± 2.1 kg/m²) completed 3 days of eucaloric feeding (EU; 100% of energy needs) and 3 days of OF (140% of energy needs). Following each condition, adaptive responses in physical activity (PA), total daily energy expenditure, and energy balance were objectively measured for 3 days in a free-living environment. Body mass and composition were measured annually by using dual-energy x-ray absorptiometry for 5 years. Adaptive responses to OF were correlated with 5-year changes in body mass and composition.

Results: Increases in sedentary time correlated with longitudinally measured changes in fat mass in the cohort taken as a whole. Those with OP reduced their levels of PA following OF, whereas those with OR maintained or increased their PA. No other variables were found to correlate with weight gain.

Conclusions: Failure to decrease sedentary behavior following short-term OF is one mechanism that may be contributing to fat mass gain.

Introduction

Energy balance, which is necessary for weight maintenance, is achieved when energy intake (EI) matches energy expenditure (EE). Energy balance is a dynamic process and its complexities have been recognized previously (1). Studying energy balance has proved to be difficult because it is likely that the dynamic processes responsible for achieving energy balance occur over a period of days, not hours (2-5). The components of energy balance (EI and EE) are influenced by many environmental, behavioral, and biological factors. In addition, EI and EE may be interdependent (6-9). Thus, to study the system responsible for maintaining energy balance, scientists have traditionally perturbed the system by under- or overfeeding (OF) animals and humans then assessing the subsequent changes in EI, EE, and body weight. Because the current environment promotes a state of positive energy balance and global rates of obesity continue to climb (10), it may be useful to understand how humans respond to imposed OF. Understanding the differential responses (physiological and behavioral) and interindividual variability in the responses to brief periods of OF may inform future obesity prevention strategies. Some individuals seem more susceptible to weight gain (i.e., those with obesity proneness [OP]) than others (i.e., those with obesity resistance [OR]). These OP and OR phenotypes have been well studied in rodent models (11-15); however, less work has been done in human subjects. Our Energy Adaptations over Time Study (EATS) was designed to measure the adaptive responses to short-term (3 days) OF that may protect from or promote weight gain in adults self-identified as having OP or OR based on personal and family history (5,16). Our previous investigations have primarily focused on identifying differences between OP and OR in fuel utilization and EE during a period of imposed OF. We found that both...
those with OP and those with OR exhibit similar responses in 24-hour EE and macronutrient oxidation; however, those with OP tend to downregulate nocturnal fat oxidation, which may drive weight gain (16,17). In a separate set of experiments, those with OP reported higher hunger, restraint, and disinhibition compared with those with OR (18). In addition, those with OP had altered regional brain activation in response to palatable food stimuli in brain areas known to be important for the regulation of EI (19). Taken together, these altered responses may represent mechanisms contributing to obesity risk on both the energy input and energy output sides of the energy balance equation.

In the present study, our goal was to study the time course of compensation following OF in adults with OP and OR. Participants were provided an ad libitum diet for 3 days following 3 days of controlled OF or an energy-balanced condition in a randomized crossover design. We objectively measured daily changes in free-living EI, PA, total daily EE (TDEE), and energy balance during 3 days following the 2 conditions. Furthermore, we sought to determine whether changes in PA, EI, and energy balance were associated with changes in body weight and composition assessed annually over 5 years of follow-up. We hypothesized that those with OP would have lower TDEE and higher EI compared with those with OR following OF, placing these individuals in positive energy balance, and that these changes would be associated with greater rates of weight gain in those with OP.

### Methods

**Participants**
Participants were a subset of male (M) and female (F) individuals (25-35 years of age) who participated in EATS, which examined the effects of OF on nutrient oxidation (16). Participants were empirically classified as having either OP or OR based on family weight history and self-report information. Complete criteria for the OP or OR designation and other pertinent inclusion and exclusion criteria have been published previously (5,16). Briefly, those with OP had a BMI of 19.6 to 30.6 kg/m², had a first-degree relative with a BMI > 30 kg/m², and reported exerting conscious effort to maintain their body weight. In contrast, those with OR had a BMI of 16.9 to 25.5 kg/m², had no first-degree relatives with a BMI > 30 kg/m², and reported difficulty gaining weight. All subjects were weight stable for at least 3 months prior to studies being conducted. Prior to enrollment, all participants provided written informed consent. This study was approved by the Colorado Multiple Institutional Review Board.

**Preliminary assessments**
At baseline, the following assessments were completed: (1) height, (2) weight assessed on a digital scale, (3) body composition assessed by using dual-energy x-ray absorptiometry (DXA; Discovery W; Hologic, Bedford, Massachusetts), (4) resting EE (REE) measured by hood indirect calorimetry (TrueOne 2400; Parvo Medics, Sandy, Utah), (5) 24-hour EE measured by using whole-room calorimetry, and (6) free-living physical activity (PA) assessed for 1 week by using a pedometer (Digi-Walker; New Lifestyles, Inc., Lee’s Summit, Missouri).

**Study design**
All subjects completed 2 study conditions (controlled eucaloric [EU] feeding vs. controlled OF) in randomized order separated by at least 1 month. Each condition included a total observation period of 10 days (Figure 1). All meals were prepared by the metabolic kitchen of the Colorado Clinical Translational Sciences Institute. During both controlled feeding conditions, individuals were provided an energy-balanced “lead-in” diet during days 1 to 4. Energy needs were individually estimated based on the average of resting metabolic rate as measured by hood indirect calorimetry and the following equation: (23.9 × fat-free mass [kg]) + 372), where fat-free mass was determined by DXA (20). The average of these 2 methods was multiplied by an activity factor (1.4-1.65), which was determined by average number of steps taken per day during the 7-day baseline PA assessment. On days 5 to 7, individuals were provided either the EU diet or the OF diet. During EU, participants were provided the same diet as in the lead-in period, whereas, during OF, participants were provided the same dietary composition with 140% of their estimated energy needs. Participants were instructed to eat all of the food provided for days 5 to 7. Days 5 and 6 were spent in a free-living condition followed by a 23-hour stay in a whole-room calorimeter on day 7. For the next 3 days following the room calorimeter stay, participants were studied under free-living conditions (i.e., allowing them to engage in normal activities) and were given meals and snacks that provided 125% of their estimated energy needs. Participants were told that they did not need to eat everything that was offered; however, they did not know that the uneaten food would be weighed to calculate consumed calories and macronutrients. Participants were also told in advance that they could request more of any food. This design was aimed to neither restrict intake nor encourage marked overconsumption. All food, wrappers, and containers were weighed before and after consumption by the metabolic kitchen to determine daily EI.

**PA assessment**
PA was assessed by using a PA monitoring system (PAMS) designed by Dr. James Levine and colleagues (Mayo Clinic) (5). This system used paired inclinometers and accelerometers positioned on the upper and lower body to assess changes in body position and movement. As previously reported, we collected pilot data to validate this approach (5). Data from these devices (worn for all waking hours from days 5-10) were used to divide PA into 6 categories: time spent (1) sitting and/or lying, (2) standing still, (3) walking at a slow pace, (4) walking at a normal pace, (5) walking at a quick pace, and (6) in vigorous activity (5). We subsequently collapsed these categories into 3 domains for the analysis reported here: (1) sedentary time (SED; sitting, lying, and standing still), (2) light PA (LPA; walking at a slow pace and walking at a normal pace), and (3) moderate-to-vigorous PA (MVPA; walking at a quick pace and...
vigorou activity). PAMS data were considered valid if the subject wore the device for at least 10 h/d (21).

To calculate TDEE, we converted REE (kilocalories per day) as measured using indirect calorimetry to kilocalories per minute. Next, time spent in each domain was multiplied by an appropriate metabolic equivalent (MET) (SED = 1.3 METs, LPA = 2.5 METs, MVPA = 4.0 METs) and by the individual’s REE. All of these assigned MET values are within published ranges for the various domains of PA (22,23). Because the PAMS was worn during the whole-room calorimeter visit, we were able to calibrate our assigned MET values with measures of EE obtained by indirect calorimetry. Nonwear time was assumed to be time spent sleeping or resting and was assigned 1.0 METs. The thermic effect of food was assumed to be 10% of EI. Thus, the calculation for TDEE was as follows: TDEE (kilocalories per day) = (REE [kilocalories per minute] × 1.0 METs × nonwear time [minutes per day]) + (REE [kilocalories per minute] × 1.3 METs × SED [minutes per day]) + (REE [kilocalories per minute] × 2.5 METs × LPA [minutes per day]) + (REE [kilocalories per minute] × 4.0 METs × MVPA [minutes per day]) + (0.1 × EI [kilocalories per day]). In addition to TDEE, we also calculated EE from PA (PAEE) as follows: TDEE – REE = the thermic effect of food.

Follow-up assessments

Body weight (measured by using a digital scale) and body composition (measured by using DXA) were assessed at the University of Colorado Hospital annually for 5 years. The rate of weight change (RoWC) and rate of fat mass (FM) change (RoFMC) were used to assess longitudinal changes in weight and body composition because follow-up duration varied among individuals (minimum: 1 year, maximum: 5 years). RoWC and RoFMC were calculated as the Δ in weight (kilograms)/the number of years of follow-up and the Δ in FM (kilograms)/the number of years of follow-up, respectively.

Statistical analyses

The primary goal of this analysis was to determine whether adaptive responses to 3 days of OF (e.g., change in PA, EI, TDEE, energy balance) differ between those with OP and those with OR. In addition, we sought to examine whether these responses were correlated with the rate of change in body weight and FM measured over a 5-year follow-up period. All variables are reported as the mean ± SD. Statistical significance was set at P ≤ 0.05. Differences between those with OP and those with OR in baseline characteristics, EI, and PA during the lead-in period were explored by using t tests. To determine whether the OP and OR groups had different responses in energy balance to OF, data were analyzed by using repeated-measures analysis of variance (ANOVA). We also calculated Δ values for each variable of interest (Δ response = OF condition – EU condition) to aid in interpretation of the data. Paired t tests with Bonferroni adjustment were used to examine within-group changes. Changes in SED, LPA, MVPA, EI, TDEE, and energy balance averaged over 3 days following OF were explored as potential predictor variables for 5-year weight gain. Pearson correlations were conducted to examine the correlation between changes in these adaptive responses and the 5-year rate of body weight and FM change. Data were analyzed by using SPSS Statistics version 24.0 (IBM Corp., Armonk, New York).

Results

EATS enrolled a total of 55 subjects (16). For the present analysis, individuals without longitudinal weight change were excluded (n = 6; 3 M and 3 F) and individuals without valid PA data on both the EU and OF conditions were excluded (n = 8; 3 M and 5 F). Thus, 41 subjects (with OP, n = 20; with OR, n = 21) were included in the final analysis. The OP group had a significantly higher age, BMI, and percent body fat compared with the OR group (P < 0.05); however, there were no other differences between the 2 groups (Table 1). In addition, there were no differences in EE, EI, or PA between the OP and OR groups during the controlled feeding periods (days 5-7, Table 2). Subjects who completed both EU and OF were prospectively followed, providing changes in weight and body composition for 5 years.

Accuracy of the calculated TDEE

The average TDEE generated by our equation was 2,285 ± 385 kcal/d compared with the whole-room indirect calorimetry on day 7 of EU (2,280 ± 452 kcal/d), with no differences between the measurements (P > 0.05) and a Pearson correlation of 0.71 (r² = 0.51). A Bland-Altman analysis showed that the mean bias between measurements was 585.9 kcal/d (95% CI: −32.1 to 1100.1 kcal/d). The accuracy of the calculated TDEE was good (intraclass correlation = 0.99).

### Table 1 Subject characteristics

|          | OP      | OR      | P     |
|----------|---------|---------|-------|
| F (n, %) | 13, 59  | 10, 50  | 0.76  |
| Age (y)  | 28.9 ± 2.6 | 27.4 ± 2.2 | 0.05<sup>a</sup> |
| Weight (kg) | 68.4 ± 10.0 | 61.3 ± 10.9 | 0.05<sup>a</sup> |
| BMI (kg/m²) | 23.8 ± 2.5 | 20.2 ± 2.1 | <0.001<sup>a</sup> |
| Body fat % | 25.6 ± 8.5 | 19.0 ± 5.7 | 0.01<sup>a</sup> |
| Fat-free mass (kg) | 50.5 ± 10.3 | 49.6 ± 10.8 | 0.79 |
| Resting energy expenditure (kcal/d) | 1,509 ± 259 | 1,510 ± 247 | 0.98 |

Data are mean ± SD.

<sup>a</sup>Significant difference between OP and OR groups (P < 0.05).

### Table 2 Energy balance and PA during days 5 to 7 of controlled EU and OF

|                      | OP      | OR      | P     |
|----------------------|---------|---------|-------|
| Calorie intake (EU) (kcal/d) | 2,325 ± 351 | 2,274 ± 409 | 0.67  |
| Calorie intake (OF) (kcal/d) | 3,251 ± 513<sup>a</sup> | 3,139 ± 531<sup>a</sup> | 0.49  |
| EE (EU) (kcal/d) | 2,367 ± 378 | 2,367 ± 408 | 0.99  |
| EE (OF) (kcal/d) | 2,439 ± 407 | 2,441 ± 438 | 0.99  |
| Energy balance (EU) (kcal/d) | −44 ± 293  | −94 ± 220  | 0.54  |
| Energy Balance (OF) (kcal/d) | 819 ± 361<sup>a</sup>  | 697 ± 260<sup>a</sup>  | 0.22  |
| SED (EU) (min/d) | 616.0 ± 75.0 | 631.2 ± 74.2 | 0.51  |
| SED (OF) (min/d) | 585.9 ± 95.2 | 605.6 ± 56.6 | 0.43  |
| LPA (EU) (min/d) | 140.2 ± 32.4 | 148.6 ± 37.2 | 0.44  |
| LPA (OF) (min/d) | 141.4 ± 44.8 | 157.1 ± 46.8 | 0.28  |
| MVPA (EU) (min/d) | 60.7 ± 20.1 | 63.7 ± 23.6 | 0.65  |
| MVPA (OF) (min/d) | 59.8 ± 34.5 | 56.9 ± 19.9 | 0.75  |

Data are mean ± SD.

<sup>a</sup>Significant difference between EU and OF conditions (P < 0.05).
Changes in PA and PAEE
The PAMS was worn for an average of 13.4 ± 1.2 h/d across all study visits, with no differences between the OP and OR groups. Wear time for the PAMS was not different between the OF and EU conditions; thus, within-subject changes in PA derived from the PAMS were not confounded by wear time. There were no significant differences between the OP and OR groups in any measurement of PA during the controlled EU and OF study periods (days 5-7, Table 2).

Changes in PA during days 8 to 10 (free-living conditions with ad libitum feeding) are shown in Figure 2. There was a significant group × feeding condition interaction for overall MVPA across days 8 to 10 (P < 0.001, Figure 2C). The OP group decreased overall MVPA across days 8 to 10 following OF compared with EU by −15.6 ± 26.1 min/d, whereas the OR group significantly increased overall MVPA during days 8 to 10 (14.7 ± 25.5 min/d). In addition, there were significant group × feeding condition interactions for MVPA on day 9 (P < 0.001) and day 10 (P = 0.03). The OP group had significant decreases in MVPA on day 9 (−24.0 ± 42.5 min/d) and day 10 (−26.4 ± 34.2 min/d), whereas the OR group increased MVPA on day 9 (27.5 ± 39.5 min/d) and maintained MVPA on day 10 (3.6 ± 34.5 min/d). There was a significant group × feeding condition interaction for LPA on day 9 (P = 0.02, Figure 2B) with the OP group decreasing LPA (−41.1 ± 88.2 min/d) and the OR group increasing LPA (19.1 ± 64.1 min/d). The OP group also had an overall decrease in LPA across days 8 to 10 following OF (P = 0.02). There were no significant differences in SED between the OP and OR groups following OF (Figure 2A).

There was a significant group × feeding condition interaction for PAEE across days 8 to 10 (P < 0.01). The OP group decreased overall PAEE by −117 ± 156 kcal/d across days 8 to 10 following OF compared with EU, whereas the OR group maintained PAEE (43 ± 118 kcal/d) across days 8 to 10. Similarly, there was a group × feeding condition interaction for PAEE on day 9 (P < 0.001). The OP group decreased PAEE on day 9 (−139 ± 239 kcal/d), whereas the OR group increased PAEE on day 9 by 120 ± 162 kcal/d. The OP group also significantly decreased PAEE on day 10 (P = 0.02).

Changes in EI, TDEE, and energy balance
There were no differences in TDEE, EI, or energy balance (calculated as EI – TDEE) between the OP and OR groups during the controlled EU and OF study periods (days 5-7, Table 2). There was no significant interaction for EI for days 8 to 10 (Figure 3A). However, the OR group had a statistically significant reduction in EI during day 8 of OF compared with EU (−270 ± 477 kcal/d, P = 0.03). There was a significant group × feeding condition interaction for TDEE across days 8 to 10 (P = 0.001, Figure 3B). Following the controlled feeding conditions, the OP group decreased overall TDEE (−122 ± 160 kcal/d) during days 8 to 10 of OF compared with EU, whereas the OR group maintained EE (33 ± 118 kcal/d). Similarly, there was a group × feeding condition interaction for TDEE on day 9 (P = 0.001), with the OP group decreasing TDEE (−133 ± 247 kcal/d) during OF compared with EU and the OR group increasing TDEE (118 ± 157 kcal/d). There was no significant interaction for overall energy balance across days 8 to 10 (Figure 3C). However, there was a significant group × feeding condition interaction on day 9 (P = 0.03). The OP group increased energy balance (190 ± 440 kcal/d) during day 9 following OF, whereas the OR group decreased energy balance (−140 ± 459 kcal/d).

Associations with weight change over 5 years
The OP and OR groups gained 4.2 ± 3.1 kg and 3.0 ± 3.2 kg, respectively, with no significant differences between groups during 4.1 ± 1.4 years of follow-up. These changes in body weight correlated to a change in FM of 3.0 ± 3.0 kg and 2.5 ± 2.3 kg for the OP...
and OR groups, respectively. The 3-day mean changes in SED, LPA, MVPA, EI, TDEE, and energy balance were explored as predictors of 5-year changes in body weight and composition. When examining predictor variables for the entire cohort (OP and OR), none of the adaptive responses predicted longitudinal weight gain. However, changes in SED were correlated with longitudinally measured changes in FM in the entire cohort. This finding was largely driven by the individuals in the OR group who had a variable response to OF and somewhat less weight gain over time. However, these adaptive responses were not strong predictors of weight gain. It is possible that examining responses to one OF episode does not correlate well with weight change because significant weight gain occurs only after numerous overeating episodes summed over time. These findings, although not dramatic, support the idea that engaging in more sedentary behavior following OF may be one mechanism that is contributing to weight gain, specifically fat gain, for some individuals.

Over the 3 days following OF, those in the OP group tended to decrease PA, leading to decreases in TDEE and PAEE. The OR group tended to increase PA, resulting in increases in PAEE and TDEE, in a manner that partially compensated for OF. During and following OF, there is an inherent increase in both sleeping and REE, despite little or no change in PA (4,16,26). We previously reported a 4% to 5% increase in 24-hour EE during 140% OF (16), whereas Thearl et al. (26) and He et al. (4) reported an increase of ~10% during 200% and 150% OF, respectively. Nonetheless, these immediate increases in 24-hour EE are insufficient to completely offset the OF stimulus. Consequently, individuals may need to increase nonexercise activity thermogenesis (NEAT) or energy

**Discussion**

We correlated adaptive responses to short-term OF with measured changes in weight and body composition over 5 years in a sample of individuals who either had a propensity for weight gain or were at a lower risk for weight gain. Based on previous observations (5,16), we hypothesized that individuals who were able to compensate for OF (by either decreasing EI or increasing TDEE through PA) would be protected against weight gain over time. We found that an increase in SED following 3 days of OF correlated with longitudinally measured changes in FM in the entire cohort. This finding was largely driven by the individuals in the OR group who had a variable response to OF and somewhat less weight gain over time. However, these adaptive responses were not strong predictors of weight gain. It is possible that examining responses to one OF episode does not correlate well with weight change because significant weight gain occurs only after numerous overeating episodes summed over time. These findings, although not dramatic, support the idea that engaging in more sedentary behavior following OF may be one mechanism that is contributing to weight gain, specifically fat gain, for some individuals.

![Figure 4 Correlations between ΔSED and 5-year changes in FM. Δ calculated as OF – EU on the 3-day mean of days 8, 9, and 10.](image-url)
expended in PA to restore energy balance. Immediate compensation for a substantial OF episode (~1,000 kcal/d), such as in the current study, would require an extreme amount of PA to be performed the following day (15-20 km of walking). Thus, it is more likely that the individual would attain energy balance by increasing PA over a period of several days. In the current study, the OP group decreased TDEE by an average ~125 kcal/d over the 3 days following OF, whereas the OR group increased TDEE by an average of ~50 kcal/d. This suggests adaptive responses in PA likely occur over a period of several days following a period of energy imbalance. Moreover, it is likely that increasing EE alone is not sufficient to restore energy balance, and individuals would need to reduce EI following OF to adequately compensate for the extra ingested calories and achieve energy balance.

Both the OP and OR groups demonstrated nonsignificant decreases in EI following 3 days of OF when compared with the energy-balanced condition, with large interindividual variations in both groups. Rodents have demonstrated an ability to downregulate food intake following OF (27-29); however, previous studies in humans have failed to observe sufficient, immediate downregulation of EI following OF (3,4,30). It has been suggested that the time course for adaptive responses in EI to OF in humans may take 3 to 4 days (2). We observed an immediate downregulation of EI on the first day following OF; however, we failed to see complete compensation for the OF condition, even after 3 days of observation. Jebb et al. observed large interindividual variations in ad libitum EI following 3 different OF conditions (3), suggesting that some individuals either inanely or cognitively have the ability to compensate for periods of OF. Other studies have suggested that changes in hormones such as insulin, leptin, peptide tyrosine-tyrosine, ghrelin, and glucagon-like peptide-1 may help regulate food intake following periods of energy imbalance; however, the overall impact of these changes on EI has been questioned (3,4,31). Moreover, other studies have suggested that PA may help to regulate EI. However, we failed to observe any consistent interactions between PA an EI following OF. Based on our study and others, it appears that following short-term periods of positive energy balance, humans do not immediately downregulate food intake to an extent necessary to restore energy balance. This inability to compensate for periods of overeating may increase humans’ propensity for weight gain.

In the current study, the OR group increased both LPA and MVPA following OF, whereas the OP group tended to decrease both LPA and MVPA. Neither the OP nor the OR group had significant changes in sedentary behavior. Previous studies have proposed that increasing PA and NEAT and decreasing sedentary behavior may help compensate following OF, thus helping to avoid weight gain (4,9,32). It is well established that MVPA is important for long-term weight loss and weight maintenance (33-35); however, the mechanisms through which PA acts to regulate body weight are unclear. PA may help prevent weight gain by increasing EE (35), regulating EI (8), increasing metabolic flexibility (36), or through other mechanisms that are not fully understood. Future studies should focus on delineating the pathways through which increases in PA promote weight maintenance. In addition, the regulating mechanisms through which OF would elicit changes in PA are unclear. These changes may be due to hormonal, behavioral, or cognitive mechanisms.

A unique aspect of this study is that we prospectively assessed changes in body weight and body composition for 5 years after the acute study period. We found that changes in free-living sedentary behavior following OF were correlated with prospective changes in FM. This relationship was primarily driven by individuals self-identifying as having OR. It is unclear why the adaptive responses between OR and OP would contribute to weight gain differently. It is possible that individuals with different phenotypes may gain weight through different mechanisms. However, more research in this area is needed. Regardless, our findings align with prior literature stating that sedentary behavior and NEAT may play a fundamental role in body weight regulation (4,9).

This study has a number of limitations. First, we estimated PAEE and TDEE using a PA monitor (accelerometry) that was calibrated to the measurement of 24-hour EE from whole-room indirect calorimetry and individuals’ resting metabolic rate. Estimates of TDEE based on PA and movement are not as accurate as measures such as doubly labeled water. Although diet order was randomized, participants were not blinded to the diet. Therefore, we do not know whether individuals altered ad libitum food intake and PA as a conscious effort to compensate for the period of OF or whether these responses were based on physiological differences between individuals. Finally, we had a limited sample for investigating predictors of long-term weight change and, as a result, may not have had adequate power to find relationships that may have been present.

Taken together, this study demonstrates that the dynamic process of energy balance likely occurs over several days. Both the OP group and the OR group had different regulatory responses to a brief episode of OF. The OP group tended to decrease PA and TDEE following a period of OF, whereas individuals with OR increased or maintained levels of PA and TDEE. In general, both groups had minimal decreases or no change in EI following the OF episode. These differences in adaptive responses to OF may affect body weight regulation differently depending on the OP or OR phenotype. Finally, for some individuals, time spent sedentary during the days following OF was related to prospective changes in body weight and body composition. Future investigations should focus on the mechanisms through which small changes in sedentary behavior, NEAT, and PA may contribute to weight gain.

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