Article:

Crochiere, R.J., Fitzgerald, D.T., Butryn, M.L. et al. (2026) Moderators of the relation between physical activity and subsequent energy intake among behavioral weight loss participants. Health Psychology. ISSN: 0278-6133 (In Press)

https://doi.org/10.1037/hea0001597

UNIVERSITY OF LEEDS   University of Sheffield   UNIVERSITY of York

Moderators of the relation between physical activity and subsequent energy intake among behavioral weight loss participants

Rebecca J. Crochiere (rjc4@williams.edu)[a], Daedalus T. Fitzgerald (dtf2@williams.edu)[a], Meghan L. Butryn (mlb34@drexel.edu)[b,c], Fengqing Zhang (fz53@drexel.edu)[c], Kristine Beaulieu (k.beaulieu@leeds.ac.uk)[d], Jaclyn P. Maher (jpmaher@uncg.edu)[e], Zhuoran Huang (zh424@drexel.edu)[b], Cleverina Cong (cc3899@drexel.edu)[b], Evan M. Forman (emf27@drexel.edu)[b,c]

[a]Department of Psychological and Brain Sciences, Williams College

[b]Center for Weight, Eating, and Lifestyle Sciences (WELL Center), Drexel University

[c]Department of Psychological and Brain Sciences, Drexel University

[d]School of Psychology, University of Leeds

[e]Department of Kinesiology, University of North Carolina Greensboro

Author Note

Abstract

Objective: Behavioral weight loss (BWL) programs prescribe reduced energy intake (EI) and moderate-to-vigorous physical activity (MVPA). However, MVPA may also acutely influence EI, and that relation may depend on body mass index (BMI) and post-MVPA cognitions. This study tested if BMI and post-MVPA cognitions moderated the within-subject relation between MVPA and subsequent EI among BWL participants. **Method:** Participants were 91 adults with overweight/obesity participating in a yearlong BWL trial. Data were collected during a 3-week midtreatment assessment, with MVPA measured using Fitbit devices, EI via a self-monitoring app, and BMI via wireless scales (weight) and self-reported height. Post-MVPA cognitions included: permissiveness to consume more calories, perceived need to replenish one's body with food, and motivation to lose weight. **Results:** Multilevel models demonstrated lower BMI and higher perceived need for replenishment amplified the positive relation between MVPA and subsequent EI in the 2-hour post-MVPA period. Exploratory analyses showed increased EI in the 2-hour post-MVPA period was associated with greater daily EI at the trend-level, and daily EI was negatively associated with percent weight loss across the midtreatment assessment. **Conclusion:** Individuals with lower BMIs and greater perceived need for replenishment post-exercise had higher EI following MVPA versus no MVPA. Findings suggest greater EI acutely following MVPA may predict greater daily EI, which in turn negatively impacts weight loss. Thus, for optimal weight loss outcomes, it may be important to increase awareness of these EI patterns among relevant subpopulations and encourage planning of EI around MVPA to ensure dietary adherence is maintained.

Keywords: physical activity, energy intake, weight control, individual differences

Public Significance: Results demonstrated BWL participants with lower BMIs and higher perceived need to replenish their bodies with food post-exercise consumed more EI acutely following MVPA relative to no MVPA. Findings suggest EI acutely following MVPA may positively predict daily EI, which in turn negatively impacts weight loss, suggesting EI in the post-MVPA period may matter for weight loss outcomes. Thus, if these BWL participants are struggling to meet weight loss goals, increased awareness around these EI patterns may help them plan their EI on MVPA days, potentially bolstering their adherence to the dietary prescription and improving weight loss outcomes.

Introduction

Gold standard behavioral weight loss (BWL) programs help individuals with overweight/obesity manage their weight by producing a negative energy balance through a reduced-calorie diet (reducing energy intake [EI]), and increased levels of moderate-to-vigorous physical activity (MVPA; increasing energy expenditure). Although MVPA is prescribed to expend energy ("burn calories"), the relation between MVPA and weight change is complicated and not well understood. As such, there may be a more complex relation between MVPA and weight control beyond MVPA's *direct* impact on weight, i.e., energy expenditure. Specifically, it may be that MVPA also *indirectly* affects weight via an impact on EI, which if true, may inform modifications to BWL programs.

The extant literature is mixed as to MVPA's acute effect on subsequent EI, and there are competing theoretical rationales proposing opposite directionality for the way in which MVPA influences subsequent eating behavior. For example, the dominant perspective posits that MVPA temporarily suppresses appetite (Dorling et al., 2018), which in turn may reduce EI; however, another theory proposes MVPA may increase subsequent EI due to post-MVPA permissiveness to consume food or perceived need to refuel one's body with food (Porter et al., 2025). Beyond these theoretical perspectives, empirical findings are also mixed. Specifically, a systematic review reported different subsets of studies have found MVPA *increases*, *decreases*, or *has no effect* on subsequent acute (<2 hours later) EI (Donnelly et al., 2014). These mixed findings may be explained by several factors, including: 1) methodological shortcomings (e.g., self-reported PA, lack of ecological validity) producing estimates that lack internal or external validity; and 2) individual differences that moderate the relation between MVPA and EI. A further limitation of the literature is that none of these reviewed studies (Donnelly et al., 2014) were conducted among BWL participants, limiting their findings' applicability to this particular population.

Recently, Crochiere et al. (2024) addressed some of these limitations by examining the prospective relation between MVPA and subsequent acute EI among BWL participants using technology that accurately measured MVPA and EI in individuals' every-day lives (i.e., accelerometers and a dietary self-monitoring app). Findings showed MVPA was associated with marginal acute *increases* (~35kcal) in subsequent EI in the 2 hours following MVPA, relative to within-subject, time-matched controls in which no MVPA occurred. However, this study did not explore individual differences, and given the significant variability in estimates, individual characteristics might moderate the relation between MVPA and subsequent EI.

Body mass index (BMI) is one factor that has strong potential to moderate the relation between MVPA and EI among BWL participants, given evidence that BMI moderates MVPA's impact on appetite-related hormones, which in turn may affect EI. A meta-analysis of individuals with overweight or obesity found that the hunger-stimulating hormone acylated ghrelin was more strongly suppressed post-MVPA as participants' BMI *increased* (Douglas et al., 2016). This suggests post-MVPA EI may be attenuated among individuals with higher BMIs relative to those with lower BMIs. However, paradoxically, other empirical evidence in different samples suggest BMI moderates the relation between MVPA and EI in the opposite direction. For example, one study found engaging in MVPA led to subsequent increased EI among females with overweight, but *decreased* EI among lean females (George & Morganstein, 2003). This effect may be explained by differential physiological effects of MVPA based on BMI; for example, findings show that relative to lean individuals, individuals with overweight/obesity experience changes in post-MVPA hormones that reduce satiety, reduce fullness, and increase hunger (Adam & Westerterp-Plantenga, 2004; Deighton et al., 2013; Heden et al., 2013; Martins et al., 2015). Thus, these findings suggest BMI may moderate the positive effect of MVPA on acute EI among BWL participants, but the directionality of that effect is unclear, in part because scant research, especially recent research, has directly compared these effects across BMI levels.

Another factor that may moderate the relation between MVPA and subsequent EI among BWL participants is cognitions following MVPA. Although no known research has explored these relations, per own theoretical rationale, there is reason to believe cognitions following MVPA could moderate the relation between MVPA and subsequent EI. For example, for some individuals pursuing weight control, engaging in MVPA may temporarily *increase* motivation to lose weight and thereby *reduce* EI, as individuals may not want to "undo" the hard work of MVPA (i.e., "burning calories") by consuming extra calories. In contrast, for other individuals, MVPA may increase thoughts of permissiveness, e.g., believing one "earned" the ability to consume more calories after expending them via MVPA, or a perceived need to replenish one's body with certain types of food (e.g., protein) after MVPA, both of which may increase EI. A recent scoping review concluded there are individual differences in the degree to which people experience these types of post-MVPA cognitions, which in turn may explain individual differences in EI post MVPA (Porter et al., 2025). Nevertheless, no known research has investigated if individual differences in post-MVPA cognitions moderate the relation between MVPA and subsequent acute EI.

The current study filled a gap in the literature by examining if these two factors, BMI and cognitions post-MVPA, moderate the relation between MVPA and subsequent acute EI—defined as the 2 hours following MVPA per Schubert et al. (2013)—among BWL participants. This 2-hour post-MVPA period was selected because: 1) findings on the relationship between MVPA and subsequent acute EI have been mixed, making ripe the possibility that individual differences are accounting for this variability; 2) the post-MVPA cognitions examined in this investigation (e.g., a perceived need to replenish one's body with food post-exercise) are most likely to produce moderating effects immediately after MVPA. Specifically, this is a secondary analysis of Crochiere et al. (2024), which examined the within-subject relations between MVPA and acute post-MVPA EI, relative to within-subject non-MVPA matched time periods, but did not investigate if main effects were moderated by individual differences. Despite mixed findings, per the most relevant evidence (George & Morganstein, 2003), we hypothesized that higher BMI would *amplify* the positive relation between MVPA and EI in the 2-hours following MVPA (i.e., that MVPA, relative to no MVPA, would be associated with *increased* EI in the subsequent 2 hours). Based on our own theoretical rationale described above, we hypothesized that increases in cognitions of permissiveness and replenishment post-MVPA would amplify the positive relation between MVPA and EI acutely following MVPA. For cognitions about motivation to lose weight, we hypothesized the opposite effect, that stronger post-MVPA motivation to lose weight would attenuate the positive relation between MVPA and EI acutely following MVPA. Data from the 6-month midtreatment assessment (3 weeks in length) were analyzed.

Method

Participants

Participants ($N = 106$) were adults with overweight/obesity actively participating in a yearlong BWL program assessing the efficacy of mindfulness and acceptance-based behavioral treatment components on weight loss. The BWL program prescribed a graduated MVPA prescription (up to 250 minutes/week, to be completed in bouts of $\geq$ 10 minutes) and a reduced-calorie diet (ClinicalTrials.gov Identifier: NCT04337619; Forman et al., 2021). The Institutional Review Board at Drexel University approved procedures. Eligibility criteria for the parent study included having a BMI in the overweight or obesity range at time of enrollment (25-50 kg/m^2), ability to engage in MVPA, and a desire to lose weight (see Forman et al., 2021 for more on eligibility criteria). Inclusion criteria for the current study comprised: active involvement in treatment, completion of the 3-week midtreatment (6-

month) assessment, and ability to collect time-stamped EI data from participants (which occurred in the first 2 out of 4 recruitment waves from the parent study, Wave 1 [began March 2020] and Wave 2 [began October 2020]).

Measures

EI. Participants logged their food and beverage intake and the timing of meals and snacks via MyFitnessPal Premium. MyFitnessPal's EI estimates have been shown to be accurate, underestimating daily EI by only 30kcal (Chen et al., 2015) and correlating strongly ($r = 0.93$) with EI in the Nutrition Data System for Research (NDSR) (Griffiths et al., 2018). Daily EI estimates were calculated by summing all EI consumed in a given day.

MVPA bouts. Participants wore a Fitbit Charge 3 or 4 during the assessment. Fitbit data were collected at the minute-level via the Fitbit API Intraday feature, with the intensity of each minute measured in metabolic equivalents (METs). Fitbit refers to moderate PA as "fairly active" (3-6 METs) and vigorous PA as "very active" (6+ METs) minutes (Semanik et al., 2020). MVPA bouts were defined as ≥30 continuous moderate or vigorous minutes, with limited allowances of interruptions, such that ≥80% of the minutes were at or above the moderate level, consistent with our original manuscript examining the main effects of MVPA on EI (Crochiere et al., 2024). Though participants were asked to complete MVPA in bouts of ≥10 minutes, for the current study, the minimum number of minutes in a bout was increased to 30 to ensure there were enough days on which *no* MVPA bouts occurred, i.e., sufficient non-PA matched controls. Non-wear days (<10 hours of Fitbit data) were excluded.

Weight and BMI. Weight was measured on study digital scales at the beginning and end of the assessment and was used to calculate percent weight loss across the 3-week period. BMI was calculated using self-reported height (due to remote assessments during COVID-19) and weight at the beginning of the assessment.

Post-MVPA cognitions. Because no existing scale assesses cognitions related to eating following MVPA among BWL participants, items were created by the authors of this study. Constructs of *permissiveness*, *motivation to lose weight*, and *replenishment* were translated into succinct and easy-to-understand measure items that would align with participant experiences. These items, representing post-MVPA cognitions, were measured via a single self-report survey at the midtreatment assessment. Each item was rated on a 1-5 Likert scale, with 1 representing "Don't agree at all" and 5 representing "Strongly agree." The wording of items were as follows: *Permissiveness*: [Wave 1]: "After I exercise, I feel that I deserve a tasty or delicious snack/meal"; [Wave 2]: "After I exercise, I feel that it is okay if I am a little less strict with my calorie intake" (due to insufficient

variability in *permissiveness* in Wave 1, wording was adjusted in Wave 2 to better reflect the construct);

Motivation: "After I exercise, I feel motivated to stick to my diet because I do not want to 'undo' the hard work I

put into exercise"; *Replenishment*: "After I exercise, I feel the need to replenish my body with certain foods."

Data preparation and analyses

This study used a within-subject matched control design. A Python script was run on the minute-level Fitbit

data to identify MVPA bouts (≥30 continuous moderate or vigorous minutes, with limited allowances for

interruptions, as defined above) and within-subject non-MVPA time-matched controls. The Python code also

identified the minute following the end of a MVPA bout as the beginning of the 2-hour acute post-MVPA period

(e.g., if MVPA ended at 8:30am, the acute post-MVPA period went from 8:31am to 10:31am). To prevent

confounding effects, only the first MVPA bout of the day was used and if another bout occurred during the 2-hour

period post-MVPA, that day was not used. Within-subject non-MVPA controls were matched based on

participant ID, end time of the MVPA bout, and weekday/weekend status of the MVPA day. Non-MVPA

matched controls had no MVPA prior to or during the acute post-MVPA window, to prevent confounding effects.

All possible within-person non-MVPA matched controls were used in analyses, e.g., if there were 4 usable non-

MVPA matched controls for 1 MVPA bout, all were included. Once all eligible non-MVPA matched controls

were identified for each MVPA bout, the data associated with those non-MVPA matched controls were averaged,

so that one averaged value represented the non-MVPA matched control. This approach allowed for comparison of

EI in the acute post-MVPA period to EI in the same time period on non-MVPA days, within person.

Analyses were conducted using SPSS v.26 and R v.4.4.0. Valid participant days needed to have ≥ 10 hours of

Fitbit data, ≥ 2 logged eating episodes, and ≥ 500 daily calories logged. Multilevel models analyzed within-person

relations between MVPA and EI, which require at least 1 MVPA and 1 non-MVPA matched control day per

participant. Model assumptions were checked and satisfied. All continuous predictors were standardized.

Restricted maximum likelihood was used to estimate model parameters and to test the significance of random

effects. Models were fit using the R package *lme4* (Bates et al., 2014). The lower level, or level one data, was

MVPA versus no MVPA. The level one data was nested within level two units (i.e., participants). Model selection

criteria such as Akaike information criterion (AIC) and ANOVAs determined models with a random intercept

better fit the data than random intercept plus random slope; thus, the intercept for EI could vary by participant.

Fixed effects were examined for all predictors. The weekday/weekend status of a day was controlled for. There were no meaningful, significant differences in daily EI nor MVPA by condition or wave; thus, they were not controlled for. Exploratory analyses tested if: 1) EI in the 2-hour post-MVPA period (and in non-MVPA matched controls) positively predicted daily EI using the multilevel model structure described above; and 2) if daily EI correlated with percent weight loss across the 3-week midtreatment assessment using Pearson's correlations.

Results

Descriptive statistics. Of the $N = 106$ initially eligible participants, the following were excluded: $n = 4$ for refusal to use or technical difficulties with MyFitnessPal or the Fitbit, $n = 1$ for MyFitnessPal non-compliance, and $n = 10$ for not meeting the multilevel model minimum criteria of ≥ 1 MVPA and ≥ 1 non-MVPA control per participant. Thus, $N = 91$ participants provided requisite data (83.5% female; 68.1% White; 26.4% Black; 5.5% Other; 4.4% Hispanic; midtreatment BMI: $M = 32.0$, $SD = 5.7$, $range = 23.0 - 47.2$ kg/m²). Analyses included 1,435 days. On average, participants consumed more calories in the 2 hours post-MVPA ($M = 209.1$, $SD = 253.9$, $range = 0.0-1,942.1$) than in non-MVPA matched controls ($M = 174.1$, $SD = 166.1$, $range = 0.0-1,397.0$). Post-MVPA cognitions showed sufficient variability and spread: *permissiveness* ($M = 1.86$, $SD = 0.91$, $range = 1-4$); *motivation* ($M = 3.76$, $SD = 1.11$, $range = 1-5$), and *replenishment* ($M = 2.10$, $SD = 1.21$, $range = 1-5$).

BMI. Contrary to hypotheses, BMI *attenuated* the positive relations between MVPA and EI in the post-MVPA period (MVPA: $b = -31.81$, $SE = 11.39$, $p = .005$; ICC $= 0.14$; marginal R^2 / conditional $R^2 = 0.018$ / 0.157; see Figure 1A). Specifically, the positive relation between MVPA and subsequent EI in the post-MVPA period was especially strong among those with lower BMIs, but as BMI increased, that difference diminished and the effect eventually reversed, such that at high BMI levels, EI was greater after no MVPA versus post MVPA.

Post-MVPA cognitions. Post-MVPA *replenishment* moderated the relation between MVPA and acute post-MVPA EI, such that higher perceived need to replenish one's body with food amplified the positive relation between MVPA and subsequent EI ($b = 23.48$, $SE = 11.40$, $p = .04$; ICC $= 0.14$; marginal R^2 / conditional $R^2 = 0.017$ / 0.155; see Figure 1B). None of the other post-MVPA cognitions significantly moderated the relation between MVPA and EI in the 2 hours following MVPA and in non-MVPA matched controls.

EI and weight change. There was a positive, within-person association between EI in the 2-hour post-MVPA period and daily EI at the trend-level ($b = 19.01$, $SE = 10.07$, $p = .06$) and between EI in non-MVPA matched

controls and daily EI ($b = 31.20$, $SE = 5.00$, $p < .001$). Further, daily EI was negatively associated with percent weight loss from the beginning to the end of the 3-week midtreatment period ($r = -0.21$, $p = 0.05$).

Discussion

This was the first study to examine if BMI and post-MVPA cognitions moderate the relation between MVPA and subsequent EI among BWL participants. Results were partially consistent with our hypotheses. The perceived need to replenish one's body after MVPA moderated the relation between MVPA and subsequent acute EI in the direction we hypothesized, such that a greater perceived need for replenishment amplified the positive relation between MVPA and EI. In contrast, BMI moderated the relation between MVPA and subsequent acute EI in the direction opposite to what we hypothesized, such that as BMI increased, the relationship between MVPA and EI was attenuated. This finding is inconsistent with previous research that suggested MVPA led to subsequent increased EI among females with higher BMIs (George & Morganstein, 2003); nevertheless, this previous study was not conducted among BWL participants, who likely have different goals around EI than do females with higher BMIs broadly. Instead, the current study's finding is consistent with the Douglas et al. (2016) meta-analysis, which suggested MVPA may suppress appetite and thus attenuate subsequent EI among individuals with higher BMIs relative to those with lower BMIs. Exploratory analyses also demonstrated that EI acutely following MVPA was positively associated with daily EI at the trend-level, and daily EI in turn was negatively associated with weight loss. Although a formal mediation analysis was beyond the scope of this brief report, these findings suggest that EI in the 2 hours post-MVPA may influence daily EI, which in turn impacts weight control. Of note, EI in the non-MVPA period also was positively associated with daily EI, with reduced variability; nevertheless, the increased variability observed in the MVPA model may be partially explained by individual differences in eating behavior following MVPA, which is directly aligned with what the current manuscript aimed to explore.

Together, these findings suggest individual differences in BMI and post-MVPA cognitions may result in certain types of individuals consuming increased EI acutely following MVPA. Theoretically, these findings may help to explain mixed findings around EI post MVPA, specifically that observed variability may be due in part to individual differences in physiological factors like BMI and psychological factors like cognitive patterns. Practically, these findings suggest individuals with lower BMIs and greater thoughts of replenishment post-MVPA are more likely to increase their EI post-MVPA, and EI in this period may increase daily EI, which in turn

may hinder weight loss efforts. Thus, these results may have implications for tailoring BWL programs based on these individual differences, as BWL participants' ability to consistently adhere to the prescribed reduced-calorie diet is of utmost importance to their weight control efforts. For example, if participants who consume more EI acutely following MVPA are not achieving their weight loss goals, BWL programs can increase awareness of these patterns and help these individuals plan their EI on MVPA days accordingly, e.g., identify other times during the day where they will consume fewer calories to effectively manage their calorie budget. Importantly, these findings should *not* be construed as recommendations against eating after MVPA among BWL participants.

The present study had limitations. The sample was relatively homogenous, largely comprising white females, limiting generalizability. In addition, the *permissiveness* item wording changed from Wave 1 to 2, which may have influenced results, and post-MVPA cognitions were measured via self-report at the midtreatment assessment, limiting the measurement's ecological validity. Future research should use ecological momentary assessment to measure these cognitions. Also, MVPA was measured in bouts and findings may differ when using a continuous MVPA variable. Last, the study design does not permit causal inferences among variables. Nevertheless, this study also had notable strengths. For example, data were collected in individuals' everyday lives, which provides more ecological validity than much of the existing literature, which predominately has been conducted in laboratory settings (Donnelly et al., 2014). Additionally, existing weight control studies primarily have examined these relations longitudinally (e.g., how different levels of MVPA predict changes in EI across 12-months; Ptomey et al., 2022), whereas this study investigated the temporal, acute relations between MVPA and EI at a more granular level. Moreover, unlike much of the existing literature, which has almost exclusively used lean samples outside of a BWL program (Donnelly et al., 2014), the current study examined a sample of individuals with overweight/obesity pursuing weight loss, a population that stands to benefit significantly from findings elucidating antecedents of EI, as adherence to a reduced-calorie diet is key to weight control.

Future research should build upon the current study by measuring post-MVPA cognitions at the momentary level using EMA. Employing other study designs also would allow for examination of additional, potential moderating variables of the relation between MVPA and subsequent EI, such as exercise intensity and duration. Future research could also investigate these relationships at different times in BWL programs, particularly during initial stages of BWL characterized by heightened motivation.

References

Adam, T. C., & Westerterp-Plantenga, M. S. (2004). Activity-induced GLP-1 release in lean and obese subjects. *Physiology & behavior*, *83*(3), 459-466.

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2014). Fitting linear mixed-effects models using lme4. *arXiv preprint arXiv:1406.5823*.

Chen, J., Cade, J. E., & Allman-Farinelli, M. (2015). The most popular smartphone apps for weight loss: a quality assessment. *JMIR mHealth and uHealth*, *3*(4), e4334.

Crochiere, R. J., Butryn, M. L., Zhang, F., Beaulieu, K., Maher, J., Huang, Z., Cong, C., & Forman, E. F. (2024). Intraday relations between physical activity and energy intake among behavioral weight loss participants. *Health Psychology*.

Deighton, K., Karra, E., Batterham, R. L., & Stensel, D. J. (2013). Appetite, energy intake, and PYY3–36 responses to energy-matched continuous exercise and submaximal high-intensity exercise. *Applied physiology, Nutrition, and metabolism*, *38*(9), 947-952.

Donnelly, J. E., Herrmann, S. D., Lambourne, K., Szabo, A. N., Honas, J. J., & Washburn, R. A. (2014). Does increased exercise or physical activity alter ad-libitum daily energy intake or macronutrient composition in healthy adults? A systematic review. *PloS one*, *9*(1), e83498.

Dorling, J., Broom, D., Burns, S., Clayton, D., Deighton, K., James, L., King, J., Miyashita, M., Thackray, A., & Batterham, R. (2018). Acute and chronic effects of exercise on appetite, energy intake, and appetite-related hormones: The modulating effect of adiposity, sex, and habitual physical activity. Nutrients, 10 (9), 1140. In.

Douglas, J. A., Deighton, K., Atkinson, J. M., Sari-Sarraf, V., Stensel, D. J., & Atkinson, G. (2016). Acute exercise and appetite-regulating hormones in overweight and obese individuals: A meta-analysis. *Journal of obesity*, *2016*.

Forman, E. M., Chwyl, C., Berry, M. P., Taylor, L. C., Butryn, M. L., Coffman, D. L., Juarascio, A., & Manasse, S. M. (2021). Evaluating the efficacy of mindfulness and acceptance-based treatment components for

weight loss: Protocol for a multiphase optimization strategy trial. *Contemporary clinical trials*, *110*, 106573.

George, V. A., & Morganstein, A. (2003). Effect of moderate intensity exercise on acute energy intake in normal and overweight females. *Appetite*, *40*(1), 43-46.

Griffiths, C., Harnack, L., & Pereira, M. A. (2018). Assessment of the accuracy of nutrient calculations of five popular nutrition tracking applications. *Public health nutrition*, *21*(8), 1495-1502.

Heden, T. D., Liu, Y., Park, Y., Dellsperger, K. C., & Kanaley, J. A. (2013). Acute aerobic exercise differentially alters acylated ghrelin and perceived fullness in normal-weight and obese individuals. *Journal of Applied Physiology*, *115*(5), 680-687.

Martins, C., Stensvold, D., Finlayson, G., Holst, J., Wisloff, U., Kulseng, B., Morgan, L., & King, N. (2015). Effect of moderate-and high-intensity acute exercise on appetite in obese individuals. *Medicine and Science in Sports and Exercise*, *47*(1), 40-48.

Porter, A., Jago, R., Robles, L. A., Cawley, E., Rogers, P. J., Ferriday, D., & Brunstrom, J. M. (2025). Investigating the psychology of eating after exercise—a scoping review. *Journal of Nutritional Science*, *14*, e12.

Ptomey, L. T., Montgomery, R. N., Gorczyca, A. M., Szabo-Reed, A. N., Sullivan, D. K., Hastert, M., Foster, R. N., Washburn, R. A., & Donnelly, J. E. (2022). The impact of exercise and cumulative physical activity on energy intake and diet quality in adults enrolled in the Midwest Exercise Trial for the Prevention of Weight Regain. *British Journal of Nutrition*, *128*(12), 2498-2509.

Schubert, M. M., Desbrow, B., Sabapathy, S., & Leveritt, M. (2013). Acute exercise and subsequent energy intake. A meta-analysis. *Appetite*, *63*, 92-104.

Semanik, P., Lee, J., Pellegrini, C. A., Song, J., Dunlop, D. D., & Chang, R. W. (2020). Comparison of physical activity measures derived from the Fitbit Flex and the ActiGraph GT3X+ in an employee population with chronic knee symptoms. *ACR Open Rheumatology*, *2*(1), 48-52.

Figure 1.

Moderating effect of body mass index (BMI) and perceived need to replenish one's body with food post-moderate-to-vigorous physical activity (MVPA) on the relation between MVPA and acute energy intake (EI)