HOW TO EFFECTIVELY BOOST FAT OXIDATION BY CALORIE RESTRICTION IN OVERWEIGHT AND OBESE ADULTS?

Rima Solianik, Artūras Sujeta, Kristina Justinavičienė, Laura Žlibinaitė
Lithuanian Sports University, Kaunas, Lithuania

ABSTRACT

Background. It is clinically important to determine the factors that increase fat oxidation and have potential to improve body composition in overweight and obese individuals. Thus, the aim of the present study was to compare the effects of a 2-day very low-calorie diet and 2-day zero-calorie diet on fat oxidation and prospective food consumption in overweight and mildly obese adults.

Methods. Eighteen subjects (body mass index above 25 kg/m^2) aged 19–33 years were tested under two conditions allocated randomly: 2-day zero-calorie diet with water provided ad libitum and 2-day very-low calorie diet. Appetite sensations, mood state, inhibitory control, and substrate oxidation were evaluated before and after each diet.

Results. Greater increase in fat oxidation ($p < .05$) was observed after zero-calorie diet when compared to a very low-calorie diet. Results showed that both diets increased ($p < .05$) sensation of hunger and prospective food consumption, whereas no changes were observed in inhibitory control. Greater decrement for vigor ($p < .05$) was observed after zero-calorie diet when compared to a very low-calorie diet, whereas other mood states were not affected by it.

Conclusion. Intermittent fasting with zero-calorie diet may boost fat oxidation to a greater extent when compared to very low-calorie diet and may assist with weight loss in overweight and mildly obese adults.

Keywords: fasting, inhibitory control, mood, substrate oxidation very-low calorie diet.

INTRODUCTION

Interventions aimed at increasing fat metabolism could reduce the symptoms of metabolic diseases such as obesity and type 2 diabetes. Thus, it is clinically important to determine the factors that increase fat oxidation (Achten & Jeukendrup, 2004; Frisancho, 2003) and have potential to improve body composition in overweight and obese individuals. Different degrees of calorie restriction regimes are important determinants of fat oxidation. It is well established that increased ketosis can burn stored fat and to produce the energy needed by the body and brain (Anton et al., 2018; Cox & Clarke, 2017). Recently, 5:2 intermittent calorie restriction has been popularized, in which a very low-calorie diet or zero-calorie diet is allowed 2 days a week and "normal" eating is resumed on non-diet days (Anton et al., 2018; Longo & Mattson, 2014; Solianik & Sujeta, 2018; Solianik, Sujeta, & Čekanauskaitė, 2018; Solianik, Sujeta, Terentjevienė, & Skurvydas, 2016). Nevertheless, recent studies showed that low glucose level is replaced by ketones (Cunnane et al., 2011), and glucose availability depends on the degree of calorie restriction (Solianik & Sujeta, 2018; Solianik et al., 2018; Solianik et al., 2016), we are not aware of any previous studies of the comparison of a 2-day zero-calorie diet and 2-day very low calorie diet on fat oxidation.

It is noteworthy that successful weight loss depends on inhibitory control that is particularly important in the maintenance of obesity-related behaviors and potentially, differential response to interventions. Recent studies observed that poor

general inhibitory control is associated with reduced weight loss outcomes (Manasse et al., 2017). It was established that neither 2-day zero-calorie diet (Solianik & Sujeta, 2018), nor 2-day very low-calorie diet (Solianik et al., 2018) affected inhibitory control. However, dietary adherence might also be limited by perceived stress, mood and appetite sensation changes. Higher food intake in response to stress and negative emotions is an important factor of the weight regain of many dieters (Van Strien, 2018). Recent studies established that feelings of emptiness and hunger were associated with a dysphoric mood (Solianik et al., 2016; Hetherington et al., 2013). It was established that both very-low calorie diet and zero-calorie diet evoke moderate stress (Solianik & Sujeta, 2018; Solianik et al., 2018). However, only zero-calorie diet increases anger in amateur weight lifters (Solianik et al., 2016) and decreases the sensation of vigor in overweight women even before the start of the diet (Solianik & Sujeta, 2018). Interestingly, despite of increase in hunger after zero-calorie diet (Solianik & Sujeta, 2018; Solianik et al., 2016) and very low-calorie diet (Solianik et al., 2018), it can be expected that increased ketones after fasting may coincide decrease in hunger (White & Venkatesh, 2011).

Nevertheless, it can be expected that a zero-calorie diet has greater efficiency in fat oxidation compared to a very low-calorie diet. Yet, subjective responses, such as hunger, desire to eat and mood degradation, might limit further weight loss. Therefore, the main aim of present study was to compare the effects of a 2-day very low-calorie diet and zero-calorie diet on fat oxidation and prospective food consumption in overweight and mildly obese adults. Moreover, inhibitory control, perceived stress responses, mood state and appetite sensations, such as hunger and fullness, were also examined.

METHODS

Participants. Twenty-six volunteers were assessed for eligibility. The criteria for inclusion were: (1) overweight or mildly obese (BMI 25–35 kg/m^2) adults; (2) age 18–35 years; (3) nonsmokers; (4) not engaged in any weight reduction program; (5) no excessive sporting activities, i.e., $\leq$ 3 times per week; (6) no medications that could affect experimental variables; (7) no history of chronic disease. Pregnant or lactating women were excluded. In total, eighteen participants

(8 men and 10 women) aged 26.4 ± 4.5 years met the inclusion criteria and agreed to participate in this study. Informed consent was obtained from all participants included in the study. All procedures were approved by the Kaunas Regional Biomedical Research Ethics Committee (No. BE-2-5) and were conducted in accordance with the Declaration of Helsinki.

Experimental protocol. We used a paired cross-over design, in which all participants participated in two experimental parts in a randomized order, at least 1 week apart. One week before the experiment, all participants were familiarized with the inhibitory control tasks. The participants were instructed to refrain from fatiguing work, and from ingesting alcoholic beverages, caffeine, and sedating antihistamines for at least 2 days before the experimental measurements.

All experimental measurements began at 8:00 a. m. The participant arrived at the laboratory after overnight fasting. Upon arrival at the laboratory, body weight was measured. The participant was then asked to rest and remain awake while lying supine for 20 min in a quiet room. Resting pulmonary gas exchange was recorded during the last 10 min. Subsequently, the participant rated current mood and appetite sensations, and a blood sample was obtained for measurement of glucose concentration. The participant was then seated at a table, and inhibitory control evaluating tasks were performed. The participant then rested 1 day before starting the 2-day very low-calorie diet (511 kcal/day) or the 2-day zero-calorie diet with water provided ad libitum as described previously (Solianik & Sujeta, 2018; Solianik et al., 2018; Solianik et al., 2016). Briefly, during the very low-calorie diet, commercially available instant oatmeal porridge (Activus, Kauno Grūdai, Kaunas, Lithuania) was packaged in 70.0 g (dry weight) packages, and two packages per day were provided to each participants for 2 days. Each package had a caloric content of 255.5 kcal. The composition of the oatmeal was 47.4 g carbohydrates (10.3 g sugars), 10.9 g protein, 3.8 g total fat (0.8 g saturated fat), 5.0 g dietary fibers, and 0.1 g salt. After both 2-day diets, the participant arrived at the laboratory after an overnight fast, and provided their subjective rating of perceived stress and repeated the experimental measurements in the same order as that described for the period before dieting.

Experimental measurements. The body weight and body mass index (BMI) were measured

using a body composition scale (model number TBF-300, Tanita, West Drayton, UK) while the participants were wearing only underwear.

Oxygen uptake (VO_2) and carbon dioxide production (VCO_2) were monitored every 5 s on a breath-by-breath basis using the mobile spirometry system (Oxycon Mobile, Jaeger/VIASYS Healthcare, Hoechberg, Germany), which was calibrated following the manufacturer's instructions. Total carbohydrate (CHO) and fat oxidation (FO) rates were computed using the following non-protein stoichiometric equations (Péronnet & Massicotte, 1991): $CHO = 4.585 \times VCO_2 - 3.226 \times VO_2$, and $FO = 1.695 \times VO_2 - 1.701 \times VCO_2$. Respiratory exchange ratio ($RER = VCO_2/VO_2$) was also used to determine substrate oxidation.

Mood states were assessed using the Brunel Mood Scale containing 24 items (Terry, Lane, & Fogarty, 2003). The items are answered on a 5-point scale ranging from 0 (not at all) to 4 (extremely), and each subscale (i.e. anger, confusion, depression, fatigue, tension, and vigor), with four relevant items, can achieve a raw score in the range of 0 to 16.

Appetite sensations (hunger, fullness, prospective food consumption and desire to eat specific foods) were assessed on a visual analogue scale ranging from 0 ("I am not hungry at all/not at all full/nothing at all/very much") to 10 ("I have never been more hungry/totally full/a lot/not at all") on a 10-cm long horizontal line (Flint, Raben, Blundell, & Astrup, 2000). Perceived stress was also assessed on a visual analogue scale ranging from 0 ("no stress") to 100 ("the highest stress imaginable") (Solianik & Sujeta, 2018; Solianik et al., 2018).

The glucose concentrations were determined in capillary blood samples using a CardioChek PA analyzer (Polymer Technology Systems Inc, Indianapolis, IN, USA) via finger-prick test.

Inhibitory control was assessed using the computerized automated neuropsychological assessment metric Version 4 (Vista Life Sciences, Parker, CO, USA) (Reeves, Winter, Bleiberg, & Kane, 2007). During Go/No-Go task, the participant was instructed to respond as quickly as possible to a letter "x" on the screen by pressing the right button each time the stimulus appeared; when a letter "o" appeared, the participant was required to withhold his response. During Stroop task, the participant was instructed to respond as quickly as possible to the color used to print the color names on the screen by pressing an associated keyboard key (1 for "red", 2 for "green", and 3 for "blue").

On each trial, a word indicating a color name was presented on the screen in different color ink (i.e. red, green, or blue).

Statistical analysis. All values are presented as means ± standard deviations. A two-way repeated measures analysis of variance with two within-subject factors was used to analyze the effects of time (before vs. after) and diet (zero-calorie diet vs. very low-calorie diet) on all variables. If a significant effect of time, diet or time-diet interaction was found, the statistical power (SP) and the partial eta squared (η_P^2) were calculated as an indication of the magnitude of the observed effect. If a significant interaction of time × diet was observed, a paired t-test was used to identify the changes within each diet and to evaluate the differences between diets. The dependent-sample t-test was also used to determine differences in the perceived stress ratings between diets. The level of significance was set at $p < 0.05$. Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS) software version 21.0 (IBM Corp., Armonk, NY, USA).

RESULTS

Anthropometry. The anthropometric parameters of the participants are reported in Table 1. Significant effects of time ($F_{1,17} = 169.27$, $p < .001$, $SP = 1.00$, $\eta_P^2 = 0.91$ for weight and $F_{1,17} = 163.46$, $p < .001$, $SP = 1.00$, $\eta_P^2 = 0.91$ for BMI) and the time × diet interaction ($F_{1,17} = 5.63$, $p = .030$, $SP = 0.61$, $\eta_P^2 = 0.25$ for weight and $F_{1,17} = 4.56$, $p = .048$, $SP = 0.52$, $\eta_P^2 = 0.21$ for BMI) were observed for anthropometric data. Participants in the zero-calorie diet and very low-calorie diet lost ($p < .001$) 2.2 ± 0.9 kg and 1.7 ± 0.8 kg of initial weight, and 0.7 ± 0.3 kg/m² and 0.5 ± 0.2 kg/m² of initial BMI, respectively. Greater decrement for weight ($p = .033$) and BMI ($p = .022$) was observed after zero-calorie diet when compared to very low-calorie diet.

Perceived stress and appetite sensations. The perceived stress during the zero-calorie diet and very low-calorie diet was rated as moderate (42.0 ± 19.3 and 39.7 ± 20.6, respectively); it did not differ between diets. The appetite sensations of the participants are reported in Table 2. Both diets decreased sensation of fullness ($F_{1,17} = 60.72$, $p < .001$, $SP = 1.00$, $\eta_P^2 = 0.78$), and increased sensation of hunger ($F_{1,17} = 69.96$, $p < .001$, $SP = 1.00$, $\eta_P^2 = 0.80$) and prospective food consumption ($F_{1,17} = 22.19$, $p < .001$, $SP = 0.99$, $\eta_P^2 = 0.57$). Participants indicated an increased desire to eat sweet ($F_{1,17} = 9.19$, $p = .008$,

$SP = 0.82$, $\eta_P^2 = 0.35$), salty ($F_{1,17} = 11.16$, $p = .004$, $SP = 0.88$, $\eta_P^2 = 0.40$), and savory foods ($F_{1,17} = 18.26$, $p = .001$, $SP = 0.98$, $\eta_P^2 = 0.52$). The significant time × diet interaction was observed only for fullness ($F_{1,17} = 5.49$, $p = .032$, $SP = 0.60$, $\eta_P^2 = 0.24$). The zero-calorie diet and very low-calorie diet significantly decreased sensation of fullness ($p < .003$) 3.2 ± 2.2 and 1.4 ± 1.7 of initial sensation, respectively. Greater decrement for fullness ($p = .002$) was observed after zero-calorie diet when compared to very low-calorie diet.

Mood states. The mood states of the participants are reported in Table 3. The significant time × diet interaction was observed only for vigor ($F_{1,17} = 5.49$, $p = .038$, $SP = 0.60$, $\eta_P^2 = 0.24$). The zero-calorie diet significantly decreased vigor ($p = .040$) 1.7 ± 3.2 of initial state, whereas this state remained unchanged during the very low-calorie diet. Greater decrement for vigor ($p = .038$) was observed after zero-calorie diet when compared to very low-calorie diet.

Table 1. **The effect of 2-day diets on the anthropometry**

	Zero-calorie diet				Very low-calorie diet				Effect of diet	Effect of time	Interaction effect of time × diet
	Before		After		Before		After				
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*			
Weight, kg	87.6	12.9	86.3	12.8	86.9	12.5	85.2	12.2	n. s.	$p < .001$	$p = .030$
BMI, kg/m²	27.7	2.3	27.0	2.2	27.5	2.2	26.9	2.2	n. s.	$p < .001$	$p = .048$

Notes. *SD,* standard deviation; BMI, body mass index; n. s., not significant ($p > .05$).

Table 2. **The effect of 2-day diets on the appetite sensations**

	Zero-calorie diet				Very low-calorie diet				Effect of diet	Effect of time	Interaction effect of time × diet
	Before		After		Before		After				
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*			
Hunger	3.9	2.4	7.3	2.3	4.0	2.3	6.2	2.0	n. s.	$p < .001$	n. s.
Fullness	3.9	2.3	0.8	0.9	3.8	1.4	2.4	1.6	n. s.	$p < .001$	$p = .032$
Prospective food consumption	5.8	1.9	7.7	1.5	5.6	1.9	6.9	1.7	n. s.	$p < .001$	n. s.
Desire to eat foods:											
Sweet	6.4	2.5	4.3	2.8	6.2	2.4	5.0	2.8	n. s.	$p = .008$	n. s.
Salty	6.4	2.2	4.1	2.5	6.1	2.3	4.5	2.5	n. s.	$p = .004$	n. s.
Savory	7.4	2.7	4.9	3.7	7.6	2.4	5.8	3.4	n. s.	$p < .001$	n. s.
Fatty	7.8	2.6	6.0	3.9	6.3	3.4	6.5	3.5	n. s.	n. s.	n. s.

Notes. SD, standard deviation; n. s., not significant ($p > .05$).

Table 3. **The effect of 2-day diets on the mood states**

	Zero-calorie diet				Very low-calorie diet				Effect of diet	Effect of time	Interaction effect of time × diet
	Before		After		Before		After				
	Mean	SD	Mean	SD	Mean	SD	Mean	SD			
Anger	0.5	0.9	1.5	1.9	0.9	1.6	0.9	1.3	n. s.	n. s.	n. s.
Confusion	1.2	2.4	1.4	2.1	1.2	2.1	0.6	0.9	n. s.	n. s.	n. s.
Depression	0.6	1.5	1.3	1.9	1.3	2.2	1.0	1.5	n. s.	n. s.	n. s.
Fatigue	4.2	3.3	5.4	4.1	4.3	3.3	3.4	2.8	n. s.	n. s.	n. s.
Tension	1.6	1.8	1.6	1.5	1.2	1.4	1.3	1.7	n. s.	n. s.	n. s.
Vigor	8.6	1.9	6.9	3.5	7.2	3.2	7.9	3.3	n. s.	n. s.	$p = .038$

Notes. SD, standard deviation; n. s., not significant ($p > .05$).

Table 4. **The effect of 2-day diets on the inhibitory control**

	Zero-calorie diet				Very low-calorie diet				Effect of diet	Effect of time	Interaction effect of time × diet
	Before		After		Before		After				
	Mean	SD	Mean	SD	Mean	SD	Mean	SD			
Go/No-Go task											
Reaction time, ms	334.5	21.5	336.4	24.6	340	26.3	334.9	16.7	n. s.	n. s.	n. s.
Accuracy, %	94.1	3.3	94.3	3.9	94.4	3.2	94.4	2.7	n. s.	n. s.	n. s.
Stroop task											
Reaction time, ms	590.5	93.3	585.3	109.7	584.5	108.1	581.7	109.5	n. s.	n. s.	n. s.
Accuracy, %	94.9	4.5	93.8	6.6	94.4	5.3	92.4	5.9	n. s.	n. s.	n. s.

Notes. *SD*, standard deviation; n. s., not significant ($p > .05$).

Table 5. **The effect of 2-day diets on the glucose level and substrate oxidation**

	Zero-calorie diet				Very low-calorie diet				Effect of diet	Effect of time	Interaction effect of time × diet
	Before		After		Before		After				
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*			
Glucose, mmol/l	5.3	0.5	4.2	0.5	5.4	0.5	5.0	0.5	$p < .001$	$p < .001$	$p = .009$
VO$_2$, l/min	0.25	0.04	0.27	0.05	0.26	0.05	0.25	0.05	n. s.	n. s.	$p = .024$
VCO$_2$, l/min	0.21	0.03	0.20	0.04	0.21	0.04	0.19	0.04	n. s.	$p = .003$	n. s.
RER	0.84	0.08	0.71	0.03	0.81	0.04	0.74	0.02	n. s.	$p < .001$	$p = .008$
CHO, g/min	0.16	0.09	0.02	0.04	0.14	0.05	0.05	0.04	n. s.	$p < .001$	$p = .012$
FO, g/min	0.07	0.04	0.13	0.02	0.08	0.02	0.11	0.02	n. s.	$p < .001$	$p < .001$

Notes. *SD*, standard deviation; VO$_2$, oxygen uptake; VCO$_2$, carbon dioxide production; CHO, carbohydrate oxidation; FO, fat oxidation; n. s., not significant ($p > .05$).

Inhibitory control. Data of inhibitory control requiring tasks are reported in Table 4. There was no significant effect of time and diet, or the time × diet interaction on the inhibitory control.

Glucose level. Data of glucose level are reported in Table 5. Significant effect of time ($F_{1,17} = 21.98$, $p < .001$, $SP = 0.99$, $\eta_P^2 = 0.61$), diet ($F_{1,17} = 58.93$, $p < .001$, $SP = 1.00$, $\eta_P^2 = 0.81$), and time × diet interaction ($F_{1,17} = 9.35$, $p = .009$, $SP = 0.81$, $\eta_P^2 = 0.40$) was observed for glucose level. Both diets significantly increased glucose level ($p < .001$). A greater glucose level was observed after the very low-calorie diet compared to zero-calorie diet.

Substrate oxidation. Data of substrate oxidation are reported in Table 5. Significant effect of time ($F_{1,17} = 85.26$, $p < .001$, $SP = 1.00$, $\eta_P^2 = 0.83$ for RER, $F_{1,17} = 93.80$, $p < .001$, $SP = 1.00$, $\eta_P^2 = 0.85$ for CHO and $F_{1,17} = 93.51$, $p < .001$, $SP = 1.00$, $\eta_P^2 = 0.85$ for FO) and time × diet interaction ($F_{1,17} = 9.00$,

$p = .008$, $SP = 0.81$, $\eta_P^2 = 0.35$ for RER, $F_{1,17} = 7.96$, $p = .012$, $SP = 0.76$, $\eta_P^2 = 0.32$ for CHO and $F_{1,17} = 14.99$, $p < .001$, $SP = 0.95$, $\eta_P^2 = 0.47$ for FO) was observed for substrate oxidation. Both diets significantly increased FO ($p < .001$), and decreased RER ($p < .001$) and CHO ($p < .001$). A greater FO, and lower RER and CHO were observed after the zero-calorie diet compared to very low-calorie diet.

DISCUSSION

The aim of the present study was to compare the effects of a 2-day different degree calorie restriction on fat oxidation and dietary adherence in overweight and mildly obese adults. Vigor decreased only after zero-calorie diet, while the effect on other mood states, perceived stress, hunger and inhibitory control did not differ between diets, causing similar responses on prospective food consumption and desire to eat specific foods. Fat oxidation increased

after both diets; however, the increase was greater after zero-calorie diet.

Substrate oxidation. In accordance with previous studies (Clayton, Creese, Skidmore, Stensel, & James, 2016; Horton & Hill, 2001; Weyer, Vozarova, Ravussin, & Tataranni, 2001; Zinker, Britz, & Brooks, 1990), we have established that zero-calorie diet and very low-calorie diet increase fat oxidation (i.e. increase FO and decrease RER (i.e. the RER was close to 0.7 indicating that mainly fat was metabolized (Frisancho, 2003)) and decrease carbohydrate oxidation. As expected, greater fat oxidation was observed after zero-calorie diet. It is well established that with the inadequate availability of carbohydrates, the metabolism shifts from lipid/cholesterol synthesis and fat storage to mobilization of fat in the form of fatty acid and fatty acid-derived ketones, which provides energy to the body and the brain (Anton et al., 2018; Gupta et al., 2017). Thus it can be expected, that lower availability of energy during fasting state, caused greater fat oxidation during zero-calorie diet rather than very low-calorie diet.

Appetite sensations. It is suggested that stress can cause changes in appetite sensation (Farr, Li, & Mantzoros, 2016). In the current study, both diets evoked similar moderate stress. As expected, both diets increased hunger and decreased fullness. Even though fullness was lower after zero-calorie diet, no differences were observed in hunger sensation between zero-calorie diet and very-low-calorie diet. It is well established that low glucose level is replaced by ketones (Cunnane et al., 2011), and ketones may suppress hunger sensation (White & Venkatesh, 2011). In the current study, lower glucose level was observed after-zero calorie diet when compared to very-low calorie diet. Thus, it might be expected that greater ketones increase masked increase in hunger after zero-calorie diet. Furthermore, similar increase in hunger after both diets coincides with similar prospective food consumption and desire to eat specific foods.

Mood states. It was established that depressive symptoms and anger are related to overeating and binge eating behavior (Skinner, Haines, Austin, & Field, 2012; Zeeck, Stelzer, Linster, Joos, & Hartmann, 2011). However, in accordance with previous studies (Solianik & Sujeta, 2018; Solianik et al., 2018), only the zero-calorie diet decreased sensation of vigor in overweight and obese adults,

whereas other mood states were not affected by it. In contrast, in previous study of Solianik et al. (2016), total calorie deprivation increased anger in amateur weight lifters. It was well established that resistance exercises increase testosterone level (Kraemer et al., 1999; Nindl et al., 2001), which may explain increased anger (O'Connor, Archer, & Wu, 2004; Solianik et al., 2016) in weight lifters but not in overweight and mildly obese adults.

Inhibitory control. It was demonstrated that poorer inhibitory control causes overeating and temptation to eat tasty and high caloric food, which is associated with future weight gain and decreased capacity to maintain weight loss (Ziauddeen, Alonso-Alonso, Hill, Kelley, & Khan, 2015; Nederkoorn, Jansen, Mulkens, & Jansen, 2007). In accordance with previous studies (Solianik & Sujeta, 2018; Solianik et al., 2018), very low-calorie diet and zero-calorie diet had no effect on inhibitory control in overweight and obese adults.

Limitations. Firstly, it should be noted that our subjects were overweight and mildly obese young-adults. Thus, the findings associated with the 2-day diets cannot be applied to other populations, such as children, older adults, lean or severely obese subjects. Secondly, the study was limited by the use of VAS for measurement of prospective food consumption and evaluation of lost weight at the end of both diets. Future studies should investigate maintenance of lost weight and estimate calorie intake after both diets.

CONCLUSIONS

Together, these findings suggest that effort to maintain weight losses are unlikely to be different between zero-calorie diet and very-low calorie diet, given current data of inhibitory control, emotional state, and appetite sensations. However, fat oxidation as a factor responsible for weight loss was greater after zero-calorie diet. Thus, intermittent fasting with zero-calorie diet may boost fat oxidation to a greater extent when compared to very low-calorie diet and assist with weight loss in overweight and mildly obese adults. Future studies should aim to compare chronic effects of different degree calorie restriction diets on weight loss-related indicators.

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Corresponding author **Rima Solianik**
Lithuanian Sports University
Sporto str. 6, Kaunas LT-44221
Lithuania
Tel. +370 606 95214
Email rima.solianik@lsu.lt