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RAPID COMMUNICATION

Effect of 8-hour time-restricted feeding on sleep quality and duration in adults with obesity

Kelsey Gabel[1], Kristin K. Hoddy[1], Helen J. Burgess[2], Krista A. Varady[1]

[1] Department of Kinesiology and Nutrition, University of Illinois at Chicago, Chicago, IL

[2] Department of Behavioral Sciences, Rush University, Chicago, IL

Correspondence and reprint requests:

Krista Varady, PhD

Associate Professor of Nutrition

Department of Kinesiology and Nutrition, University of Illinois at Chicago

1919 West Taylor Street, Room 532, Chicago, IL, 60612

Tel: 312-996-7897, Email: varady@uic.edu

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Abstract

This study examined the effects of time restricted feeding (TRF; 8-h feeding window/16-h fasting window daily) on sleep. Obese adults (n = 23) followed 8-h TRF for 12 weeks. Pittsburgh Sleep Quality Index (PSQI) total score was below 5 at week 1 (4.7 ± 0.5) and week 12 (4.8 ± 0.7) indicating good sleep quality throughout the trial. Subjective measures of wake time, bedtime, and sleep duration remained unchanged. Findings from this secondary analysis indicate that TRF does not alter sleep quality or duration in subjects with obesity.

Novelty:

- This study is the first to show that time restricted feeding (TRF; 8-h feeding window/16-h fasting window daily) does not alter sleep quality or duration in subjects with obesity.

Key words: Time restricted feeding, time restricted eating, fasting, sleep, weight loss, obesity

Introduction

Only 35% of adults meet the recommended 7-9 h of sleep each night (Knutson et al. 2017). Obesity is associated with poor sleep quality and shorter sleep duration (Beccuti and Pannain 2011; Hasler et al. 2004; Zimberg et al. 2012). Weight loss by means of dietary restriction may help improve sleep quality and quantity (Alfaris et al. 2015; Martin et al. 2016). Time-restricted feeding (TRF) is an intermittent fasting weight-loss strategy, which involves an ad libitum feeding window of 4-10 h and a fasting window 14-20 h per day (Rothschild et al. 2014). Evidence from animal studies suggests that TRF lowers body weight in a way that may improve circadian rhythmicity and sleep (Sunderram et al. 2014). In humans, it's been shown that 10-h TRF resulted in 4% weight loss and improved sleep in overweight participants over 16 weeks (Gill and Panda 2015). Whether the same beneficial effects on body weight and sleep would occur in individuals with *obesity*, remains unknown. Accordingly, this study examined the effects of 8-h TRF on body weight, sleep quality and duration in adults with obesity. We hypothesized that 12 weeks of TRF would increase sleep quality and duration, and that these improvements would be more pronounced in subjects who were poor sleepers at baseline.

Methods

Subject selection

This is a secondary analysis of a 12-week study examining the effects of TRF on body weight and metabolic disease risk (Gabel K 2018). Subjects were recruited from the Chicago area by flyers placed around the University of Illinois Chicago campus. Inclusion criteria were as follows: BMI 30-45 kg/m^2; age 25-65 y; sedentary to moderately active (<7500 steps/d); weight stable for 3 months prior to the beginning of the study (< 4 kg weight loss or weight gain); non-diabetic; no history of cardiovascular disease (myocardial infarction or stroke); non-smoker; not a shift worker; and not taking weight loss, lipid- or glucose-lowering medications. A total of 40 subjects were assessed for eligibility, 11 subjects were excluded because they did not meet one or more inclusion criteria, and 6 subjects declined to participate after qualifying. At total of 23 subjects began the trial and 6 dropped out by week 12. The University of Illinois Chicago Office for the Protection of Research Subjects approved the experimental protocol, and all research participants gave their written informed consent to participate in the trial.

Time restricted feeding protocol

The trial consisted of a 2-week baseline period followed by a 12-week TRF intervention period. During the baseline period, subjects were asked to remain weight stable by continuing their regular diet and exercise routines. During the 12-week TRF intervention, subjects were instructed to eat ad libitum from 10:00 to 18:00 h daily, and fast from 18:00 to 10:00 h daily. During the 8-h feeding window, there were no restrictions on types or quantities of foods

consumed and subjects were not required to monitor calorie intake. During the 16-h fasting period, only water and calorie-free beverages, such black tea, coffee, and diet sodas, were permitted.

Body weight, diet compliance, and physical activity

Body weight was assessed using a balance beam scale (HealthOMeter, Boca Raton, FL) at the beginning of each week at the research center. Body composition (fat mass, lean mass, visceral fat mass) was measured using dual x-ray absorptiometry (DXA; iDXA, General Electric Inc). Compliance to the 8-h TRF window was measured using a daily adherence log, which recorded the time that the subjects started and stopped eating each day. The day was coded as "adherent" if the subject consumed food only within the 8-h window (10:00 to 18:00 h), and "not adherent" if the subject consumed food outside of this window. Total percent compliance was calculated as: number of days adherent / total number of days in the trial x 100. Subjects were asked to maintain their current level of physical activity throughout the trial. Changes in physical activity were assessed by a pedometer (Yamax Digi-walker SW-200, Yamax Inc., San Antonio, TX) over a 7-d period at the beginning and end of the study.

Sleep measures

All questionnaires were administered at the beginning of the baseline period, on the first day of the intervention (week 1) before the diet commenced, and at week 12. The severity of insomnia in the past week was measured by the Insomnia severity index (ISI), which is a 7-item questionnaire (Bastien et al. 2001). Each item is rated by a 5-point Likert scale (where 0

indicates no problem, and 4 indicates a very severe problem) yielding a total score of 0-28. The total score for the ISI is interpreted as follows: no clinically significant insomnia (0-7), sub-threshold insomnia (8-14), moderate severity insomnia (15-21), and severe insomnia (22-28). Sleep quality, timing and duration was measured by the Pittsburgh Sleep Quality Index (PSQI) (Buysse 1988). This 19-item self-report questionnaire measures total sleep quality in the past month, yielding a total score of 0-21. A PSQI total score greater than 5 indicates poor sleep quality. The questionnaire also asks for usual bedtime, usual wake time, and hours of actual obtained sleep, which were also analyzed in the study. Risk of obstructive sleep apnea was estimated using the Berlin Questionnaire at baseline (Chung et al. 2008).

Statistical analyses

All data are presented as mean ± standard error of the mean (SEM). Statistical analyses were performed using SPSS 25.0 for Mac (SPSS Inc.). $P < 0.05$ was considered statistically significant. Data were included for the 23 participants who began the study, and means were estimated using an intention-to-treat analysis using last observation carried forward. One-way ANOVA with Tukey's post-hoc test was used to assess changes in continuous variables between baseline, week 1 and week 12. Paired t-test was used to assess changes between week 1 and 12. We also performed a sub-analysis to examine the effects of the TRF intervention in "good sleepers" and "poor sleepers". Good sleepers were subjects with PSQI total score equal to or below 5 at baseline (n = 13) and poor sleepers were subjects with a PSQI total score greater than 5 at baseline (n = 10).

Results

Body weight, diet compliance, and physical activity

In “all subjects” (n = 23), body weight and fat mass were reduced ($P < 0.01$) after 12 weeks of TRF (**Table 1**). Reductions ($P < 0.05$) in body weight and fat mass were also observed in “good sleepers” (n = 13) and “poor sleepers” (n = 10) by the end of the study. Lean mass and visceral fat mass did not change over the course of the trial in any group. “All subjects” complied with the 8-h TRF window on 80% of days during the 12-week study (**Table 1**). “Good sleepers” were adherent with 8-h feeding window on 83% of days, and poor sleepers were adherent 76% of days. Physical activity, measured as steps/d, did not change over the course of the trial in any group (**Table 1**).

Sleep

Results from the ISI survey indicate an absence of clinically significant insomnia (ISI score 0-7) in “all subjects” and “good sleepers” at baseline, week 1 and 12 (**Table 1**). “Poor sleepers”, in contrast, displayed sub-threshold insomnia (ISI score 8-14) at baseline, with no significant difference by week 1 or 12. Sleep quality was measured by the PSQI questionnaire (**Figure 1**). At baseline, PSQI total score was below 5 in “all subjects” and “good sleepers” indicating no sleep disturbance issues. PSQI score did not change significantly after 12 weeks of TRF in “all subjects” and “good sleepers”. PSQI total score was greater than 5 in “poor sleepers” at baseline, indicating sleep disturbance issues at the beginning of the trial. PSQI score did not change significantly after 12 weeks of TRF in “poor sleepers”. Wake time, bedtime, and sleep duration did not change over the course of the study in any group (**Table 1**). Risk for

obstructive sleep apnea was present in 32% of “all subjects”, 23% of “good sleepers” and 44% of “poor sleepers” at baseline (**Table 1**).

Discussion

This study is the first to assess the effects of 8-h TRF on sleep in adults with obesity. Our findings suggest that TRF has no effect on sleep quality, timing, duration, or insomnia severity after 12 weeks of intervention. We also performed a sub-analysis to examine if poor sleepers would see greater improvements in sleep. Results reveal no improvements in sleep quality, timing or duration in poor sleepers by TRF.

Accumulating evidence suggests that nighttime eating is associated with reduced sleep duration and poor sleep quality (Antelmi E 2014; Yamaguchi M 2013). Thus, we hypothesized that an 8-h TRF intervention, that requires subjects to stop eating by 18:00 h every day, would result in improved sleep in subjects with obesity. Contrary to our hypothesis, we did not observe any improvements in sleep after 12 weeks of TRF. It is possible, however, that no benefits were seen as our cohort had good sleep quality at baseline (i.e. PSQI score less than 5) (Buysse 1988). Additionally, our participants had a mean sleep duration of 7.5 h at baseline, which is in line with the recommended 7 h minimum stipulated by the National Sleep Foundation (Hirshkowitz et al. 2015). Bearing this in mind, we performed a sub-analysis to examine if TRF would improve sleep in subjects with *poor* sleep habits at baseline. Interestingly, no improvements in sleep quality, timing or duration were noted in this subgroup of poor sleepers. It should be noted that the group of poor sleepers only had mild disturbances in sleep based on PSQI and ISI scores (Buysse 1988) ((Bastien et al. 2001). It will be of interest for future studies in this field to examine whether TRF can improve sleep in individuals with severe insomnia and persistent sleep disturbances.

Our study has several limitations. First, we had a small sample size (n = 23). Since our power calculation was based solely on body weight, it is likely that this study was not powered adequately to identify significant changes in sleep quality, timing or duration. However, our findings can serve as pilot data to inform future studies that examine the impact of TRF on sleep. Second, this intervention was not a randomized control trial. Future studies should implement a control group to determine if TRF improves sleep to a greater extent than subjects receiving no intervention. Third, we did not implement the morningness-eveningness questionnaire (MEQ) (Horne 1976) to assess the choronobiology of our subjects at baseline. Last, all measures of sleep were given by self-report. This study would have benefitted from using wrist actigraphy to provide more objective assessments of rest-activity patterns.

In summary, these preliminary findings suggest that TRF does not impact sleep quality, timing and duration in obese subjects with healthy habits at baseline. TRF also displayed no benefits in the subgroup of individuals with poor sleep habits at baseline. Although our study showed no positive effects, it's important to note that TRF did not have any negative effects on sleep in this population group (i.e. sleep quality did not get worse, and sleep duration was not shortened). Thus, TRF can be viewed as an effective weight loss strategy that has no negative impact on sleep habits in subjects with obesity.

Authors' contributions

KG and KKH conducted the clinical trial and wrote the manuscript. HJB analyzed the data and assisted with the preparation of the manuscript. KAV designed the experiment, analyzed the data, and assisted with the preparation of the manuscript.

Conflict of interest: The authors declare no conflict of interest.

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Figure legend

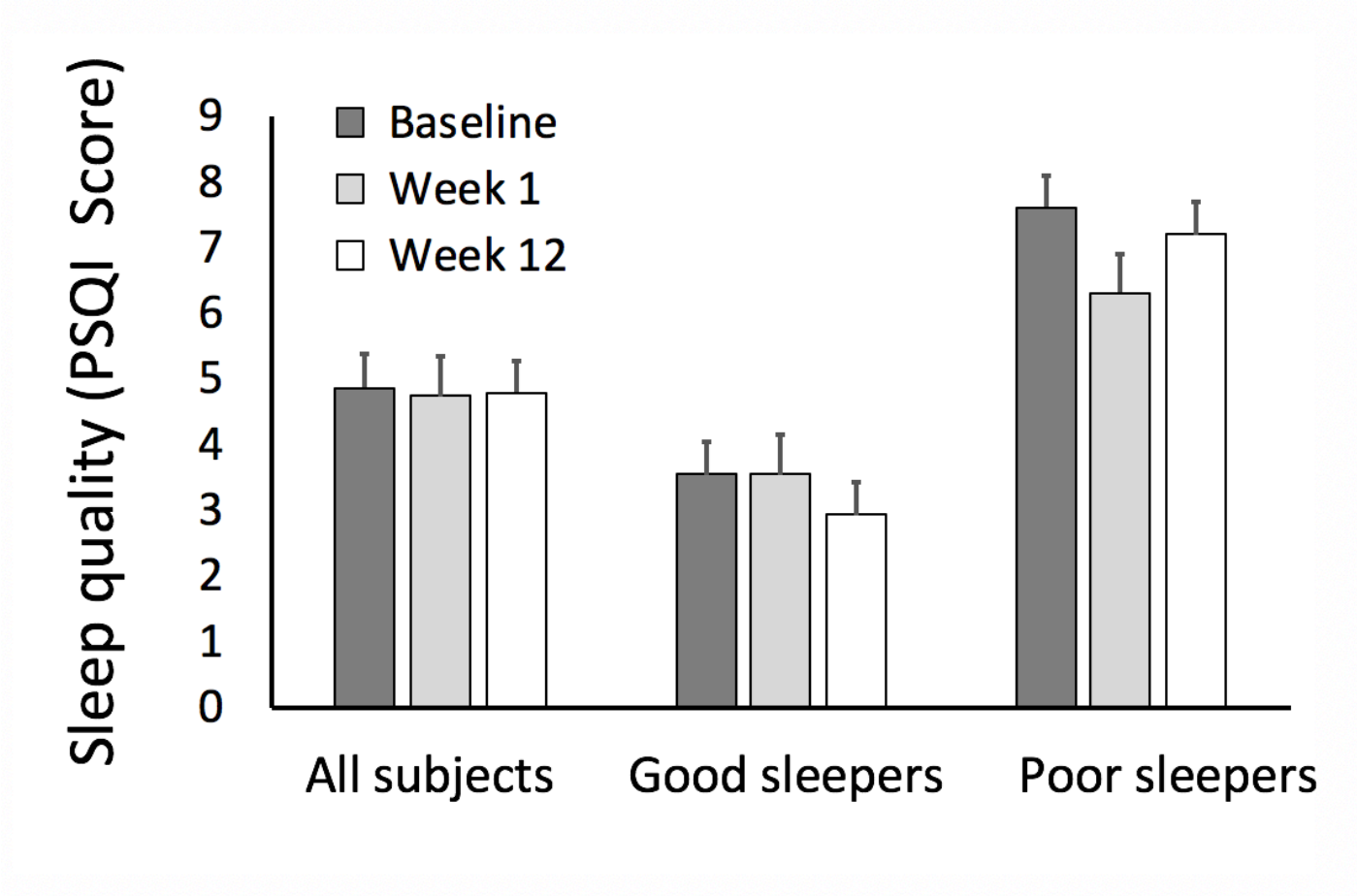
Figure 1. Sleep quality after 12 weeks of time restricted feeding

Values reported as mean ± SEM. Pittsburgh Sleep Quality Index (PSQI) questionnaire. "All subjects" represents the group of subjects as a whole (n = 23). Subjects were then divided into groups based on baseline sleep quality: "Good sleepers" (n = 13) are subjects with a PSQI total score equal to or below 5 at baseline and "Poor sleepers" are subjects with a PSQI total score greater than 5 at baseline (n = 10). There were no statistically significant changes between baseline, week 1, and 12 in any group.

Table 1. Body weight, body composition, and sleep variables after 12 weeks of time restricted feeding

	All Subjects (n = 23)			Good sleepers (n = 13)			Poor sleepers (n = 10)		
	Baseline	**Week 1**	**Week 12**	**Baseline**	**Week 1**	**Week 12**	**Baseline**	**Week 1**	**Week 12**
Demographics									
Age	50 ± 2	--	--	49 ± 2	--		51 ± 3	--	
Sex (Female/Male)	20 / 3	--	--	12 / 1	--		8 / 2	--	
Anthropometrics									
Body weight (kg)	95 ± 3 [a]	95 ± 3 [a]	92 ± 3 [b]	93 ± 4 [a]	93 ± 4 [a]	90 ± 4 [b]	101 ± 5 [a]	101 ± 5 [a]	99 ± 5 [b]
Fat mass (kg)	--	42 ± 2	40 ± 2*	--	40 ± 3	38 ± 3*	--	44 ± 3	42 ± 3*
Lean mass (kg)	--	50 ± 2	50 ± 2	--	49 ± 2	48 ± 2	--	52 ± 3	52 ± 3
Visceral fat mass (kg)	--	1.2 ± 0.1	1.1 ± 0.1	--	1.0 ± 0.1	1.0 ± 0.1	--	1.5 ± 0.1	1.3 ± 0.2
Compliance with diet (%)	--	--	80 ± 4	--	--	83 ± 4	--	--	76 ± 8
Steps/d	--	6896 ± 723	7443 ± 880	--	6324 ± 998	7212 ± 1483	--	7533 ± 1069	7700 ± 957
Insomnia severity index (ISI)									
Total score	6.2 ± 1.0	5.2 ± 0.9	5.3 ± 0.9	3.9 ± 1.1	2.5 ± 0.5	2.5 ± 0.6	9.1 ± 1.1	8.6 ± 1.2	9.0 ± 1.3
Pittsburgh Sleep Quality Index (PSQI)									
Total score	4.9 ± 0.5	4.7 ± 0.5	4.8 ± 0.7	3.5 ± 0.4	3.5 ± 0.4	2.9 ± 0.4	7.6 ± 0.7	6.3 ± 0.8	7.2 ± 1.0
Wake time (h:min)	6:05 ± 0:15	5:50 ± 0:20	6:05 ± 0:15	6:30 ± 0:25	5:40 ± 0:25	6:30 ± 0:20	6:00 ± 0:25	6:00 ± 0:20	6:00 ± 0:25
Bedtime (h:min)	22:35 ± 0:20	22:30 ± 0:20	22:35 ± 0:20	22:30 ± 0:25	22:30 ± 0:20	22:30 ± 0:20	22:55 ± 0:40	22:35 ± 0:30	22:55 ± 0:40
Sleep duration (h)	7.5 ± 0.2	7.7 ± 0.2	7.9 ± 0.2	8.0 ± 0.3	7.2 ± 0.2	8.0 ± 0.1	6.9 ± 0.3	7.3 ± 0.4	6.9 ± 0.3
Berlin questionnaire									
High risk of obstructive sleep apnea (%)	32%	--	--	23%	--		44%	--	

Values reported as mean ± SEM.
Good sleepers: Subjects with a Pittsburgh Sleep Quality Index (PSQI) total score equal to or below 5 at baseline.
Poor sleepers: Subjects with a Pittsburgh Sleep Quality Index (PSQI) total score greater than 5 at baseline.
Means not sharing a common letter are significantly different ($P < 0.05$) based on one-way ANOVA with Tukey's post- hoc test.
* Significantly different ($P < 0.05$) from week 1 to week 12 based on paired t-test.


Sleep quality (PSQI Score)
9
8
7
6
5
4
3
2
1
0
Baseline
Week 1
Week 12
All subjects
Good sleepers
Poor sleepers