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Effects of Time-Restricted Feeding and Whey Protein Isolate Supplementation on Dietary Intake, Mood, and Sleep in a 12-Week Randomized Controlled Trial

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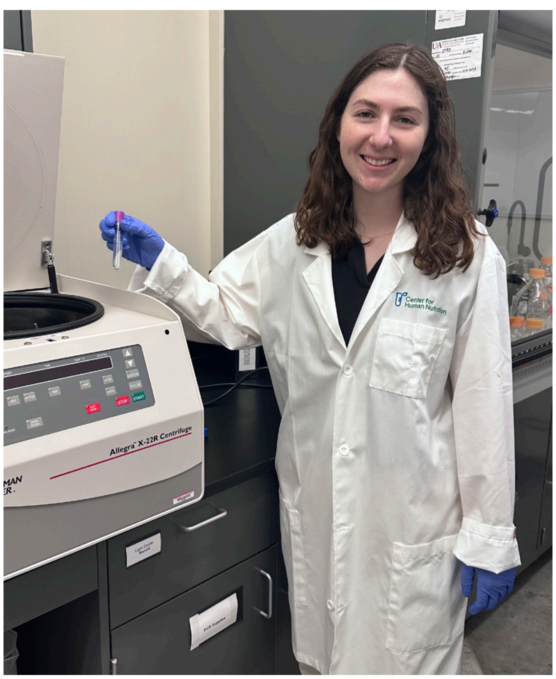
Meet the Student-Author

Sydney Boudrey

I graduated in May 2022, majoring in Human Nutrition and Dietetics. I grew up in Farmington, Arkansas, graduating from Farmington High School with interests in many different career paths. After beginning my college career as a nursing major and taking multiple nutrition classes, I became very interested in how food and nutrition can make lasting impacts on individuals' lives and decided to pursue a career in the field of nutrition. Throughout my college career, I have held multiple jobs and positions, including getting the opportunity to work as a lab assistant at the Center for Human Nutrition, a Career Peer Mentor, and involvement in multiple student organizations. These experiences have helped shape me into who I am today. I would like to thank my honors mentor, Dr. Aubree Hawley, for her guidance and support throughout the past two years. Additionally, I would like to thank Dr. Sabrina Trudo and Dr. Jamie Baum for serving on my honors committee, and the Arkansas Department of Higher Education and Bumpers College for their funding for this project.



Sydney in the lab at the Center for Human Nutrition, operating the centrifuge and removing the specimen after it was separated.

Research at a Glance

- Due to increasing obesity rates, there is a need for dietary interventions to lessen the health impacts and improve overall well-being.
- We tested two specific dietary interventions congruently being time-restricted feeding (TRF) and protein supplementation.
- Overall sleep and mood were unchanged throughout the study in both intervention groups.

Effects of Time-Restricted Feeding and Whey Protein Isolate Supplementation on Dietary Intake, Mood, and Sleep in a 12-Week Randomized Controlled Trial

Sydney E. Boudrey* and Aubree L. Hawley†

Abstract

Obesity affects adults in the United States, leading to chronic diseases and reduced well-being. Time-Restricted Feeding (TRF) is a type of dietary intervention lacking current data regarding the effectiveness on facets of well-being. This study's objective was to determine the effect of time-restricted feeding supplemented with whey protein isolate on food intake, sleep, and mood in overweight or obese adults. Nineteen participants were randomly assigned to the control or experimental group: 1) control, TRF, and 2) experimental, TRF with whey protein supplementation. Participants followed the assigned dietary intervention for 12 weeks. Every 4 weeks (baseline, week 4, week 8, and week 12), anthropometrics, including height and weight, were measured along with the Pittsburg Sleep Quality Index (PSQI) questionnaire, Profile of Mood States (POMS) questionnaire, and dietary record results. Additionally, ActiGraphy measured objective sleep quality at week 1 and week 12. There were no differences between the control and protein groups regarding sleep and mood parameters. The PSQI results indicated no difference in sleep between groups. The POMS subscores for tension-anxiety, when controlled for baseline, were different, with a decrease in the protein group compared to the control at week 12 ($P < 0.01$). Total food consumption was similar between groups. The results suggested whey protein isolate supplementation with TRF may improve outcomes of mood with no effect on sleep. Therefore, a need for further research to investigate the benefits of TRF and protein supplementation on sleep and mood is necessary.

* Sydney Boudrey is a May 2023 honors program graduate with a major in Human Nutrition and Dietetics.
† Aubree Hawley, the faculty mentor, is an Instructor in the School of Human Environmental Sciences.

Introduction

Currently, more than two-thirds of adults in the United States are overweight or obese, and all states and territories have an adult obesity rate of over 20% (CDC, 2022). Not only does obesity increase the risk of chronic disease, but it also has major impacts on well-being, including sleep and mood (Fatima et al., 2016; Luppino et al., 2010). According to the Centers for Disease Control (2018), well-being is an encompassing concept to describe one's overall life satisfaction in many aspects, including sleep and mood.

Evidence suggests that the associations between mood and sleep are bidirectional, and changes in diet may ameliorate poor sleep and mood via shifts in body composition (Watson et al., 2015; Vashadze Sh, 2007; Milaneschi et al., 2019; Luppino et al., 2010; Kahn et al., 2013). While there are many methods that are used to encourage weight loss, most are associated with increased hunger and reduced fullness (Nickols-Richardson et al., 2005).

Research suggests that high-protein diets may promote weight loss by influencing energy balance and improved body composition in obese adults (Simonson et al., 2020). For instance, increased protein consumption can be linked to higher levels of satiety and energy expenditure (Smeets et al., 2008). Moreover, protein quantity and quality are suggested to influence the effectiveness of dietary protein as a treatment strategy for obesity. While most Americans receive the proper amount of protein based on the Recommended Dietary Allowance, the quality of the protein is also an important factor to consider.

Overall, animal proteins such as beef and milk protein stimulate muscle protein synthesis more effectively than plant-based proteins such as soy (Volpi et al., 2013). One example of a high-quality protein widely used in weight loss interventions is dairy, specifically whey protein isolate (WPI) (Hoffman and Falvo, 2004). Time Restricted Feeding (TRF) is another dietary pattern that may promote weight loss through caloric restriction. To our knowledge, long-term manipulation of macronutrients while following a TRF regimen has not been extensively studied. Therefore, the objective of this study is to determine the effect of time restricted feeding supplemented with whey protein isolate on food intake, sleep, and mood, in overweight or obese adults.

Materials and Methods

Subjects were recruited through the university digital newspaper, advertisements on the Center for Human Nutrition website, the Food Science Department website, social media, and by word of mouth. Candidates were phone interviewed to meet the following requirements: must not have taken supplements that may interfere with metabolism, no food allergies, non-smoking, consumed alcohol less than four times per week, non-breastfeeding, not used illicit drugs, or have dieted in the past three months. A total of 19 participants completed the study, 10 were in the intervention group, and 9 were in the control group. All participants were overweight or obese (body mass index, BMI ≥ 25 kg/m^2).

Participants signed a consent form following a complete explanation. The protocol was submitted and approved by the University of Arkansas Institutional Review Board before subjects were recruited. The 12-week study was conducted as a randomized control trial with one control group and one dietary intervention group. Participants were randomly assigned to the control group or experimental group: 1) control, TRF (n = 10), and 2) TRF with powdered whey protein supplementation (20 grams/day; n = 9).

Protein supplements were allocated in powder form to individual sachets and were consumed at the breaking of the fasting period each day, and both groups followed a TRF dietary intervention (8-hour eating window with a 16-hour fast) and ate ad libitum. Participants followed the assigned dietary intervention for 12 weeks. Subjects came to the University of Arkansas System Division of Agriculture's Center for Human Nutrition for sample collection and measurements to be taken. Anthropometrics, including height and weight, were measured. Participants were asked to complete two questionnaires, the Pittsburg Sleep Quality Index (PSQI) and Profile of Mood States (POMS) questionnaire. Results were measured every 4 weeks (baseline, week 4, week 8, and week 12) at the Center for Human Nutrition. Objective sleep quality was measured via an accelerometer at baseline and week 12.

Participants were provided with a booklet that corresponded with their dietary intervention. The booklet provided a guide for TRF and example schedules that the participants could follow. Details for the ActiGraph sleep monitor, sleep diaries, and instructions for filling out food records were also included. Booklets given to participants in TRF and WPI supplementation groups included a section with easy and quick recipes for protein supplementation consumption.

Objective sleep quality and duration were assessed via an ActiGraph triaxial wrist accelerometer, a validated method of sleep assessment. Participants wore the ActiGraphs for one week before the start of the study (baseline) and one week prior to their final visit (week 12). A 7-day average was calculated for each sleep outcome (sleep efficiency, sleep latency, wake after sleep onset, number of awakenings, and length of awakenings). While wearing the ActiGraph, participants kept a sleep diary to confirm their sleep schedule and awakenings. Subjective sleep quality was self-assessed using the Pittsburg Sleep Quality Index (PSQI) questionnaire. This questionnaire is the most widely used and accepted for subjective sleep quality (Fabbri et al., 2021). A compiled global score of the seven scored sleep

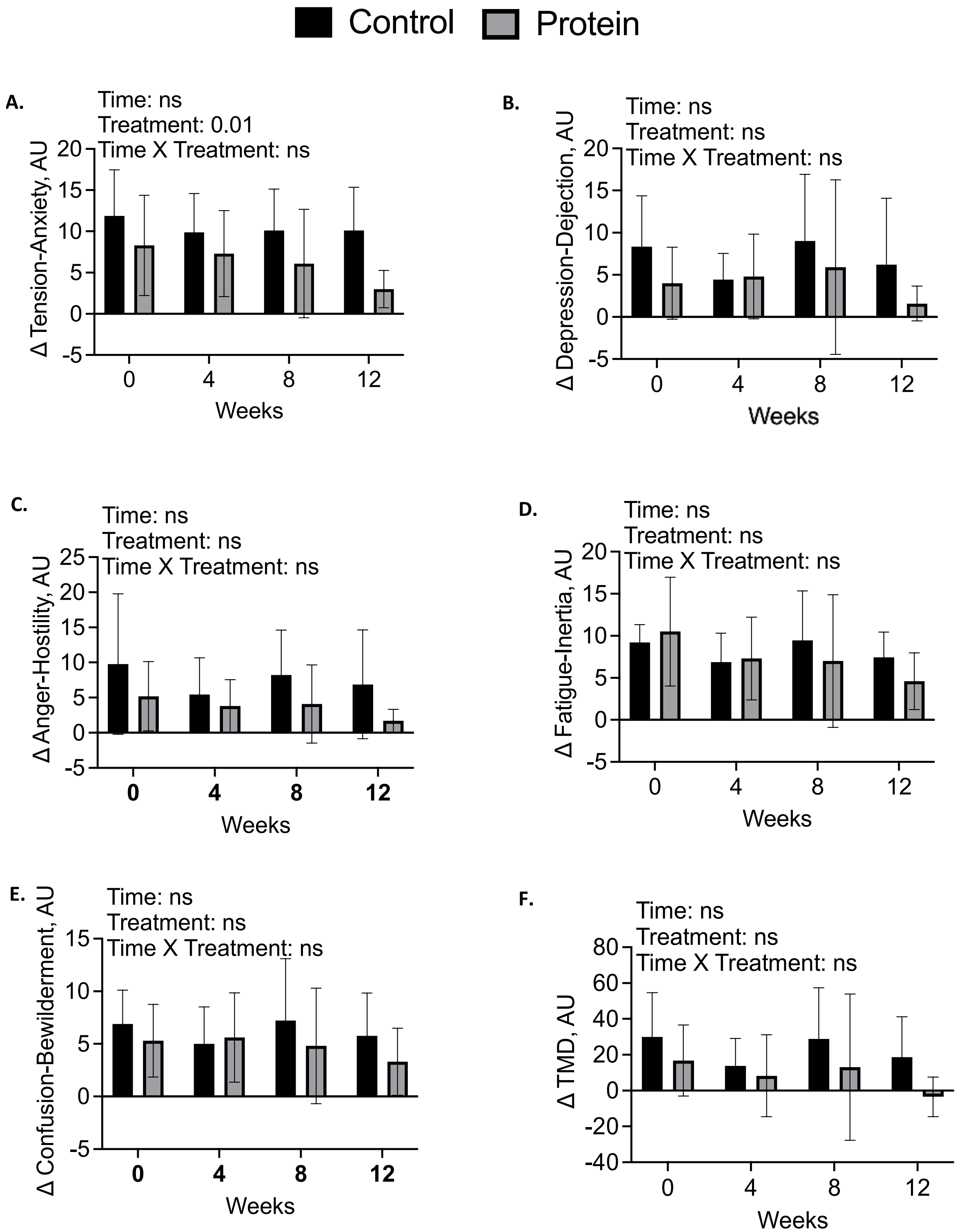


Fig. 1. POMS Scores. (A) The mean tension-anxiety score of control and treatment groups. Significance was found for treatment ($P = 0.0124$). (B) The mean depression-dejection score of control and treatment groups. (C) The mean of anger-hostility of control and treatment groups. (D) The mean fatigue-inertia of control and treatment groups. (E) The mean confusion-bewilderment of control and treatment groups. (F) The mean total mood disturbance (TMD) of control and treatment groups. ns = not significant. AU = arbitrary units.

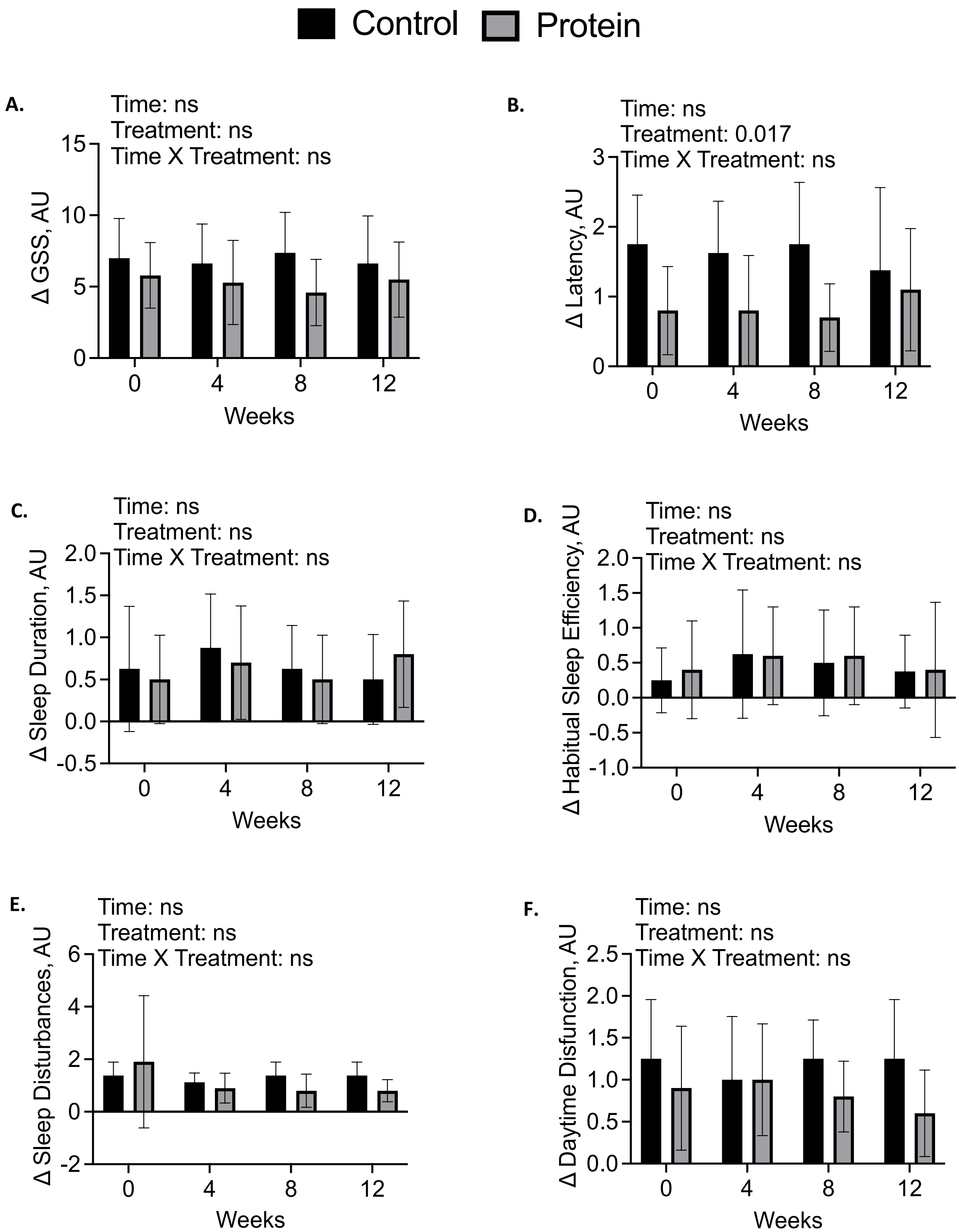


Fig. 2. PSQI Scores. (A) The mean PSQI Global Sleeping score (GSS) of control and treatment groups. (B) The mean sleep latency score of control and treatment groups. (C) The mean sleep duration of control and treatment groups. (D) The mean habitual sleep efficiency control and treatment groups. (E) The mean sleep disturbances of control and treatment groups. (F) The mean total daytime dysfunction of control and treatment groups. ns = not significant. AU = arbitrary units.

components (sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction) distinguished good sleepers (≤ 5) from poor sleepers.

We administered the Profile of Mood States (POMS). This survey has been used since 1971, and exhibits construct and predictive validity of the 6 POMS subscales (McNair et al., 2003). The test contained a one-word adjective of mood to measure and identify six affective states. The six identifiable mood/affective states were tension-anxiety, depression-dejection, anger-hostility, vigor-activity, fatigue-inertia, and confusion-bewilderment. The Total Mood Disturbance (TMD) score is calculated by summing the scores across all six factors (weighting vigor negatively). Higher subscores for all affect states, but the vigor domain represents poorer mood. The TMD score is the most clinically relevant and ranges from -32 (best possible score) to 200 (worst possible score). Mood was quantified with a 5-point Likert scale by participants.

Each participant completed a 3-day (2 weekdays and 1 weekend day) food intake record every 4 weeks of the intervention. Food records were reviewed and input into the Nutrition Data System for Research (NDSR) software. Total energy intake, macronutrients, total dietary fiber, total saturated fatty acids, total trans-fatty acids, omega-3 fatty acids, and essential amino acids, including tryptophan amounts, were analyzed immediately following 3-day food record collection via the NDSR software providing a report and analysis of nutrient consumption.

Student *t*-tests were used to determine the difference between the control and intervention groups in participant characteristics, including age, weight, PSQI GSS, POMS TMD, and sleep efficiency at baseline. Repeated-measures analysis of variance (ANOVA) was used to determine the differences in height, weight, food intake, Global PSQI scores, POMS scores, and wrist actigraphy over the course of the 12-week period. Two-way ANOVA was used to determine the difference between the beginning and end of the intervention. All tests were two-sided with *P*-values ≤ 0.05, indicating significance. Analysis of data was conducted by using the statistical software GraphPad Prism version 9.0.

Results and Discussion

A total of 19 participants were included in the final data analysis (n = 14 females) (n = 5 males). The control group had a lower BMI ($P = 0.04$) and weight ($P = 0.03$) when compared to the protein group at baseline; however, there were no differences in height, global sleeping score, total mood disturbance, or sleep latency between groups at baseline.

Results from POMS scores are presented in Fig. 1. There was a difference in treatment for tension-anxiety scores, with the protein group having lowering scores over the duration of the study. Additionally, anger-hostility scores decreased over time in both groups after controlling for baseline. Furthermore, total mood disturbance (TMD) scores exhibited a decrease in both groups at week 12 compared to baseline, with the control group having lower TMD at week 12 ($P = 0.03$). There were no other differences in results including depression-dejection, anger-hostility, fatigue-inertia, confusion-bewilderment, and total mood disturbance. This data provides insight into potential mood outcomes of individual's TRF in a larger study.

Figure 2 depicts PSQI global sleeping scores and sub scores. Significance was found in treatment of sleep latency ($P = 0.02$), as the protein group's scores started below and stayed below the control. When sleep latency was controlled for baseline, it increased in the control group compared to the protein group at week 4 and week 8 with no differences at week 12 ($P < 0.01$). No other statistical significance was found between global sleeping score, sleep duration, habitual sleep efficiency, sleep disturbances, and total daytime dysfunction. Some studies indicate that increased protein consumption can lead to better sleep quality. For example, Sutanto et al. (2022) found an association between dietary tryptophan levels and sleep quality. Conversely, in a study conducted by Kim et al., 2020, there were no differences in structure of sleep in a 4-week TRF intervention in metabolically healthy adults among a Korean version of the PSQI. Similarly, in our study, the results from the PSQI did not yield differences.

Sleep actigraphy results were compared at week 1 and week 12. There was a difference in the protein group that had a higher awakening length compared to the control group ($P < 0.01$). There was no time effect nor treatment effect on total sleep time or total minutes in bed. However, there was a group × time interaction ($P < 0.05$). No other results were different, including sleep latency, sleep efficiency, and wake after sleep onset.

The amount of protein consumed by the protein group was greater than the control group ($P < 0.01$), as well as an increasing trend for tryptophan (0.09). There was also a group effect for total energy consumed; however, when total energy consumption and protein intake values were controlled for baseline, there were no differences. All other dietary intake remained similar throughout the study. Previous studies investigating a high protein diet had consumption of between 25% to 35% of protein; therefore, the protein supplement consumption may not have been adequate to see results (Smeets et al., 2008; Due et al., 2004). There were no differences in other dietary components between groups eliminating aspects of diet as confounding variables.

Conclusions

As the problems of obesity and its impacts on sleep and mood shape our current society, it has become necessary to turn to dietary interventions as a means to improve overall well-being. While some aspects of the study differed, it is necessary to pursue future research in this field to improve the lives of those who face these problems.

Acknowledgments

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