

Effect of 5:2 Intermittent Fasting Diet for Weight Loss among Overweight and obese College Students

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Abstract: Objective: A study was designed to determine whether 5:2 intermittent fasting diet intervention (IF 5:2 diet) benefits the weight loss among overweight and obese college students. **Methods:** Nine subjects with BMI>24 were maintained for 4-week IF 5:2 diet in which they ate restrictedly twice a week, while women or men consuming respectively less than 500 or 700 calories on the fasting days from September 2020 to January 2021. The first four weeks were the control phase, while the last four weeks were the intervention phase, with IF 5:2 diet. **Results:** All indexes measured were no significant difference during the control phase ($P>0.05$). In the intervention phase, reductions in body weight ($2.678\pm 2.230\text{kg}$) waist circumference ($3.389\pm 2.868\text{cm}$), hip circumference ($2.733\pm 2.560\text{cm}$), BMI (0.875 ± 0.667) and waist-to-height ratio (0.019 ± 0.015) were observed ($P<0.05$); change of waist-to-hip ratio was not significant ($P>0.05$). Change of the average number of exercise steps, heart rate and sleep scores were not significant ($P>0.05$). The fullness on the light fasting day increased significantly ($P<0.05$), but there were no significant differences in hunger, satisfaction, mood and persistence confidence ($P>0.05$). **Conclusions:** These findings demonstrate that a 4-week IF 5:2 diet has a significant weight loss effect for overweight and obese college students, which effectively improves their body shape, without suffering from hunger for a long time. This diet pattern, with high safety and value, suggests a novel approach for weight loss among overweight and obese college students.

Keywords: Intermittent fasting, 5:2 diet, Diet pattern, Overweight and obesity, Weight loss among college students

1. Introduction

In recent years, prevalence of overweight and obesity has been a gradual rise [1], which has considerable impact on the public health system with a huge economic burden [2]. Their overall physical health is worrying, therefore, a new weight loss method, intermittent fasting (IF), is proposed, which is a dietary pattern alternately conducted by normal energy and energy limitation (or complete fasting) [3]. Time distinguishes four different types of it, i.e. Periodic fasting (PF), Alternate day fasting (ADF), Time-limited fasting (TRF), and Intermittent fasting 5:2(IF 5:2) [4]. Among them, IF 5:2 is the most widely used, which refers to choosing non-consecutive twice a week for fasting (500kcal for female and 700kcal for male), and eat normally for the remaining 5 days [5]. Then, extensive research, which is mostly 16 to 24 weeks and the longest intervention period is up to 2 years, has shown that the effects of this diet mode for weight loss are significant. However, the lack of follow-up study makes it difficult to show the sustainability of the diet pattern, and it is hard to judge whether the effect of IF is effective or not. On the other hand, there is little published data on overweight and obese college students who participated in these kinds of trials and then the extrapolation of trials' findings of general population is limited. Furthermore, current research generally takes moderate exercise as another variable, while it is difficult for overweight and obese subjects to assess their own sports injury risk, which can easily lead to accidents. At the same time, it is beyond the scopes of those studies to judge whether it is interfered by their exercise level. Based on the above, in order to improve efficiency and persistence for weight loss, and physical fitness of college students, this study, balancing many uncontrollable confounding factors, uses an 8-week before-after control study to investigate the changes of the body morphology indexes as well as exercise steps, heart rate and sleep scores among overweight and obese college students to bring reference and guidance for weight loss.

2. General information and methods

2.1 General information

Nine college students (6 males and 3 females) with BMI>24 were included in the this trial from September 2020 to January 2021. All participants were healthy without any relevant diagnosis, and they were randomly numbered without grouping.

2.2 Methodology

2.2.1 Operation Method

1) Control group: In the first four weeks, the subjects were required to eat a normal diet with no special restriction on calories; their living habits were as same as before, including exercise habits.

2) IF 5:2 diet group: In the last four weeks, the subjects were required to adopt the IF 5:2 diet. A one-day diet is customized based on the height and their own references to ensure that the total energy intake for male and female on fasting days is about 700kcal and 500kcal, respectively. What's more, they are supposed to take photos of the food that they eat on fasting days and indicated the weight of the food through WeChat where the data was collected in a timely manner; no calorie restriction on remaining normal eating days, and try to control the diet to the same level as when they did not undergo this trial.

2.2.2 Observation indicators

(1) Body morphology indexes: Determine if the differences of weight, waist circumference, hip circumference and their derived indexes BMI, waist-to-hip ratio, waist-to-height ratio were statistically significant during the control phase (in the first four weeks) and the intervention phase (in the last four weeks), respectively. In addition, Height data is based on recent physical examination.

(2) Exercise steps, heart rate and sleep status: The subjects are required to maintain their original exercise habits; use the same type of bracelet to measure the above indicators, and then record the data after the end of each week. In the end, to analyse whether their exercise steps, heart rate or sleep status changed throughout the day.

(3) Hunger, satiety, satisfaction, mood and persistent confidence scores: Use the VAS evaluation Form to evaluate and upload these data immediately before going to bed on fasting days, and analyse whether the difference in VAS scores during the intervention phase is statistically significant.

(4) Safety and compliance score: The subjects are required to report adverse reactions caused by fasting, such as fatigue, headache, constipation, and stomach pain and so on. Then, the investigator should judge whether the trial needs to be suspended according to the severity; record the number and frequency of adverse reactions.

3. Result and discussion

Of ten responders to the social media advertisement, all of them met inclusion and exclusion criteria and all agreed to enrol in the study. Of these, nine completed the study; one subject did not complete the study because she volunteered that she was non-compliant with the IF 5:2 diet.

3.1 Body morphology indexes

None of these differences were statistically significant during control phase ($P>0.05$). In the 4-week intervention phase, reductions in weight ($2.678\pm 2.230\text{kg}$), waist circumference ($3.389\pm 2.868\text{cm}$), hip circumference ($2.733\pm 2.560\text{cm}$), BMI (0.875 ± 0.667) and waist-to-height ratio (0.019 ± 0.015) were observed ($P<0.05$), while change in waist-to-hip ratio (0.009 ± 0.027) was no significant difference ($P>0.05$) at baseline, 4 and 8 weeks (Fig.1.).

Several reports have proved that body morphometric indexes are the most commonly used set of indicators to study the effects of fasting, and they provide a good indication of body shape. For example, BMI, which combines weight and height, is the most common and operational measure of overweight and obesity in adults; waist circumference is a good indicator of visceral fat content and can be used as a risk indicator for metabolic disorders. The results of this study showed there were significant decreases in body weight, waist circumference, hip circumference, BMI and waist-to-height ratio, while the waist-

to-hip ratio was not significantly different after the 4-week IF 5:2 diet in 9 subjects. Similarly, Huang [6] found that the volunteers' body weight, BMI and waist circumference reduced by 4.87 ± 1.92 kg, 1.68 ± 0.62 and 3.55 ± 1.38 cm, respectively after the 6-week IF 5:2 diet. This is also in line with the findings of Wu et al. [7] who found significant reductions in body weight, BMI and waist circumference in the 8-week IF 5:2 diet. On the other hand, as for small sample trials, Johnson et al. [8] found a weight loss of 8.5 ± 1.7 kg in an 8-week IF 5:2 diet study with a sample size of 10, while Sun et al. [9] found there were significant reductions in body weight, BMI, waist circumference and hip circumference, but not significant change in waist-to-hip ratio after a 12-week IF 5:2 diet, which is fully consistent with the results of this trial.

An implication of this is the possibility that the IF 5:2 diet has a moderate and sustained effect on improving body shape in overweight and obese individuals. What is surprising is that the IF 5:2 diet is more efficient in improving the relevant body morphology indexes over time through a rough comparison of the 4-week intervention with the 6, 8 or 12-week intervention. These results therefore need to be interpreted with caution, and therefore, further work is required to establish the optimal duration of IF 5:2 diet.

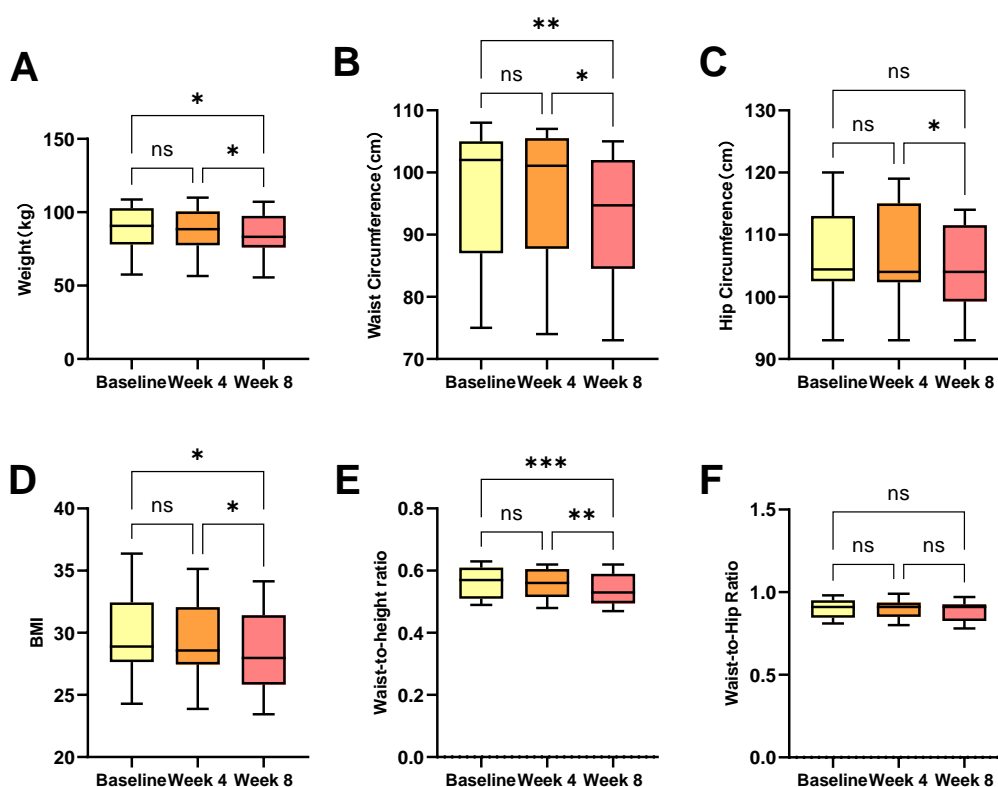


Figure 1: Effects of IF 5:2 diet on body morphology indexes in 9 subjects at baseline and at 4 and 8 weeks. (A) Change of weight in the trial. (B) Change of waist circumference in the trial. (C) Change of hip circumference in the trial. (D) Change of BMI in the trial. (E) Change of waist-hip ratio in the trial. (F) Change of waist-to-hip ratio in the trial. All above data were determined by one-way repeated measured ANOVA with Bonferroni's multiple comparison test, $n=9$, (* $p < 0.05$, ** $p < 0.01$, ns $p > 0.05$)

3.2 Exercise steps, heart rate, and sleep status

As shown in Figure 1, there were no difference in exercise steps count, heart rate and sleep status scores of the nine subjects decreased by 493.048 ± 3755.014 , 1.538 ± 3.521 , and 0.026 ± 2.030 , respectively between control phase and intervention phase. Also, differences in exercise steps count (904.876 ± 1724.38), heart rate (1.281 ± 3.380) and sleep scores (0.669 ± 2.962) were significant ($P < 0.05$) between the fasting day and non-fasting day.

In reviewing the literature, very little was found on the differences of these variables in any phase. This study supports evidence from previous observations (e.g. Klempel et al., 2011 [10]). These relationships partly are explained by a disproportionate effect on the number of steps with insufficient energy intake, and these finding suggests that the original intensity of exercise before this trial is

acceptable and feasible in the IF 5:2 diet phase. Pretty fewer relevant studies on heart rate and sleep status scores, and therefore further studies, which take these variables into account, will need to be undertaken. In line with the results of this trial, Klempel et al. [11] found a 3 ± 2 unit increase in mean heart rate in study participants after an 8-week fasting diet, which was not statistically significant. The finding which 25% of the subjects had delayed sleep time due to hunger during 6-week IF 5:2 diet by Zhu et al. [12]. This may be related to factors such as the short duration of the study or the physical quality of the group. However, Betts et al. [13] showed that regular and prolonged night time fasting had no effect on sleep duration or sleep quality. Despite these promising results, questions remain. However, with a small sample size, caution must be applied, as the findings might not be the same. In future investigations, it might be possible to use a large-scale sample for obtaining more convincing test results.

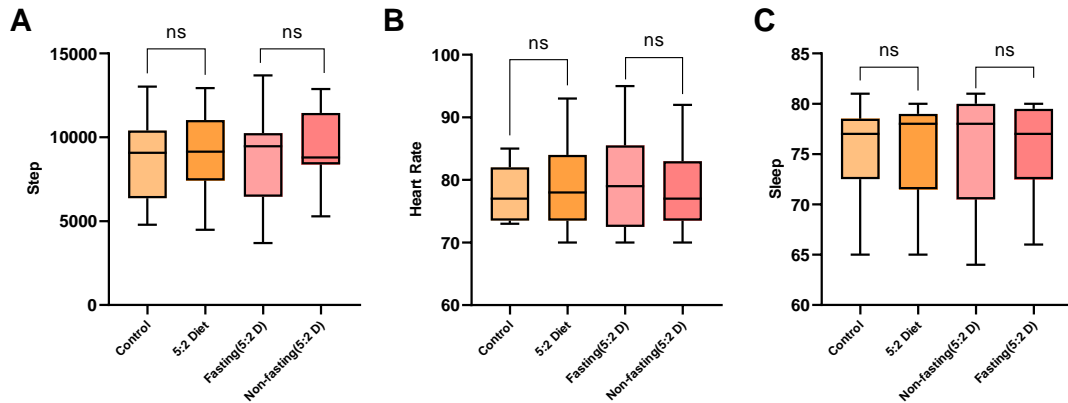


Figure 2: Effects of IF 5:2 diet on exercise steps, heart rate, and sleep status in 9 subjects. Exercise steps (A) heart rate (B) and sleep status scores(C) in control period matching with 5:2diet period and fasting days matching with non-fasting days during the IF 5:2 diet phase were determined by t test respectively, $n=9$, ($* p < 0.05$, $** p < 0.01$, $ns p > 0.05$)

3.3 VAS relevant scores in fasting days

Five items on the questionnaire measured the extent of sustainability IF 5:2 diet. However, these results were not very encouraging that there was a slight increase ($P < 0.05$) in the satiety scores, while no significant differences ($P > 0.05$) were found in the scores of hunger, satisfaction, mood or persistent confidence during the 4-week IF 5:2 diet (Fig.3.).

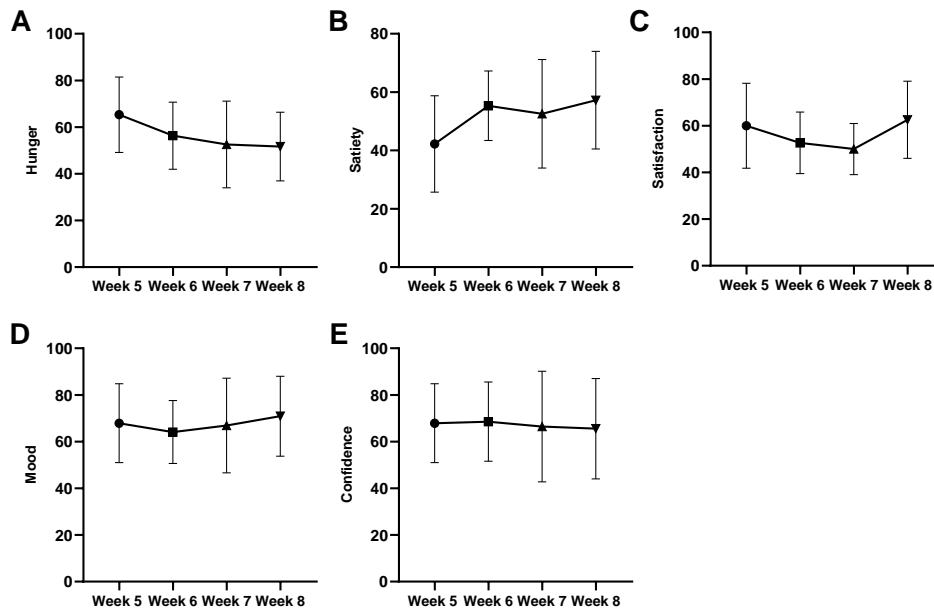


Figure 3: nine subjects lost weight and improved satiety when maintained on IF 5:2 diet. Hunger scores (A), satiety (B), satisfaction(C) mood scores (D) and persistent confidence were measured at light fasting days every weeks during the 4-week IF 5:2 diet phase.

Currently, there are only a few studies on the effects of IF 5:2 diet on these five variables; however, among other types of fasting diet, Hoddy et al. [14] found no statistical difference in hunger through an 8-week alternate day fasting diet, which is consistent with the results of this trial. In addition, Klempel et al. [10] showed a significant change in hunger after the second week of the intervention, which continued to decrease, and a significant increase in satisfaction at the third week of the intervention, which continued to increase, with no statistically significant change in satiety. There are still many unanswered questions about changes in the above variables that evaluate the sustainability of subjects during intermittent fasting, and therefore future studies on the current topic are therefore recommended.

3.4 Adverse effects of fasting days

The adverse effects on IF 5:2 days were counted (Tab.1.): two participants showed no adverse effects (22.22%), however, seven participants showed different degrees of adverse effects (77.78%), of which the first two were fatigue (40%), anxiety (3%).

Prior studies (Harvie et al., 2013 [15]) that have noted adverse effects on fasting days in this study were mainly mild, such as fatigue, anxiety, palpitations, acid reflux and gastric distention, and no serious adverse effects were observed. Due to the short duration of the study and the fact that the study population was university students who were in better physical condition compared to other populations, the adverse effects were mild. A strong evidence about adverse effects on fasting days has been reported in the literature by Ke et al. [16], which supported that the reactions to calorie restriction were self-protective responses to stress, and that all physiological indicators were stable. Therefore, IF 5:2 diet is relatively safe when carried out under the guidance of professional health managers.

Table 1: Symptoms of adverse effects during the trial

Symptoms of adverse reactions	Number of people	Proportion
Fatigue	4	40%
Anxiety	3	30%
Acid reflux, bloating or gastric pain	2	20%
Heart palpitations	1	10%

4. Conclusion

In summary, 4-week short-term IF 5:2 diet has a significant weight loss effect among overweight and obese college students with high safety and high use value, which not only effectively improves their body morphology indexes levels without prolonged hunger, but also is free for the selection of favourite foods. Similarly, this diet mode relieves psychological discomfort and prolong their persistence, therefore, it is worth popularizing in the aspect of weight management in health management. However, what are now needed are more large-scale randomized controlled trials involving micro-mechanism of IF 5:2 diet among these students. Further research might then usefully explore how to apply to general chronic non-communicable diseases for future practice in conjunction with health managers, epidemiologists, clinical nutritionists, sports experts, and psychological behaviours. In the end, this would be a fruitful area for promoting work.

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