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Effect of Intermittent Fasting on Appetite and Dietary Intake

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ABSTRACT

Background: The role of 5:2 intermittent fasting (IF) in influencing appetite to improve dietary compliance and sustain long-term weight loss is unclear. This study aimed to evaluate changes in appetite on fasting days for an IF group and to compare dietary intakes between the IF and continuous calorie restriction (CR) groups.

Methods: A three-month longitudinal study was conducted using data from the Iranian National Obesity Registry. Eligible participants (body mass index (BMI) ≥25 kg/m², 18-65 years old) were assigned to a 5:2 IF group (n=40) or a CR group (n=42) for 12 weeks. To evaluate appetite-related variables on fasting days, we used a validated visual analog scale to measure hunger, fullness, estimated eating capacity, and other factors related to appetite. These measurements were taken at the beginning and the end of fasting days. To assess dietary intake, we conducted 3-day food recalls at baseline and after three months.

Results: Both groups showed significant reductions in macro- and micronutrient intakes compared to baseline values, but no significant differences between the two groups were observed (p>0.05). Hunger and estimated eating capacity significantly decreased on fasting days (p=0.02 and p<0.001, respectively), and fullness significantly increased (p=0.03). No significant changes were observed in satisfaction (p=0.88) or eating desire intensity (p=0.41).

Conclusion: These findings suggested that the 5:2 IF regimen effectively reduced hunger and estimated eating capacity; while increasing fullness on fasting days. These effects may contribute to the efficacy of IF as a weight loss strategy over a 12-week period.

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Introduction

Obesity has become a serious public health issue as it is associated with an increased risk of developing metabolic and cardiovascular diseases (1, 2). To address this, various weight loss strategies have been investigated, including intermittent

fasting (IF) as an alternative to calorie restriction (CR) for overweight and obese individuals (3, 4). One popular form of IF is the 5:2 diet, in which individuals restrict their caloric intake to 20-25% on two non-consecutive days of the week maintaining normal eating habits on the remaining five days. Multiple studies have demonstrated that this diet results in approximately 4% weight loss in eight weeks and 7% if adhered to for periods ranging from 24 to 52 weeks in overweight and obese men and women (5). The 5:2 diet has gained popularity due to its relatively flexible structure, enabling better adherence in comparison with other weight loss strategies (4).

Managing hunger is a significant obstacle to the success of weight loss diets(7, 8). Some studies have indicated that hunger tends to be increased with continuous energy restriction and even exercise, which can impede weight loss efforts (9, 10). On the other hand, IF regimens have proved promising in managing hunger and controlling satiety. Nevertheless, the mechanism behind this effect has not yet been fully understood(11, 12). Researches exploring the relationship between IF and hunger/satiety are still in their early stages. Nonetheless, several studies have offered valuable insights into this relationship(13-16). For example, an eight-week study on alternate-day fasting discovered decreased hunger and increased satiety in participants by the end of the study (16). Additionally, a separate study comparing IF and CR for weight loss (both resulting in a 12.5% weight loss over 12 weeks) found no significant differences in hunger, fullness, food cravings, or anticipated food intake between the two groups (17).

Despite these initial inconsistent findings, while a limited number of previous studies have explored the effects of the 5:2 intermittent fasting regimen on hunger, fullness, and appetite (18, 19), no study has comprehensively investigated the impact of different food compositions, particularly for high-protein diets in relation to appetite variables during fasting days. The previous studies on hunger and IF have typically assessed hunger at a single time point and in a non-fasting state that potentially led to limited conclusions. The present study sought to examine changes in dietary intake after 12 weeks of adherence to the 5:2 diet, comparing it to a standard CR approach. Additionally, the study aimed to evaluate the impact of 5:2 IF, with a protein-rich diet on fasting days (IF-P), and on appetite status during fasting days. The findings of this study could enhance our understanding of how IF impacts hunger, fullness, and dietary intake, potentially guiding the creation of more successful weight loss interventions.

Materials and Methods

To conduct this three-month longitudinal study, data were obtained from participants who visited the Iranian National Obesity Registry (IRNOR) clinic, where a standardized protocol was applied to all subjects. The inclusion criteria consisted of being overweight or obese (body mass index (BMI) ≥25 kg/m^2), aged between 18 and 65 years, and having complete information recorded for the three-month follow-up period. Individuals receiving other treatment strategies for obesity were excluded. Out of the 345 individuals who visited IRNOR between August and October 2023, 82 people met the eligibility criteria for our study. This research was carried out in accordance with the principles outlined in the Helsinki Declaration. All procedures involving human participants were approved by the Research Ethics Committee of Mashhad University of Medical Sciences (Approval Code: IR.MUMS.MEDICAL.REC.1402.333). This study was supported by Mashhad University of Medical Sciences, Iran, under Project Number 4020591. It was ensured that thestudy to be adhered to all ethical standards and regulations for conducting research involving human subjects.

All participants received care at the same clinic, and the protocol for the registry was standardized and identical for all participants. The Harris-Benedict formula was used to calculate the basal metabolic rate (BMR) for each individual. Female Participants in the 5:2 group were allowed to consume 500 Kcal on fasting days. This allowance for the male was 600 Kal, which occurred on two non-consecutive days each week for both men and women. On feeding days, participants were instructed to satisfy a 100% of their baseline energy needs. The diet on fasting days included three main meals and two snacks, with a macronutrient distribution of 30% of calories from fat, 30% from protein, and 40% from carbohydrates.

On fasting days, participants were allowed to consume zero-calorie beverages such as black coffee and tea. On feeding days, individuals in the 5:2 group followed a diet which included three main meals and five snacks. This diet consisted of 30% of calories from fat, 15% from protein, and 55% from carbohydrates. The CR group also adhered to a similar macronutrient distribution and meal frequency pattern. However, they limited their daily calorie intake by 500-1000 Kcal per day. All participants received dietary education from a clinical nutrition specialist to ensure they properly followed their assigned diets.

Subjective feelings of hunger, satisfaction,

fullness, estimated eating capacity, and eating desire intensity were assessed at the beginning and by the end of the 12th week of the study usinga validated visual analog scale (VAS) (20). Participants in the IF group marked a vertical line on a 100-mm scale to indicate their feelings, with 0 representing "not at all" and 100 representing "extremely". Dietary intakes were assessed at the beginning and end of the third month through a 3-day, 24-hour food recall in both study groups by a trained dietitian. All dietary information was analyzed using Nutritionist Pro software (version X.X, Axxya Systems). Participants' compliance with the prescribed diets was monitored biweekly using an extra food log, which recorded any additional food intake beyond their prescribed daily energy goal. Adherence was defined as having a daily energy intake not exceeding 200 Kcal above the prescribed goal. Monthly monitoring of changes in weight and body composition was also conducted, with adjustments made to the prescribed diets accordingly.

Descriptive statistics, including frequency, percentage, mean, standard deviation, median, and interquartile range were utilized to summarize both the qualitative and quantitative data in the study. The data's normality was evaluated using the Kolmogorov-Smirnov test, which helped determine the most suitable statistical tests to use. To compare quantitative variables between the two groups, the student's t-test was employed for normally distributed data, while the Mann-Whitney test was used for non-normally distributed data. The Chi-square test was utilized for qualitative variables. To evaluate within-group changes (from baseline to the end of the intervention), paired t-test or the Wilcoxon signed-rank test was used, depending on the data distribution.

Table 1: Demographic data, dietary history and nutritional habits of the participants.

Variable	Group		*P* value
	IF (n=40)	CR (n=42)	
Age (year), median (IQR)	30 (19.75)	35 (15.25)	0.10
Sex, n (%)			
Male	12 (30.0)	12 (28.6)	0.89
Female	28 (70.0)	30 (71.4)	
Diet history, n (%)			
Yes	34 (85.0)	23 (54.8)	0.003
History of a successful diet, n (%)			
Yes	30 (88.2)	27 (91.3)	0.71
Type of diet, n (%)			
Low-calorie diet	26 (86.7)	20 (95.2)	0.31
Others	4 (13.3)	1 (4.8)	
Diet start method, n (%)			
Self-directed	3 (10.0)	6 (28.6)	0.09
Medically supervised	27 (90.0)	15 (71.4)	
Amount of weight loss (kg), median (IQR)	10.5 (10)	8 (7)	0.08
Within a period (month), median (IQR)	6 (6.63)	3 (5)	0.22
Appetite statue, n (%)			
Low or moderate	25 (62.5)	20 (47.6)	0.18
High	15 (37.5)	22 (52.4)	
Eating rate, n (%)			
Slow	2 (5.0)	4 (9.5)	0.73
Moderate	18 (45.0)	18 (42.9)	
Fast	20 (50.0)	20 (48.8)	
Eating out, n (%)			
Yes	33 (82.5)	31 (73.8)	0.34
Frequency of eating out, median (IQR)	2 (3)	1.5 (4)	0.85
Consumption of fast food, n (%)			
Yes	28 (70.0)	27 (64.3)	0.58
Frequency of fast-food consumption, median (IQR)	2 (3.75)	1 (3)	0.31
Number of meals per day, median (IQR)	4 (2)	4 (2)	0.63
Breakfast eating habit, n (%)			
Yes	32 (80.0)	31 (73.8)	0.51

Continuous variables were presented as mean±SD or median (IQR: interquartile range) according to variable distributions determined by Kolmogorov-Smirnov test. Categorical variables were presented as number (percent). To compare groups, independent sample T-test or Mann-Whitney U test was used for continuous variables and Chi-square test was performed for categorical variables. IF: intermittent fasting; CR: calorie restriction.

To compare differences between groups, analysis of covariance (ANCOVA) was conducted while controlling for baseline values. The dietary intake variables were not adjusted for energy intake.All statistical analyses were carried out using SPSS software (version 25, Chicago, IL, USA) with a significance level set at 0.05.

Results

The study groups (IF and CR) did not differ significantly in terms of age and gender distribution (p>0.05). However, an important distinction was found in relation to the dieting history, as 85% of IF participants reported a previous dieting experience when compared to only 54.8% in the CR group (p=0.003). No significant differences were found in success with prior diets, daily meal frequency, or eating habits such as eating rate and breakfast consumption between the groups (all p>0.05) (Table 1). Table 2 shows the changes in appetite over the 12-week period of fasting. The results revealed a asignificant decrease in hunger (p=0.02) and a significant increase in fullness (p=0.03). The estimated eating capacity significantly decreased too (p<0.001). However, changes in satisfaction (p=0.88) and eating desire intensity (p=0.41) demonstrated no statistically significant differences.

The study examined changes in macronutrient intake for both IF and CR groups throughout the study as depicted in Table 3. Significant changes in weight and BMI were observed in both the IF and CR groups (p<0.001), but no significant differences were noticed between the groups (p>0.05). The findings illustrated that both methods led to significant reduction in energy intake (p<0.001). However, the CR group experienced a greater decrease in energy intake (-525.33 vs. -506.23 Kcal). Fat and carbohydrate intake also decreased significantly for both groups (p<0.05). Nevertheless, there were no statistically significant differences in protein intake changes for either group (p=0.52 for IF and$p$=0.13 for CR, respectively).Both groups displayed a significant decrease in total starch and sugar consumption (p<0.05). However, no significant difference was seen between the two groups (p=0.32 and p=0.09, respectively). Reductions in sucrose and maltose intake were significant in both groups (p<0.05), while changes in glucose, fructose, lactose, and starch polysaccharides depicted no statistical significance (p>0.05). Additionally, fiber intake significantly decreased in both the IF and CR groups (p=0.01 and 0.03, respectively), but the difference between the two groups was not statistically significant (p=0.06).

Both the IF and CR groups showed significant reductions in saturated fat and polyunsaturated fat (p=0.05 and p=0.01, respectively). However, it is important to exercise caution when interpreting the p value of 0.05 as it was considered a borderline significant. There were no significant differences between the two groups in terms of saturated and polyunsaturated fat intake (p=0.32 and p=0.69, respectively). Changes in monounsaturated fat, trans fat, or cholesterol intake were not statistically significant in either group (all p>0.05).

Detailed changes in micronutrient intake for the IF and CR groups were presented in Table 4. Both groups denoted to significant reductions in sodium intake (p<0.001 and p=0.02, respectively), with no significant difference between the groups (p=0.09). Chlorine intake also decreased in both groups, with a significant difference observed between the groups (p=0.04). Magnesium intake decreased significantly in the CR group (p=0.03); but it only approached significance in the IF group (p=0.06). The difference in magnesium intake between the two groups was not statistically significant (p=0.07). Selenium intake change was significant in the IF group (p=0.02), with a borderline significant difference noticed between the groups (p=0.05). No significant changes were found between the groups in terms of vitamins (all p>0.05), although vitamin B5 and B12 intakes were at the threshold of significance between the two groups (p=0.06 and p=0.07, respectively).

Discussion

The results of this study suggest that IF and CR diets can significantly alter various dietary components and micronutrient intakes. The importance of dietary components and micronutrient intakes have been discussed before (21-23). In our study, specifically, both groups experienced reduced intakes of sodium, chlorine, and selenium, indicating that these nutrients were affected by caloric restriction.

Table 2: Changes in appetite in fasting days, during the 12-week study.

Variable, Median (IQR)	Baseline	Week-12	Change	*P* value
Hunger	50 (50)	50 (37.5)	-10.00 (30)	0.02
Satisfaction	90 (20)	90 (20)	0.0 (10)	0.88
Fullness	60 (30)	70 (30)	10 (27.5)	0.03
Estimated eating capacity	50 (40)	50 (30)	-10 (27)	<0.001
Eating desire intensity	50 (40)	50 (40)	-10 (37.5)	0.41

Wilcoxon signed rank test.

Table 3: Participants' dietary characteristics during the 12-week study.

Variable	Group	Baseline	Week-12	Change	*P* value intragroup	*P* value[c] Inter-group
Weight (kg)	IF	92.05±19.40	84.42±16.66	-7.62±4.83	<0.001[a]	0.30
	CR	90.68±16.50	84.11±16.53	-6.57±3.82	<0.001[a]	
Body mass index (Kg/)	IF	33.68±5.23	30.92±4.45	-2.76±1.60	<0.001[a]	0.15
	CR	33.61±5.42	31.29±5.77	-2.33±1.08	<0.001[a]	
Protein (g/day)	IF	79.08±32.51	71.00±32.66	-8.08±43.68	0.52[a]	0.12
	CR	69.37±26.79	60.07±19.62	-9.30±29.06	0.13[a]	
Protein (g/kg)	IF	0.86±0.30	0.88±0.44	0.03±0.51	0.74[a]	0.08
	CR	0.77±0.28	0.71±0.28	-0.06±0.32	0.25[a]	
Fat (g/day)	IF	64.16±51.32	46.23±25.79	-17.93±50.53	0.03[b]	0.49
	CR	71.77±3.20	51.41±31.16	-20.36±51.78	<0.001[b]	
Carbo-hydrate (g/day)	IF	226.06±116.41	155.19±63.08	-70.87±111.82	<0.001[b]	0.08
	CR	277.37±144.50	190.85±79.58	-86.52±148.50	<0.001[b]	
Energy (Kcal/day)	IF	1754.50±843.94	1248.27±442.93	-506.23±763.24	<0.001[b]	0.08
	CR	1991.40±769.46	1466.07±489.96	-525.33±831.01	<0.001[a]	
Starch (g/day)	IF	132.79±72.72	90.17±42.66	-42.63±75.12	<0.001[b]	0.32
	CR	140.89±66.38	101.47±49.39	-39.42±71.30	<0.001[a]	
Total sugar (g/day)	IF	86.63±65.27	64.57±35.27	-22.06±60.22	0.03[a]	0.09
	CR	113.53±75.85	85.62±48.03	-27.92±75.69	0.03[b]	
Glucose (g/day)	IF	17.92±17.96	14.73±9.86	-3.19±18.45	0.55[b]	0.08
	CR	23.61±19.64	20.91±15.37	-2.70±20.51	0.60[b]	
Fructose (g/day)	IF	25.67±22.23	18.78±12.10	-6.89±22.37	0.15[b]	0.06
	CR	31.34±23.05	26.43±18.41	-4.91±22.79	0.22[b]	
Sucrose (g/day)	IF	20.38±26.75	13.07±15.18	-7.31±26.61	0.04[b]	0.60
	CR	37.48±50.92	15.63±15.35	-21.84±52.55	<0.001[b]	
Maltose (g/day)	IF	4.35±4.19	2.67±2.54	-1.69±4.53	0.03[b]	0.76
	CR	5.29±5.12	2.97±2.58	-2.32±4.92	0.01[b]	
Lactose (g/day)	IF	11.86±11.57	10.83±10.74	-1.03±12.23	0.99[b]	0.14
	CR	11.00±11.38	15.06±16.68	4.06±18.66	0.32[b]	
Non- starch polysaccharides (g/day)	IF	10.74±6.35	10.74±5.01	-0.00±6.25	0.97[b]	0.88
	CR	14.49±8.43	11.74±6.90	-2.75±8.64	0.06[b]	
Dietary fiber (g/day)	IF	13.33±8.71	9.92±4.54	-3.41±8.23	0.01[b]	0.06
	CR	14.84±7.17	12.52±6.43	-2.32±7.41	0.03[b]	
Saturated fat (g/day)	IF	24.25±19.65	15.97±9.70	-8.28±20.67	0.05[b]	0.32
	CR	24.93±19.10	18.86±15.10	-6.07±24.32	0.05[b]	
Mono-unsaturated fatty acids (g/day)	IF	21.47±21.48	17.74±24.72	-3.74±32.86	0.12[b]	0.80
	CR	22.25±21.19	16.64±13.50	-5.61±23.67	0.07[b]	
Poly-unsaturated fatty acids (g/day)	IF	12.05±11.87	9.32±9.09	-2.73±8.08	0.05[b]	0.69
	CR	13.95±15.22	9.17±4.28	-4.78±15.50	0.01[b]	
Trans fat (g/day)	IF	2.31±3.41	1.22±1.43	-1.09±3.85	0.32[b]	0.34
	CR	1.90±4.58	1.80±3.52	-0.10±5.63	0.57[b]	
Cholesterol (g/day)	IF	258.59±198.36	261.34±165.36	2.74±271.36	0.95[b]	0.68
	CR	309.94±222.94	286.09±218.17	-23.85±257.76	0.55[a]	

[a]Paired T-test, [b]Wilcoxon signed rank test, [c]Analysis of Covariance (ANCOVA), adjusted for baseline values. Abbreviations: IF: intermittent fasting; CR: calorie restriction.

Magnesium and several B vitamins, such as B5 and B12, seemed to be impacted by the diet type, with borderline significant differences noted between the IF and CR groups.Additionally, during the diet period, especially on fasting days, feelings of fullness increased while hunger decreased over the same period. Moreover, the estimated eating capacity significantly decreased. These results may be related to the effects of intermittent fasting or the higher protein content of the diet on appetite regulation.

The effects of intermittent fasting on appetite regulation have been explored in several previous studies, with conflicting results. Various short-term studies (13-16, 24) and a long-term study examined the hypothesis of these effects on appetite (25). In an 8-week study, hunger level remained consistent, but feeling of fullness significantly rose, which was attributed toanelevated level of the hormone peptide yy (PYY), known for promoting satiety. However, no significant connections were found between satiety, PYY, weight loss, or resting metabolic rates (16).

Table 4: Changes in minerals, trace elements and vitamin levels in IF and CR groups during the 12-week study.

Variable	Group	Baseline	Week-12	Change	*P* value intragroup	*P* value [c] intergroup
Sodium (mg/day)	IF	2200.34±1601.21	1429.36±739.77	-770.97±1496.29	<0.001[b]	0.09
	CR	2206.35±1583.41	1682.58±657.55	-523.77±1586.49	0.02[b]	
Potassium (mg/day)	IF	2276.67±1004.31	2147.88±914.47	-128.80±1052.03	0.44[a]	0.40
	CR	2734.15±1102.95	2491.08±1205.85	-243.07±1411.08	0.19[b]	
Calcium (mg/day)	IF	831.79±507.83	719.37±437.95	-112.41±494.41	0.16[a]	0.25
	CR	929.88±512.15	875.46±589.50	-54.42±753.28	0.42[b]	
Magnesium (mg/day)	IF	225.32±120.11	189.14±72.38	-36.17±129.00	0.06[b]	0.07
	CR	283.83±129.25	230.76±99.78	-53.07±153.64	0.03[a]	
Phosphorus (mg/day)	IF	1105.13±484.88	956.72±358.39	-148.42±477.70	0.07[b]	0.14
	CR	1240.44±511.09	1146.18±591.17	-94.27±719.45	0.22[b]	
Iron (mg/day)	IF	8.14±4.19	7.09±3.54	-1.05±4.28	0.10[b]	0.73
	CR	9.17±4.48	7.57±3.93	-1.61±5.75	0.02[b]	
Copper (mg/day)	IF	1.04±0.57	0.90±0.44	-0.14±0.64	0.30[b]	0.25
	CR	1.37±0.81	1.07±0.69	-0.31±1.09	<0.001[b]	
Zinc (mg/day)	IF	14.03±39.62	6.04±1.80	-7.99±39.82	<0.001[b]	0.22
	CR	48.11±252.51	13.78±40.32	-34.33±256.90	0.05[b]	
Chlorine (mg/day)	IF	3764.62±2521.14	2578.32±1193.98	-1186.30±2335.76	<0.001[b]	0.04
	CR	3691.27±2566.96	3072.66±092.21	-618.62±2469.01	0.09[b]	
Manganese (mg/day)	IF	2.67±1.58	2.08±0.85	-0.59±1.44	0.02[b]	0.30
	CR	3.41±2.56	2.38±1.11	-1.03±2.66	0.01[b]	
Selenium (µg/day)	IF	47.48±21.02	39.99±15.53	-7.50±20.25	0.02[b]	0.05
	CR	55.53±28.58	51.23±27.40	-4.29±38.52	0.38[b]	
Iodine (µg/day)	IF	147.19±111.69	129.13±89.20	-18.07±113.71	0.35[b]	0.19
	CR	147.03±110.44	166.96±167.79	19.94±174.52	0.80[b]	
Retinol (µg/day)	IF	202.26±188.73	173.33±96.02	-28.93±202.92	0.29[b]	0.27
	CR	265.25±228.82	216.26±155.30	-48.99±217.37	0.31[b]	
Carotene (µg/day)	IF	1336.83±1828.18	1936.41±3019.18	599.59±3117.31	0.15[b]	0.61
	CR	2094.01±3805.68	1645.31±312.36	-448.70±4624.66	0.44[b]	
Vitamin D (µg/day)	IF	1.52±1.59	1.59±1.09	0.07±1.84	0.64[b]	0.85
	CR	1.85±1.50	1.70±1.58	-0.15±1.85	0.52[b]	
Vitamin E (mg/day)	IF	20.15±46.17	11.15±20.77	-9.01±50.92	0.99[b]	0.71
	CR	11.87±30.80	9.51±20.55	-2.36±37.37	0.14[b]	
Vitamin B1 (mg/day)	IF	1.01±0.60	0.89±0.34	-0.13±0.60	0.16[b]	0.10
	CR	1.22±0.54	1.10±0.54	-0.12±0.64	0.23[a]	
Vitamin B2 (mg/day)	IF	1.45±.67	1.33±0.64	-0.12±0.73	0.29[a]	0.19
	CR	1.70±1.07	1.64±1.09	-0.05±1.36	0.71[b]	
Vitamin B3 (mg/day)	IF	15.06±11.51	12.72±7.79	-2.33±14.07	0.71[b]	0.10
	CR	17.77±13.43	16.14±9.53	-1.63±14.91	0.63[b]	
Vitamin B6 (mg/day)	IF	1.29±0.62	1.07±0.40	-0.22±0.60	0.05[b]	0.14
	CR	1.59±0.77	1.66±2.11	0.06±2.19	0.09[b]	
Vitamin B12 (µg/day)	IF	3.26±2.67	2.73±1.35	-0.52±2.66	0.22[a]	0.07
	CR	5.74±17.08	4.50±5.77	-1.24±17.75	0.29[b]	
Vitamin B9 (µg/day)	IF	201.22±97.16	216.03±122.99	14.81±126.02	0.91[b]	0.95
	CR	234.59±117.25	230.75±124.52	-3.84±139.82	0.61[b]	
Vitamin B5 (mg/day)	IF	5.05±2.26	4.63±1.70	-0.43±2.59	0.54[b]	0.06
	CR	7.09±5.57	5.76±3.15	-1.33±6.48	0.14[b]	
Vitamin B7 (µg/day)	IF	29.88±23.74	27.85±11.00	-2.03±25.05	0.80[b]	0.24
	CR	36.47±18.44	32.66±17.94	-3.82±22.04	0.27[a]	
Vitamin C (mg/day)	IF	75.88±74.16	83.89±85.94	8.01±93.71	0.42[b]	0.16
	CR	130.31±97.09	128.61±105.66	-1.70±131.92	0.93[a]	

[a]Paired T-test, [b]Wilcoxon signed rank test, [c]Analysis of Covariance (ANCOVA), adjusted for baseline values. Abbreviations: IF: intermittent fasting; CR: calorie restriction.

Another 12-week study found when hunger level remained unchanged, feeling of satiety significantly increased in individuals with obesity. However, this increase was not significantly correlated with weight loss (15).

While several studies have suggested that intermittent fasting can affect appetite, others have reported conflicting results (14, 19, 25). For instance, a study comparing intermittent fasting to daily calorie restriction found that while appetite decreased in both groups, feelings of satiety did not change significantly (14). Similarly, a long-term study lasting 12 months did not observe any significant improvement in appetite regulation, attributing this to inadequate weight loss and poor adherence to the diet (25). Additionally, another study found no significant difference between intermittent fasting and continuous energy restriction regarding appetite, fullness, desire to eat, or prospective food consumption (19). To our believes, these conflicting results may arise from variations in study design, such as differences in fasting regimens, study duration, participant characteristics, and adherence level. Furthermore, the methodological quality of the studies, including potential biases, could have contributed to the discrepancies.

Intermittent fasting influences appetite regulation through a complex interplay of hormonal changes. The weight loss associated with intermittent fasting results in reduced levels of leptin and insulin, both of which are hormones that naturally suppress appetite(26). The decrease in these hormones may lead to reduced sensitivity of the brain to satiety signals, which can result in an increased hunger and greater calorie intake (27). However, the increased level of PYY, an appetite-suppressing hormone, may counteract the negative effects of reduced leptin and insulin levels, thus aiding appetite regulation (16). Activation of autophagy, which occurs during intermittent fasting, can affect metabolism and appetite regulation in several ways. Autophagy in hypothalamic neurons is a crucial process for maintaining energy balance and controlling appetite by regulating neuropeptides such as agouti-related protein (AgRP) and pro-opiomelanocortin (POMC), which influence hunger and satiety signals (18). Autophagy also affects lipid metabolism (28), enhances insulin sensitivity, and contributes to weight loss through fasting, thereby regulating metabolism and appetite(29, 30). Additionally, intermittent fasting can impact the gut-brain axis by changing the composition of gut microbiota, increasing the production of short-chain fatty acid (SCFA), and reducing circulating lipopolysaccharide levels (31).

It appears that consuming a high-protein diet on fasting days is crucial in boosting satiety. Protein helps release satiety hormones like PYY and glucagon-like peptide 1 (GLP-1), while decreasing the hunger hormone ghrelin. This leads to longer-lasting feelings of fullness too. Furthermore, protein consumption slows down gastric emptying that further amplifies this effect(32, 33). The psychological aspects of intermittent fasting are important as it was shown that controlled diets can increase an individual's awareness of their eating behaviors and help establish regular eating habits. This leads to a better understanding of hunger and satiety cues, which may reduce overeating and increase long-term adherence to the diet (34).

Additionally, it is important to note that participants in the IF group had a higher history of prior dieting, greater weight loss before entering the study, and lower baseline energy intake. These factors may have contributed to a potential weight loss plateau before the study began. As a result, this could have affected their response to the intermittent fasting regimen, possibly reducing the observed impact of the 5:2 diet on appetite regulation. This study had several strengths. First, to the best of our knowledge, it is one of the first studies to directly examine changes in appetite and related factors during fasting days. Second, the 12-week duration of the study allowed for a thorough examination of the effects of these dietary method on appetite over time. Finally, the inclusion of a high-protein diet on fasting days was a unique feature of this study that had not been explored in previous intermittent fasting studies. Moreover, the use of registry-based studies provided real-world data from diverse populations, enhancing the generalizability of results. This observational study design also allowed for the observation of natural behaviors without direct intervention, contributing to more accurate public health insights and aiding policy-making (35).

However, there were several limitations in this study. First, appetite changes were only assessed in the IF group on fasting days, limiting the ability to draw conclusions about the effects of continuous calorie restriction on appetite regulation. Furthermore, the study did not consider psychological factors such as emotional eating, which are known to influence appetite and may have affected the results. Moreover, the use of 24-hour dietary recalls may have introduced recall bias, potentially impacting the accuracy of the self-reported data. Lastly, the relatively short duration of the study may not have been long enough to capture the long-term effects of these approaches on dietary intake and appetite.

Conclusion

This study suggested that both intermittent fasting and continuous calorie restriction could result in significant changes in dietary components, micronutrient intake, and appetite regulation. However, further research is required to validate these findings and to investigate the impact of these methods on different populations, particularly individuals with obesity. Overall, the findings of this study can add to the increasing evidences on the effects of intermittent fasting and continuous calorie restriction on appetite regulation, potentially influencing weight management interventions.

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Authors' Contribution

Study concept and design: N.A., N.S., M.A.N., and M.Gh.M.; Investigation: N.A., and N.H.; data analysis and interpretation of data: N.A., and H.E.; drafting of the manuscript: N.A.; funding acquisition and supervision: M.Gh.M.; editing and critical revision: G.A.F., N.S., and M.A.N. All authors contributed to the article and approved the submitted version.

Conflict of Interest

The authors confirm no conflicts of interest.

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