



An Observational Study of a Time-Restricted Eating Regimen on a Cohort of Participants at an Intermittent Fasting Clinic

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Abstract

Overweight and obesity prevalence present significant health challenges on a global scale. Hence, the objective was to explore the effects of a time restricted eating (TRE) protocol on a specific group of participants for weight-loss management. This was an observational study with participants recruited from a specialized clinic, the Intermittent Fasting Research Foundation, Ahmedabad, Gujarat, over a period of 6-months. Obesity was evaluated using the BMI and all Anthropometric parameters were quantified using the bioelectrical impedance method. First month was completed by 239 participants, followed by 224 in the second month, 89 in the third month, 39, 19 and 8 for the fourth, fifth and sixth month respectively. A severe attrition rate was observed due to either having achieved goals or difficulty in following protocol. Each patient was provided a personalized diet and TRE under medical supervision, tailored to their specific needs and weight loss objectives. We consistently observed a statistically significant overall decrease in body weight, BMI, visceral fat, subcutaneous fat, and waist circumference at one-month interval throughout the six-month study period. Furthermore, the absence of skeletal muscle mass loss suggests that the decrease in BMI was not due to muscle loss. These observations suggest that TRE may be a safe and effective intervention for overweight and obese individuals who are highly motivated.



Article History

Received: 18 September 2025

Accepted: 01 December 2025

Keywords

BMI;
Body Composition;
Obesity;
Resting Metabolic Rate;
Skeletal Muscle Mass;
Visceral Fat;
Weight Loss.

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Doi: <http://dx.doi.org/10.12944/CRNFSJ.14.2.17>

Introduction

The progress of technology coupled with the easy availability of food and decreased physical activity has created a modern-day curse on the human race, referred to as "Lifestyle disorders". Obesity is undeniably one of the most prevalent chronic diseases that pose a serious challenge to global health with its comorbidities and the ensuing death overtime.¹ A major study has shown that the global obesity rates have more than doubled between 1990 and 2022. Additionally, over 1 billion people (including adults, children and adolescents) worldwide are living with obesity as of 2022.² The etiology of obesity is widely regarded as multifactorial, with a complex interplay between obesity-associated genes and several environmental factors. Obesity and overweight condition are significant health concern that, independently and in association with other diseases, causes or exacerbates many health issues. These health issues include but are not limited to insulin resistance, type 2 diabetes, heart disease, hypertension, osteoarthritis, respiratory complications, and an increased incidence of certain forms of cancer. Maintaining a healthy weight is paramount to reducing the risk of developing these conditions. Even a slight reduction of 1 kg in body weight can have a significant impact on reducing the risk of developing diabetes by as much as 16%.³ The repercussions of obesity on health can be severe; hence, it is crucial to take necessary steps to manage weight. Consequently, those seeking a simple fix are turning to various diet plans. Nowadays, many researchers have been exploring intermittent fasting (IF) as a potential substitute for traditional continuous energy restriction (ER) methods for weight loss. IF has gained considerable attention and interest in the scientific community as a viable approach to weight management.⁴ It is essential to understand that therapeutic fasting is a controlled and voluntary action of abstaining from calorie-containing foods and drinks for a specific time; this is entirely different from the involuntary and uncontrolled act of starvation.⁵ Fasting is a powerful eating pattern that revolves around the idea of restricting calorie intake for extended periods. This pattern helps to give the body a break from constant digestion and allows it to use stored energy for fuel. It is an effective, costless, natural dietary intervention promoting health and preventing ageing and diseases.¹ The term "intermittent fasting" has been employed to describe various types of caloric restriction for the purpose of health and weight

loss. Alternate-day fasting involves fasting one day followed by unrestricted eating on the next. Periodic regimen is another method where individual fasts for one or two days a week, also referred to as 5:2 or 6:1 fasting. Time-restricted eating is a widely adopted method for regulating food consumption. This approach involves limiting the time window for meals, typically with a daily fast of 16-20 hours and 8-4 hours feeding period.⁶ Here, we aimed to study the impact of time restricted eating (TRE) on overweight and obese individuals.

Materials and Methods

This research has been approved by the Institutional Human Ethics Committee of Gujarat University (Ref: GU-IEC(Niv)/02/PhD/033) and written informed consent was obtained from all subjects. An observational cohort study was conducted at the Intermittent Fasting Research Foundation (IFRF), Ahmedabad. The IFRF works with clients to adopt and use time restricted eating for metabolic syndromes. The clinic data is being used to understand the effects of TRE on weight loss. Two hundred and thirty-nine individuals completed the first month of the study, and 224 individuals completed the second month. Moving forward, 89 patients were able to complete the third month of the study, while only 39 and 19 individuals completed the fourth and fifth months, respectively. Finally, only eight patients continued the study through the sixth month. The number of participants decreased significantly in the following months owing either to a challenge in continuing, or having achieved their goals.

Inclusion Criteria consisted of individuals aged >18 years, who had BMI above 20 and wanted to lose weight due to health purposes and fitness goals, and obese or overweight women and men with a BMI above 25. Exclusion Criteria consisted of people on chronic medication or pregnant and lactating women. Obesity was evaluated using the BMI, and all Anthropometric parameters were quantified using the bioelectrical impedance method by Karada scan. The parameters such as height, weight, and waist circumference were recorded. Karada scan data, including body fat, visceral fat, subcutaneous fat, resting metabolism, BMI, and skeletal muscle mass, were measured at fifteen days interval.

Dietary interventions: The patients in the study were firmly instructed to follow a specific eating and fasting

schedule and were instructed to fast for 16-14 hours and consume their meals within an 8-10 hour feeding window daily throughout the study period. There were no specific uniform dietary intake requirements; each patient received a customised diet and fasting plan under medical supervision and weight loss goals following a thorough examination. This flexible dietary plan is a great advantage because it allows individuals to design meal plans according to their food preferences. Also, nutritional and balanced food education was given to each individual at the start.

The patients adhered to a dietary regimen which emphasized consuming whole foods and unprocessed unsaturated fats. Furthermore, they significantly reduced their intake of sugars and refined carbohydrates while concurrently increasing their consumption of natural fats. Without strictly counting calories, all reported satiety. During fasting, they were permitted zero-calorie fluids, including water, green tea, black

tea and black coffee. The fasting window and diet were self-monitored by the patients themselves and we have not focused on tracking of other variables such as physical activity.

Statistical methods: Statistical analyses were performed using GraphPad prism version 8.0.1. Data are presented as mean $\pm$ SD. Data within experiments were evaluated by repeated measures one-way ANOVA with Geisser-Greenhouse correction testing where appropriate. All tests were two-tailed and conducted at a 95% confidence interval. The mean effect size was calculated using Cohen's d metric. Statistical significance was accepted at $p < 0.05$.

Results

All the individuals were classified into three groups according to their BMI: Group 1 (Normal), Group 2 (Overweight) and Group 3 (Obese).

Table 1: Shows Anthropometric data before and after 1 month of Intermittent Fasting

Parameters	Before IF	After 1st month(n=239)	Percent Change
BMI	32.01 $\pm$ 5.33	30.69 $\pm$ 4.98****	4.12% ↓
Group 1	23.87 $\pm$ 0.70	23.24 $\pm$ 0.58**	
Group 2	27.61 $\pm$ 1.27	26.56 $\pm$ 1.31****	
Group 3	35.48 $\pm$ 4.34	33.93 $\pm$ 4.05****	
BODY WEIGHT	85.64 $\pm$ 17.48	82.36 $\pm$ 16.84*	3.82% ↓
Group 1	66.12 $\pm$ 6.34	64.33 $\pm$ 5.19**	
Group 2	72.99 $\pm$ 9.11	70.22 $\pm$ 9.12****	
Group 3	95.35 $\pm$ 15.68	91.69 $\pm$ 15.10 NS	
BODY FAT	37.77 $\pm$ 5.34	36.89 $\pm$ 5.45****	2.32% ↓
Group 1	28.16 $\pm$ 3.83	26.76 $\pm$ 3.63*	
Group 2	35.80 $\pm$ 4.68	34.97 $\pm$ 4.67****	
Group 3	39.63 $\pm$ 4.65	38.76 $\pm$ 4.82****	
VISCERAL FAT	17.23 $\pm$ 17.19	15.86 $\pm$ 7.13****	7.95% ↓
Group 1	8.33 $\pm$ 3.07	7.44 $\pm$ 2.80 NS	
Group 2	11.67 $\pm$ 3.57	10.53 $\pm$ 3.58****	
Group 3	21.51 $\pm$ 6.02	19.96 $\pm$ 6.22****	
RESTING METABOLISM	1650.61 $\pm$ 333.09	1611.14 $\pm$ 386.29*	2.39% ↓
Group 1	1449.55 $\pm$ 174.50	1424.55 $\pm$ 153.94 NS	
Group 2	1476.07 $\pm$ 214.56	1389.72 $\pm$ 308.81**	
Group 3	1786.09 $\pm$ 341.5	1770.92 $\pm$ 365.48 NS	
SUBCUTANEOUS FAT	32.42 $\pm$ 7.51	31.02 $\pm$ 7.41****	4.31% ↓
Group 1	24.00 $\pm$ 5.22	21.84 $\pm$ 4.70*	
Group 2	30.26 $\pm$ 5.86	28.85 $\pm$ 5.59****	
Group 3	34.40 $\pm$ 7.87	33.06 $\pm$ 7.77****	
SKELETAL MUSCLE MASS	23.76 $\pm$ 3.51	24.13 $\pm$ 3.54****	1.5% ↑
Group 1	27.81 $\pm$ 4.07	28.62 $\pm$ 4.11*	
Group 2	24.02 $\pm$ 3.45	24.51 $\pm$ 3.24*	
Group 3	23.32 $\pm$ 3.33	23.59 $\pm$ 3.45*	
WAIST CIRCUMFERENCE	107.60 $\pm$ 13.57	101.71 $\pm$ 14.29****	5.47% ↓
Group 1	93.28 $\pm$ 9.58	88.35 $\pm$ 9.13**	
Group 2	98.46 $\pm$ 7.98	93.68 $\pm$ 6.90****	
Group 3	114.00 $\pm$ 12.66	107.37 $\pm$ 15.03****	

Data are represented as mean $\pm$ SD **** $p < 0.0001$ ** $p < 0.01$ * $p < 0.05$ NS = non-significant
Group 1: Normal BMI, Group 2: Overweight, Group 3: Obesity

Table 1 shows the data of 239 individuals who completed their first month of fasting, where the first group comprised 9 participants with a normal BMI, while the second group included 92 participants and the third group, consisted of 138 individuals. During the first month of fasting, there was a decrease of 4.12% and 3.82% in BMI and weight, respectively in all the cases. However, there was a non-significant reduction in the body weight of the obese group.

Moreover, body fat decreased by 2.32%, and visceral fat decreased by 7.95%. The mean visceral fat in the normal BMI group did not significantly decrease from 8.33 to 7.44. The resting metabolism decreased by 2.39%, and there was a non-significant change in groups 1 and 3. The skeletal muscle mass significantly increased. Additionally, waist circumference and subcutaneous fat were reduced by 5.47% and 4.31%, respectively.

Table 2: Shows Anthropometric data before and after 2 months of Intermittent Fasting

Parameters	Before IF	After 2nd month(n=224)	Percent Change
BMI	32.33±5.42	30.47±4.95****	4.12% ↓
Group 1	23.87±0.70	22.90±0.43***	
Group 2	27.62±1.29	26.22±1.41****	
Group 3	35.57±4.38	33.38±4.04****	
BODY WEIGHT	86.91±17.80	81.78±17.31****	3.82% ↓
Group 1	66.12±6.34	63.17±5.88***	
Group 2	73.45±9.13	69.69±9.13****	
Group 3	95.94±15.98	89.89±16.40****	
BODY FAT	37.85±5.37	36.24±5.70****	4.25% ↓
Group 1	28.16±3.83	25.66±3.51**	
Group 2	35.75±4.58	34.08±4.72****	
Group 3	39.59±4.73	38.07±5.08****	
VISCERAL FAT	17.55±7.32	15.55±7.14****	11.39% ↓
Group 1	8.33±3.07	7.44±2.79*	
Group 2	11.63±3.74	10.75±3.70****	
Group 3	21.52±6.16	19.24±6.31****	
RESTING METABOLISM	1670.40±339.07	1611.87±322.16**	3.5% ↓
Group 1	1449.55±174.50	1408.44±153.60 ^{NS}	
Group 2	1472.79±216.49	1426.03±204.18*	
Group 3	1797.42±343.96	1731.06±329.13*	
SUBCUTANEOUS FAT	32.55±7.54	30.36±7.57****	6.72% ↓
Group 1	24.00±5.22	21.33±4.67*	
Group 2	30.33±5.79	28.04±5.77****	
Group 3	34.37±7.85	32.29±7.83****	
SKELETAL MUSCLE MASS	23.82±3.52	24.63±3.80****	3.40% ↑
Group 1	27.81±4.07	29.05±4.21*	
Group 2	24.08±3.46	25.09±3.64***	
Group 3	23.41±3.35	24.09±3.65****	
WAIST CIRCUMFERENCE	108.38±13.82	101.37±12.73****	6.46% ↓
Group 1	93.28±9.58	86.57±9.07**	
Group 2	98.75±8.85	92.90±7.05****	
Group 3	114.22±12.67	106.60±12.17****	

Data are represented as mean ± SD ****p<0.0001 ***p<0.001 **p<0.01 *p<0.05 NS = non-significant
Group 1: Normal BMI, Group 2: Overweight, Group 3: Obesity

Table 2 reveals that 224 people finished their two-month fasting protocol. Group 1 had 9 participants, while Group 2 and Group 3 had 78 and 137 individuals. BMI was reduced by 4.12%, weight by 3.82%, body fat by 4.25%, visceral fat by 11.39%; while the

skeletal muscle mass increased by 3.40%. Their resting metabolism decreased by 3.5%, and was non-significant for Group 1. Waist circumference and subcutaneous fat were reduced by 6.46% and 6.72% respectively.

Table 3: Shows Anthropometric data before and after 3 months of Intermittent Fasting

Parameters parameter	Before IF	After 3rd month(n=89)	Percent Change
BMI	32.51±5.05	30.08±4.40****	7.47% ↓
Group 1	23.72±0.73	21.90±0.61 ^{NS}	
Group 2	27.78±1.32	25.93±1.17****	
Group 3	35.06±4.00	32.36±3.34****	
BODY WEIGHT	85.29±17.69	81.88±16.38****	3.99% ↓
Group 1	65.15±7.42	61.05±6.21*	
Group 2	73.75±8.54	68.83±8.13****	
Group 3	95.95±16.66	88.70±14.92****	
BODY FAT	38.02±5.46	35.87±5.90****	5.65% ↓
Group 1	30.72±0.78	27.10±3.37 ^{NS}	
Group 2	35.46±5.46	33.57±5.87****	
Group 3	39.57±4.85	37.41±5.23****	
VISCERAL FAT	18.19±6.59	15.38±6.18****	15.55% ↓
Group 1	8.62±3.90	6.65±2.05 ^{NS}	
Group 2	11.84±2.71	9.78±2.27****	
Group 3	21.48±5.18	18.30±5.24****	
RESTING METABOLISM	1697.56±370.53	1634.03±304.96 ^{NS}	3.74% ↓
Group 1	1415.25±189.52	1363.50±166.51*	
Group 2	1493.08±201.04	1427.96±192.35 ^{NS}	
Group 3	1801.58±390.36	1737.93±297.18 ^{NS}	
SUBCUTANEOUS FAT	32.28±7.65	30.00±7.61****	7.06% ↓
Group 1	23.67±3.61	20.45±6.00 ^{NS}	
Group 2	30.10±6.35	28.03±6.30****	
Group 3	33.77±7.80	31.45±7.65****	
SKELETAL MUSCLE MASS	23.70±3.39	24.72±3.77****	4.30% ↑
Group 1	26.57±2.12	27.82±2.47 ^{NS}	
Group 2	24.37±3.32	25.53±3.84 ^{NS}	
Group 3	23.32±3.40	24.28±3.73****	
WAIST CIRCUMFERENCE	109.94±13.40	100.50±12.39****	8.58% ↓
Group 1	95.25±12.14	83.75±12.41**	
Group 2	100.22±7.57	92.20±7.16****	
Group 3	114.98±12.50	105.08±11.41****	

Data are represented as mean ± SD ****p<0.0001 **p<0.01 *p<0.05 NS = non-significant
Group 1: Normal BMI, Group 2: Overweight, Group 3: Obesity

Table 3 shows that 89 participants finished three months of fasting. Only four individuals remained in Group 1, and groups 2 and 3 had 25 and 60 subjects respectively. The BMI, body fat, visceral fat, and subcutaneous fat were reduced by 7.47%, 5.65%, 15.55%, and 7.06% respectively. All these

four parameters of normal BMI individuals were non-significant. Body weight and waist circumference significantly reduced in 3rd month by 3.99% and 8.58%. Resting metabolism decreased non-significantly, and skeletal muscle mass improved considerably by 4.30%.

Table 4: Shows Anthropometric data before and after 4 months of Intermittent Fasting

Parameters	Before IF	After 4th month(n=39)	Percent Change
BMI	33.74±5.11	30.36±4.16****	10.01% ↓
Group 1	0	0	
Group 2	28.03±1.45	25.67±1.16****	
Group 3	35.45±4.53	31.77±0.66****	
BODY WEIGHT	91.26±19.25	82.30±16.36****	9.81% ↓
Group 1	0	0	
Group 2	71.00±5.79	65.04±5.08****	
Group 3	97.34±17.63	87.48±14.95****	
BODY FAT	39.05±4.67	36.11±5.46****	7.52% ↓
Group 1	0	0	
Group 2	35.82±5.62	33.31±7.18**	
Group 3	40.02±3.96	36.96±4.66****	
VISCERAL FAT	19.76±6.35	15.79±6.16****	20.09% ↓
Group 1	0	0	
Group 2	11.88±2.61	9.16±2.09****	
Group 3	22.13±3.09	17.78±5.55****	
RESTING METABOLISM	1753.28±337.49	1580.44±385.33*	9.85% ↓
Group 1	0	0	
Group 2	1443.00±167.99	1355.00±141.51 NS	
Group 3	1846.36±320.35	1648.08±410.52 NS	
SUBCUTANEOUS FAT	33.61±7.12	30.35±7.21****	9.69% ↓
Group 1	0	0	
Group 2	30.36±7.13	27.38±7.61****	
Group 3	34.53±6.92	31.20±7.00****	
SKELETAL MUSCLE MASS	23.47±3.12	24.67±3.54****	5.11% ↑
Group 1	0	0	
Group 2	23.87±3.58	24.85±4.20**	
Group 3	23.35±3.02	24.62±3.39***	
WAIST CIRCUMFERENCE	110.97±15.26	98.40±11.96****	11.32% ↓
Group 1	0	0	
Group 2	95.55±4.74	86.38±4.71****	
Group 3	115.75±14.19	102.13±11.04****	

Data are represented as mean ± SD ****p<0.0001 ***p<0.001 **p<0.01 *p<0.05 NS = non-significant

Group 1: Normal BMI, Group 2: Overweight, Group 3: Obesity

Table 4 shows that only 39 subjects could sustain the routine by 4th month, and all normal BMI patients left the study due to achieving their goals. Groups 2 and 3 had 9 and 30 individuals respectively. All parameters and sub-divisions significantly decreased. BMI and body weight had reduced by 10.01% and

9.81%. Body fat, visceral fat, subcutaneous fat, and waist circumference reduced by 7.52%, 20.09%, 9.69%, and 11.32% respectively. Skeletal muscle mass improved by 5.11%, which was a significant increase.

Table 5: Shows Anthropometric data before and after 5 months of Intermittent Fasting

Parameters	Before IF	After 5th month(n=19)	Percent Change
BMI	32.11±4.21	28.26±3.17****	11.99% ↓
Group 1	0	0	
Group 2	27.84±1.48	25.48±1.19****	
Group 3	34.60±3.09	29.88±2.82****	
BODY WEIGHT	73.44±24.83	64.98±21.99****	11.51% ↓
Group 1	0	0	
Group 2	71.50±6.18	65.45±5.21***	
Group 3	74.58±31.37	64.70±27.86****	
BODY FAT	38.54±5.66	34.92±6.27****	9.39% ↓
Group 1	0	0	
Group 2	35.57±6.40	32.87±6.67**	
Group 3	3.72±4.60	5.00±5.99****	
VISCERAL FAT	18.02±5.89	13.21±5.25****	26.69% ↓
Group 1	0	0	
Group 2	12.28±2.64	9.35±2.13**	
Group 3	21.37±4.45	15.45±5.26****	
RESTING METABOLISM	1655.00±271.16	1519.68±235.49 ^{NS}	8.17% ↓
Group 1	0	0	
Group 2	1460.57±185.20	1381.14±170.23 ^{NS}	
Group 3	1768.83±251.83	1600.50±235.79 ^{NS}	
SUBCUTANEOUS FAT	33.37±8.04	29.63±7.89****	11.20% ↓
Group 1	0	0	
Group 2	29.75±7.64	27.00±7.40***	
Group 3	35.49±7.79	31.16±8.07****	
SKELETAL MUSCLE MASS	23.36±3.60	24.47±4.09**	4.75% ↑
Group 1	0	0	
Group 2	24.11±4.04	25.05±4.18**	
Group 3	22.92±3.42	24.14±4.18*	
WAIST CIRCUMFERENCE	107.36±11.73	92.84±8.38****	13.52% ↓
Group 1	0	0	
Group 2	96.28±5.08	86.85±2.41***	
Group 3	113.83±9.35	96.33±8.71****	

Data are represented as mean ± SD ****p<0.0001 ***p<0.001 **p<0.01 *p<0.05 NS = non-significant
Group 1: Normal BMI, Group 2: Overweight, Group 3: Obesity

Only 19 subjects completed the 5-month study; the table 5 shows data of 7 and 12 subjects in groups 2 and 3 respectively. The BMI, weight, body fat, visceral fat, subcutaneous fat, and waist circumference reduction

percentage was 11.99%, 11.51%, 9.39%, 26.69%, 11.20%, and 13.52%, respectively. Resting metabolism showed non-significant reduction and skeletal muscle mass significantly increased.

Table 6: Shows Anthropometric data before and after 6 months of Intermittent Fasting

Parameters	Before IF	After 6th month(n=8)	Percent Change
BMI	32.32±5.69	28.08±4.20**	13.11% ↓
Group 1	0	0	
Group 2	28.05±2.05	24.85±1.30**	
Group 3	36.60±4.76	31.32±3.39*	
BODY WEIGHT	85.26±17.95	74.02±14.33**	13.18% ↓
Group 1	0	0	
Group 2	69.17±3.87	61.40±3.13**	
Group 3	101.35±6.86	86.65±6.66*	
BODY FAT	39.31±4.19	36.15±5.26**	8.03% ↓
Group 1	0	0	
Group 2	38.83± 2.93	36.40±2.09*	
Group 3	42.00±3.34	38.16±7.05 ^{NS}	
VISCERAL FAT	17.18±7.63	12.81±6.68****	25.43% ↓
Group 1	0	0	
Group 2	11.25±2.36	8.00±1.41*	
Group 3	23.12±6.03	17.62±6.36**	
RESTING METABOLISM	1639.25±329.90	1488.75±265.72 ^{NS}	9.18% ↓
Group 1	0	0	
Group 2	1363.25±63.79	1261.50±43.37 ^{NS}	
Group 3	1915.25±216.22	1716.00±158.61 ^{NS}	
SUBCUTANEOUS FAT	33.88±6.90	30.07±7.46****	11.14% ↓
Group 1	0	0	
Group 2	33.76±2.85	30.33±2.12*	
Group 3	33.97±9.48	29.87±10.41*	
SKELETAL MUSCLE MASS	22.61±2.97	23.85±3.42***	5.48% ↑
Group 1	0	0	
Group 2	21.60±1.61	22.60±0.81 ^{NS}	
Group 3	23.62±3.921	25.10±4.74 ^{NS}	
WAIST CIRCUMFERENCE	107.00±13.52	92.25±8.44***	11.24% ↓
Group 1	0	0	
Group 2	96.50±5.19	85.00±2.44*	
Group 3	117.50±10.27	99.50±4.50*	

Data are represented as mean ± SD ****p<0.0001 ***p<0.001 **p<0.01 *p<0.05 NS = non-significant
Group 1: Normal BMI, Group 2: Overweight, Group 3: Obesity

Table 6 shows that only eight participants continued the 6-month study, and groups 2 and 3 both had four individuals. The BMI, weight, body fat, visceral fat, subcutaneous fat, and waist circumference reduction

percentage was 13.11%, 13.18%, 8.03%, 25.43%, 11.24%, and 13.78% respectively. Body fat in group 3 individuals showed non-significant reduction; and skeletal muscle mass in both groups was non-

significantly increased, but overall skeletal muscle mass significantly increased. Resting metabolism showed non-significant reduction.

The magnitude of the observed difference was quantified and the mean effect size was 2.29 across all comparisons.

Discussion

All creatures on Earth have evolved circadian oscillators that permit them to anticipate and get ready for activity, food consumption, and sleep at particular times due to the 24-hour cyclicity in environmental conditions and the daily rhythm of food convenience and predator evasion. Cycles of feeding and fasting changes the metabolic state and have a circadian rhythm of molecular responses over a 24 hour period. Thus, the circadian oscillator and time-of-feeding coordinate daily patterns of gene expression and protein activity, allowing the body to anticipate and respond to feeding actions properly each day.⁷ The interruption of circadian rhythms, whether through genetic manipulation in animals or behavioural changes in shift workers, has been shown to disturb such temporal regulation and can lead to an increased risk of metabolic syndromes.⁸ Frequent caloric intake in diet-induced obese animal models disrupt molecular circadian rhythms, which can harm metabolic regulation and increase the risk of obesity-related health issues.⁹

Over the past few years, an eating habit consisting of three main meals and multiple snacks in between has become a norm in our society and it can be challenging to adopt a fasting protocol in our daily lives. In this study, 239 participants were recruited in the initial month, but some of them could not adopt and continue this regimen and we observed a decline in participant numbers during the study period. In prior research some participants reported excessive hunger pangs, being short-tempered, and having trouble focusing during the initial period of fasting regimen. However, these adverse effects are known to go away in about a month. We noticed that after the initial excitement, the third to fifth days were most challenging in majority individuals of our study, and if they could sustain till a week, they were more likely to continue successfully. In the initial first few days, we advised individuals to not be tough on themselves, listen to their bodies and give the system time to adapt

to the new regimen. Hence, we met the individuals every fifteen days to collect data and did telephonic follow up every week as and when required to keep the motivation high and we were available for any queries they might have. Therefore, it is critical to raise awareness of these concerns and maintain motivation among those starting IF during this time.¹⁰

The present data demonstrates a significant increase in the percentage of BMI decrease (from 4.12% to 13.11%) directly proportional to months of fasting (1 to 6). Weight and body fat were significantly reduced after TRE. Our study validates that weight loss by fasting protocol is dependent on BMI, and chances are that higher the BMI more would be the weight loss and vice-versa. After 2 months of TRE, individuals with normal BMI exhibited a non-significant decrease in BMI and body fat, which is interpreted as a positive effect of TRE. This is an important observation for individuals with normal BMI who want to pursue fasting for medical benefits but are not interested in weight loss.

Visceral adipose tissue acts as both a paracrine and endocrine organ by producing adipokines. Some of these adipokines, like leptin, are pro-inflammatory and cause chronic low-level inflammation, while others, like adiponectin, have anti-inflammatory properties.¹¹ Leptin is recognized for its pivotal role in controlling of the body weight through the signalling mechanism directed towards the hypothalamus and other associated brain regions. This signalling pathway serves to reduce food intake and concurrently elevate energy expenditure.¹² In obese conditions, elevated levels of BMI cause insulin resistance and the development of leptin resistance. High accumulation of visceral fat drops the level of adiponectin. A normal to high level of adiponectin is associated with the oxidation of fatty acids, an increase in skeletal muscle mass, a decrease in hepatic gluconeogenesis, and an increase in glucose uptake. The body switches during fasting from using glucose as its primary fuel source to fatty acids and ketones. The body starts to move during this phase, from producing and storing lipids to activating fat through free fatty acids and ketone bodies. Some of the advantageous outcomes of intermittent fasting have been linked to this metabolic reprogramming, or shift in energy source.¹³ Our study

demonstrated a substantial reduction in visceral fat and waist circumference and a clear increase in skeletal muscle mass. Hence, this fasting regimen has decreased adiposity, especially truncal and visceral fat.

Our study systematically examined the relationship between eating patterns, healthy food consumption, and metabolic health. Obesity exerts substantial health effects, encompassing cardiovascular disease, high blood pressure, type II diabetes mellitus, hyperlipidaemia, osteoarthritis, obstructive sleep apnea, and certain cancers. It is also a recognized independent risk factor for numerous non-communicable diseases. The escalating health-related costs associated with treating these diseases, coupled with a decline in overall public efficiency, can inflict immediate and severe harm on the community in terms of health and financial losses.¹³ Therefore, reducing abdominal obesity unequivocally reduces the risk of all metabolic syndromes. Multiple studies have consistently shown decreased waist circumference and improved body composition with Time-Restricted Eating.^{14,15} Our research showed similar results in reducing abdominal obesity and subcutaneous fat, indicating a decrease in the risk of non-alcoholic fatty liver. TRE can be deemed an effective dietary strategy for weight management and improved metabolic well-being in individuals capable of successfully adhering to a restricted feeding window.

In our study, highly-significant reduction was not observed in the resting metabolic rate throughout the study period. This work comprehensively adds to the evidence that links TRE with weight loss by providing data from a clinic setting. Furthermore, it presents a well-structured framework for future research on this topic. Similarly, a previous study also lends support to our observations that time-restricted eating is a viable strategy for improving body composition even without calorie restriction.¹⁵ In another study, participants lost a significant amount of weight after 3 months of fasting, consuming an average of 1388 kcal.¹⁰

Humans are diurnal and traditionally, have been eating between the sunrise and sunset period, since they could forage for food during day time only. Hence, it is advisable to keep the eating window during daytime for optimal outcome. One advantage is that according

to individual's schedule, this can be personalised and the period can change to a little less or more. Our body undergoes three cycles: ingestion, digestion, and elimination. By practicing TRE, we align ourselves with nature's inherent eating pattern, allowing our bodies to rest and heal in between periods of digestion and next ingestion. Fasting helps to recover because the body does not have to continuously spend energy on digestion, so it spends energy on healing. Some IF-based research has demonstrated a decrease in oxidative stress and life span extension in conjunction with a reduction of abdominal fat tissue.⁴

Limitation of the study is that individuals should be highly motivated to continue with this regimen and one can encounter high dropout rates. Once the desired results are obtained they might not continue with the regimen religiously but might do it infrequently. Hence, the observed findings cannot be reliably generalized to broader demographic groups. The weight loss observed could partly also be due to calorie restriction and proper diet during time restricted eating.

Conclusion

Our study provides some support to the existing literature that TRE is an effective option for patients with overweight and obesity management. The results suggest a positive association between TRE protocol and weight loss in a specific population of obese individuals and has a potential for reducing broader health risks and metabolic improvements, but further research is needed to confirm these findings. The skeletal muscle mass was preserved, indicating that the decrease in BMI was due to favourable changes in body composition. Additionally, the participants demonstrated a largely stable resting metabolic rate throughout the study period. These observations are consistent with the hypothesis that TRE may be a safe and effective intervention for overweight and obesity management for individuals who are motivated and willing to make lifestyle changes. Moreover, it has the advantage of being flexible, affordable and accessible worldwide.

Acknowledgement

The authors would like to thank all the study participants at Intermittent Fasting Research Foundation (IFRF), Ahmedabad.

Funding Sources

Priya Chaudhary received the SHODH - Scheme of Developing High Quality Research fellowship, by the Education Department of Gujarat, India. (Student Ref No: 2021013878)

Conflict of Interest

The author(s) do not have any conflict of interest.

Data Availability Statement

This statement does not apply to this article.

Ethics Statement

This study has received ethical clearance from the Institutional Ethics Committee of Gujarat University (Ref: GU-IEC(Niv)/02/PhD/033)

Informed Consent Statement

Informed consent was obtained from the participants and the privacy rights of human subjects was observed.

Clinical Trial Registration

This research does not involve any clinical trials.

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Not Applicable

Author Contributions

- **Priya Chaudhary:** Data Collection and Compilation, Results Analysis, Manuscript Drafting.
- **Rajesh Hydrabadi:** Conceptualization, Consultant Doctor, Started "The Intermittent Fasting Research Foundation" (IFRF), Ahmedabad, India.
- **Sumit Prajapati:** Supervision, Consultant Doctor.
- **Divya Chandel:** Study Design, Result Interpretation, Supervision, Manuscript Preparation.

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