Original Article

Intermittent Fasting: A Panacea for Good Health

Pratyusha Vavilala[1], Shravani Baruah[2], Sadhna Jain[3*] and Lakshmi P. Sarin[4*]

[1,2,3,4]Department of Biochemistry, Shaheed Rajguru College of Applied Sciences for Women, University of Delhi, New Delhi-96, India.

Abstract **Objective:** Obesity-linked metabolic syndrome is a global health concern which if sustained is found to result in insulin resistance that predisposes people to Type-2 Diabetes Mellitus and cardiovascular disease. Obesity is exacerbated in persons with inconsistent and high-calorie diets and sedentary lifestyles. Over time, various methods of weight loss caloric restrictions and intermittent fasting practices have been experimented to test their effectiveness in weight loss and improving metabolic markers and to see if they are feasible for long term weight management in obese individuals. This study examined the effects of intermittent fasting alone on obese individuals and in adjunct with physical exercise in weight reduction. The present study aims to study the effectiveness of intermittent fasting on the overall health and BMI of the individuals. **Methodology:** An online survey was conducted and participants were asked to answer simple questions about their general diet pattern and of they observed any changes in their BMI and general wellbeing after intermittent fasting. All the participants were assured full anonymity. **Results:** Intermittent fasting lead to weight loss in all people following intermittent fasting, with or without exercise. **Conclusion:** Intermittent fasting, if combined with regular physical exercise can lead to sustained weight loss and improvement in overall health.

Keywords: Exercise, Intermittent fasting, Lipid profile, Obesity, Weight loss, Nutritional biochemistry

Address for correspondence: Sadhna Jain and Lakshmi P. Sarin, Department of Biochemistry, Shaheed Rajguru College of Applied Sciences for Women, University of Delhi, New Delhi-96, India. E-mail: jainsadhna2015@gmail.com, Dr. Lakshmi Sarin at lakshmi.sarin@rajguru.du.ac.in

Submited: 11-Jan-2022 **Accepted:** 20-Apr-2022 **Published:** 29-Aug-2022

INTRODUCTION

Obesity proves to be a major health concern as 13% of the global adult population were found to be obese, while 39% were overweight as reported by the W.H.O in 2016(1). Obesity, accompanied by dyslipidaemia, hyperglycaemia, and hypertension-collectively termed as the metabolic syndrome-may be exacerbated by the present-day maladaptive lifestyle modifications such as sedentary behaviour, inconsistent sleep cycle, and calorie-rich diets. Such a lifestyle, if sustained, predisposes obese persons to insulin resistance which could ultimately culminate into Type-2 Diabetes Mellitus (T2DM) along with an increased vulnerability to developing cardiovascular disease(2, 3). Since these metabolic conditions generally arise from an energy surplus in the body owing to nutritional imbalance, interventional dietary regimens could be an efficient means to control this imbalance(4,5). Intermittent fasting is one such dietary modification which may people are following currently with the goal of achieving a healthy lifestyle. We aim to perform a population analysis on the health benefits of intermittent fasting.

Access this article online
Website: www.ijfans.org
DOI: 10.4103/ijfans_153_22

Cultural Perspective of Fasting Practices

The importance of fasting practices has been recognised since ancient times and finds prevalence among different cultures for both religious beliefs and therapeutic purposes. Religious fasts vary according to the temporal window in which they are observed. They range from weekly to monthly fasts in accordance with diurnal or seasonal variations that involve either a total restriction on all food and drink or specific food items(6,7). Seasonal fasting regimes (*Ritucharya*) also find prevalence in preventive healthcare in that they aid in the acclimatisation of the diet to the changing seasons(8).

How to cite this article: Pratyusha Vavilala, Shravani Baruah, Sadhna Jain and Lakshmi P. Sarin. Intermittent Fasting: A Panacea for Good Health. Int J Food Nutr Sci 2022; 11:34-39.

Although entirely observational, transient changes in body weight were reported in different populations which have invited profound interest in the nutritional aspect of fasting for better health and weight management(6).

Fasting for Better Health

Fasting has become increasingly popular in recent years since the rise in cases of metabolic syndrome and a growing awareness on maintaining a healthier lifestyle. Of these, caloric restriction (CR) involves a reduction in the average daily caloric intake but maintains the optimum nutritional requirement. Previous studies have reported that daily caloric restriction effectively improves insulin sensitivity, inflammatory response, mitochondrial function and weight loss(9, 10). Intermittent fasting on the other hand involves a periodic alternation between fasting and feeding windows where an individual consumes food *ad libitum* such that instead of a strict restriction in food intake for a prolonged period, the fasting stage is divided into multiple shorter periods(11). Multiple fasting patterns are encompassed by the term "Intermittent fasting" viz., alternate day fasting (ADF), 5:2 regime, and time-restricted fasting (TRF)(12, 13). Alternate-day fasting typically involves an alternation between a "feed day" and "fast day" wherein a person eats as per requirement followed by a day of total restriction in calorie intake(5). Modified ADF allows ~25% of baseline intake of calories on a fast day to enhance long term compliance(12). The 5:2 regime is based on a strict 2-day fasting process every week. Time-restricted feeding (TRF) allows feeding within a smaller temporal window followed by fasting for the rest of the day(4). Previous studies show that IF regimes were successful in reducing visceral fat, increasing adiponectin levels and decreasing leptin and LDL levels in obese individuals and diabetic patients(14). IF was also reported to reduce ageing markers, induce ketogenesis and optimize the circadian system(15, 16).

When compared for effectiveness in weight reduction, CR and IF regimes produced similar results across different randomised control trials. A study by *Trepanowski et. al (2017)* observed that the mean weight loss in CR in the first six months was 6.8% as in IF subjects. Weight loss patterns in 12 months were almost equivalent with a reduction of 6.0% in CR and 5.3% in IF participants(17). Similar trends have been observed in changes in mean weight loss and body fat reduction reported by Headland *et al.* (2019) with 7% rise in HDL levels and a 13% decrease in serum triglycerides(18). Changes in visceral fat mass were also comparable with a decrease of 3-4 kg across both CR and IF regimes as observed by(19). The similarities in the decrease in the levels of leptin, total and LDL cholesterol and triglycerides in both caloric restriction and intermittent fasting have also been proven by the study conducted by(20). Despite that, poor adherence to CR often impedes its success rate. To ensure better compliance, intermittent fasting (IF) regimes that are relatively flexible seem to produce better results in long term weight management.

Biochemical Effects of Intermittent fasting on Metabolic Markers

The carbohydrates, fats and proteins found in the diet are the fuel for metabolic energy requirements. Glucose, the principal fuel for the brain, undergoes the glycolytic pathway whose products undergo further modification for energy production. In the fed state, when the ingested carbohydrates are in excess relative to the energetic demand, they are stored as hepatic glycogen that undergoes de novo lipogenesis, following which lipids are stored as subcutaneous fat in the body(21). Conversely, the fasting state induces gluconeogenesis, breakdown of hepatic glycogen and promotes lipolysis followed by mitochondrial beta-oxidation to meet energy demands. The pancreatic β-secretion of insulin favours lipogenesis and glycogenesis but inhibits gluconeogenesis while glucagon counters this effect. The body maintains its energy homeostasis and appetite through the action of orexigenic and anorexigenic hormones that are under hypothalamic control(22). Orexigenic hormones like ghrelin are reciprocally secreted relative to the adiposity in subjects, in that they are elevated prior to meals and immediately drop post meals(23). Anorexigenic hormones cholecystokinin, leptin and insulin induce satiety after local release into the circulation(24-26).

In the event of prolonged fasting when hepatic glycogen reserves are exhausted, the energy source "switches" from glucose obtained from endogenous glycogenolysis to ketone bodies derived from the oxidation of fatty acids. Activation of cytosolic hormone-sensitive lipases (HSLs) in adipocytes induces lipolysis, thereby increasing the levels of plasma free fatty acids (FFAs) which upon mobilisation to hepatocytes undergo β-oxidation to form ketone bodies: β-hydroxybutyrate, acetone and acetoacetate which permeate the blood-brain barrier to become the preferred metabolic fuel for the brain and peripheral tissues(27-29). From an evolutionary perspective, animals make use of this preferential metabolic switch to store energy as fat mass in times of food availability and conversely, to generate energy during times of food deficit in a way that the protein mass, which is the principal supplier of carbon chains and nitrogen, does not undergo excessive wasting(9). This process of switching to fatty acid oxidation during glycogen paucity is comparable to conditions of strenuous physical exercise. Relatively high levels of AMP that is indicative of intense muscular contraction stimulate the enzyme AMP-activated protein kinase (AMPK) which catalyses lipolysis, inhibits lipogenesis and regulates autophagy(30, 31). AMPK also targets the mTOR pathway which when inactivated under fasting conditions is known to favour the mobilisation of triglycerides and induce glycogen breakdown(32).

Figure 1 illustrates the metabolic pathway for ATP synthesis during fasting conditions. The lipid droplets stored in adipocytes undergo breakdown to release free fatty acids which are mobilised in the circulating blood into hepatocytes where they undergo beta oxidation to produce ketones. Circulating ketones are converted to Acetyl CoA and enter the Krebs cycle to produce ATP to meet energy demands (ATP: Adenosine triphosphate, TCA cycle: Tricarboxylic acid cycle, FFA: free fatty acids, TAG: Triacylglycerol, DAG: Diacylglycerol, MAG: Monoacylglycerol).

It could be a possibility that fasting when coupled with exercise could be more efficient in reducing ectopic fat mass in obese individuals. The purpose of this qualitative study is to examine the efficacy of intermittent fasting protocols in individuals and its effect on body compositions like weight loss and abdominal circumference. It also aims to determine if intermittent fasting combined with exercise produced better results in terms of weight loss.

MATERIALS AND METHODS

A questionnaire was constructed with a total of 29 open and close-ended questions and circulated. Incidental data was collected from 181 respondents and processed statistically using Microsoft Office Excel. The significance of intermittent fasting regimes both with and without exercise was statistically analysed using a paired T-test at 95% CL.

RESULTS AND DISCUSSION

The respondents were grouped into 4 categories on the basis of age and the distribution of obesity and overweight conditions across the various age groups is shown in Table 1. Obese and overweight individuals were predominantly seen in the above 45 age group. Moreover, a significant percentage of overweight individuals were also seen in the 12-25 age group, of which a sizeable majority in both age groups led sedentary lifestyles as shown in Table 2.

Furthermore, it was observed that metabolic diseases such as type 2 diabetes mellitus and hypertension were prevalent in overweight (BMI = 25-30) and obese (BMI>30) groups. 50% of subjects who had hypertension and T2DM were reported to be overweight however an albeit lesser proportion of T2DM and hypertensive patients were found to be obese as elucidated in Table 3.

The mean body weight of subjects pre-intermittent fasting was calculated to be 70.23 ± 13.37 and post-intermittent fasting at 65.83 ± 12.29 from Table 4. The *P* value for the paired T-test was calculated to be 0.0003235 at 95% CL with (30-1) = 29 degrees of freedom. The result thus obtained indicates a highly significant effect ($P < 0.001$) of intermittent fasting on weight loss.

Weight loss in subjects with IF combined with exercise from the data in Table 5 was found to be be highly significant, at $P = 0.0009$ with D.O.F. = 18 at 95% CL for mean pre-fast and post-fast body weights of 70.23±13.37, and 65.83 ± 12.29 respectively. In contrast, the *P* value when calculated for the subject group "intermittent fasting without exercise" from Table 3 was found to be 0.0052 with D.O.F. = 10 at 95% CL.

These results suggest that intermittent fasting alone produces significant weight loss in subjects. Moreover, when combined with exercise, its efficacy on weight loss is further enhanced. This result is comparable with previous randomised control trial performed on obese subjects by *Bhutani et. al* which has found that the fasting and exercise combination brought forth better weight loss and improved LDL and HDL cholesterol levels against only-fasting and only-exercise groups(33). Similar findings on mean fat mass and BMI reduction were reported by Oh and group among exercise-combined alternate day fasting and fast-only groups(34).

Table 1: Age-Wise Distribution of Obese and Overweight Individuals in Sample Population

BMI	44920	25-35	35-45	45+
Obese	0.1667	0.0555	0.1667	0.6111
Overweight	0.2791	0.1628	0.1163	0.4418

Table 2: Percentage Distribution of Sedentary and Active Lifestyle Patterns in 12-25 and 45+ Age Groups for Obese and Overweight Subjects

Lifestyle	45+ Age Group		12-25 Age Group	
	Sedentary	Active	Sedentary	Active
Obese	0.7273	0.2727	1	0
Overweight	0.7895	0.2105	0.9167	0.0833

Table 3: Percentage Distribution of Subjects Suffering from Type-2 Diabetes Mellitus (T2DM) and Hypertension (HBP) w.r.t BMI

BMI	<18	18-25	25-30	>30
T2DM	0	0.25	0.5	0.25
HBP	0.0625	0.0625	0.5	0.375

Table 4: Body Weight in kg in Subjects Pre and Post IF

Fasting	Body Weight in kg in Subjects with and Without Exercise														
Pre	79	85	65	60	60	62	69	60	82	77.5	62.5	51	68	67	63
Post	75	85	65	58	52	52	65	56	70	74	57	47	68	65	61
Fasting	Body Weight in kg in Subjects with and Without Exercise														
Pre	68	72	64	48	66	62	105	60	92	72	67	81	55	98	86
Post	68	58	64	48	64	62	95	58	70	70	59	78	55	98	78

Table 5: Body Weight in kg in Subjects with IF Combined with Exercise

Fasting	Body Weight in kg in Subjects with Exercise																		
Pre	79	85	65	60	60	62	69	60	82	51	68	67	63	72	62	92	72	81	55
Post	75	85	65	58	52	52	65	56	70	47	68	65	61	58	62	70	70	78	55

Table 6: Body Weight for IF Without Exercise

Fast	Body Weight in kg in Subjects Without Exercise										
Pre	77.5	62.5	68	64	48	66	105	60	67	98	86
Post	74	57	68	64	48	64	95	58	59	98	78

The objective of this paper was to study the effects of lifestyle and dietary patterns on obesity and to examine the efficacy of intermittent fasting as a means to reduce visceral fat and ameliorate obesity related metabolic syndrome. Previous studies have shown that intermittent fasting has a wide spectrum of benefits in obesity, diabetes mellitus and cardiovascular disease. Observational data showed that people who led sedentary lifestyles were mostly obese or were prone to obesity and among these, a major proportion suffered from metabolic disorders like T2DM and hypertension. In this study, we observed that intermittent fasting alone showed significant weight loss ($P = 0.0003$) in subjects. In addition to limiting the frequency of food intake, intermittent fasting when combined with exercise was seen to produce even more effective results as weight loss in exercise-combined IF was much more significant ($P = 0.0009$) than without any exercise ($P = 0.005$).

CONCLUSION

Although the effects on weight loss and metabolic markers across IF regimes and daily caloric restriction are almost similar, longer compliance is seen in people following intermittent fasting than in total caloric restriction. That exercise induced energy stress is important for burning accumulated fat along with fasting, was also revealed by the analysis made in this study. In conclusion, it can be stated that intermittent fasting alone as well as in combination with sustained exercise is an effective measure for weight loss in both obese persons and normal weight individuals who desire to adopt a healthier lifestyle.

REFERENCES

1. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. World Health Organ Tech Rep Ser. 2000; 894: i–xii, 1–253.
2. Burger A. and Abraham D. J. (2003). Burger's medicinal chemistry and drug discovery. 6th Ed. Hoboken, N.J: Wiley; 6 p.
3. Ye J. (2013). Mechanisms of insulin resistance in obesity. Front Med. Mar; 7(1): pp. 14-24.
4. The role of low-calorie diets and intermittent fasting in the treatment of obesity and type-2 diabetes. J Physiol Pharmacol [Internet]. 2018 [cited 2022 Jan 9]; Available from: https://doi.org/10.26402/jpp.2018.5.02
5. Tinsley G. M. and La Bounty P. M. (2015). Effects of intermittent fasting on body composition and clinical health markers in humans. Nutr Rev. Oct; 73(10): pp. 661-74.
6. Christian P. (2003). Religious Customs and Nutrition. In: Encyclopedia of Food Sciences and Nutrition

[Internet]. Elsevier [cited 2022 Jan 9]. pp. 4933-8. Available from: https://linkinghub.elsevier.com/retrieve/pii/B012227055X010105

7. Kalra S., Bajaj S., Gupta Y., Agarwal P., Singh S., Julka S. *et al.* (2015). Fasts, feasts and festivals in diabetes-1: Glycemic management during Hindu fasts. Indian J Endocrinol Metab. 19(2): p. 198.

8. Sarkar P. and Thakkar J. (2011). Chaudhari S. Ritucharya: Answer to the lifestyle disorders. AYU Int Q J Res Ayurveda. 32(4): p. 466.

9. Anton S. D., Moehl K., Donahoo W. T., Marosi K., Lee S. A., Mainous A. G. *et al.* (2018). Flipping the Metabolic Switch: Understanding and Applying the Health Benefits of Fasting: Flipping the Metabolic Switch. Obesity. Feb; 26(2): pp. 254-68.

10. Redman L. M. and Ravussin E. (2011). Caloric Restriction in Humans: Impact on Physiological, Psychological, and Behavioral Outcomes. Antioxid Redox Signal. Jan 15; 14(2): pp. 275-87.

11. Patterson R. E. and Sears D. D. (2017). Metabolic Effects of Intermittent Fasting. Annu Rev Nutr. Aug 21; 37(1): pp. 371-93.

12. Brown J. E., Mosley M. and Aldred S. (2013). Intermittent fasting: a dietary intervention for prevention of diabetes and cardiovascular disease? Br J Diabetes Vasc Dis. Mar; 13(2): pp. 68-72.

13. Welton S., Minty R., O'Driscoll T., Willms H., Poirier D., Madden S. *et al.* (2020). Intermittent fasting and weight loss: Systematic review. Can Fam Physician Med Fam Can. Feb; 66(2): pp. 117-25.

14. Malinowski B., Zalewska K., Wêsierska A., Sokolowska M. M., Socha M., Liczner G. *et al.* (2019). Intermittent Fasting in Cardiovascular Disorders—An Overview. Nutrients. Mar 20; 11(3): p. 673.

15. Dong T. A., Sandesara P. B., Dhindsa D. S., Mehta A., Arneson L. C., Dollar A. L. *et al.* (2020). Intermittent Fasting: A Heart Healthy Dietary Pattern? Am J Med. Aug; 133(8): pp. 901-7.

16. Stekovic S., Hofer S. J., Tripolt N., Aon M. A., Royer P., Pein L. *et al.* (2019). Alternate Day Fasting Improves Physiological and Molecular Markers of Aging in Healthy, Non-obese Humans. Cell Metab. Sep; 30(3): pp. 462-476.

17. Trepanowski J. F., Kroeger C. M., Barnosky A., Klempel M. C., Bhutani S., Hoddy K. K. *et al.* (2017). Effect of Alternate-Day Fasting on Weight Loss, Weight Maintenance, and Cardioprotection Among Metabolically Healthy Obese Adults: A Randomized Clinical Trial. JAMA Intern Med. Jul 1; 177(7): p. 930.

18. Headland M. L., Clifton P. M. and Keogh J. B. (2019). Effect of intermittent compared to continuous energy restriction on weight loss and weight maintenance after 12 months in healthy overweight or obese adults. Int J Obes. Oct; 43(10): pp. 2028-36.

19. Beaulieu K., Casanova N., Oustric P., Turicchi J., Gibbons C., Hopkins M. *et al.* (2020). Matched Weight Loss Through Intermittent or Continuous Energy Restriction Does Not Lead To Compensatory Increases in Appetite and Eating Behavior in a Randomized Controlled Trial in Women with Overweight and Obesity. J Nutr. Mar 1; 150(3): pp. 623-33.

20. Harvie M. N., Pegington M., Mattson M. P., Frystyk J., Dillon B., Evans G. *et al.* (2011). The effects of intermittent or continuous energy restriction on weight loss and metabolic disease risk markers: a randomized trial in young overweight women. Int J Obes. May; 35(5): pp. 714-27.

21. Pang G., Xie J., Chen Q. and Hu Z. (2014). Energy intake, metabolic homeostasis, and human health. Food Sci Hum Wellness. Sep; 3(3-4): pp. 89-103.

22. Liu K., Liu B. and Heilbronn L. K. (2020). Intermittent fasting: What questions should we be asking? Physiol Behav. May; 218: 112827.

23. Cummings D. E., Purnell J. Q., Frayo R. S., Schmidova K., Wisse B. E. and Weigle D. S. (2001). A Preprandial Rise in Plasma Ghrelin Levels Suggests a Role in Meal Initiation in Humans. Diabetes. Aug 1; 50(8): pp. 1714-9.

24. Ahima R. S. and Antwi D. A. (2008). Brain Regulation of Appetite and Satiety. Endocrinol Metab Clin North Am. Dec; 37(4): pp. 811-23.

25. Austin J. and Marks D. (2009). Hormonal Regulators of Appetite. Int J Pediatr Endocrinol. 2009: pp. 1-9.

26. Liddle R. A., Goldfine I. D., Rosen M. S., Taplitz R. A. and Williams J. A. (1985). Cholecystokinin bioactivity in human plasma. Molecular forms, responses to feeding, and relationship to gallbladder contraction. J Clin Invest. Apr 1; 75(4): pp. 1144-52.

27. Hegarty B. D., Turner N., Cooney G. J. and Kraegen E. W. (2009). Insulin resistance and fuel homeostasis: the role of AMP-activated protein kinase. Acta Physiol. May; 196(1): pp. 129-45.

28. Hunter R. W., Treebak J. T., Wojtaszewski J. F. P. and Sakamoto K. (2011). Molecular Mechanism by Which AMP-Activated Protein Kinase Activation Promotes

Glycogen Accumulation in Muscle. Diabetes. Mar 1; 60(3): pp. 766-74.

29. Soeters M. R., Soeters P. B., Schooneman M. G., Houten S. M. and Romijn J. A. (2012). Adaptive reciprocity of lipid and glucose metabolism in human short-term starvation. Am J Physiol-Endocrinol Metab. Dec 15; 303(12): pp. E1397-407.

30. Hardie D. G. (2011). AMP-activated protein kinase—an energy sensor that regulates all aspects of cell function. Genes Dev. Sep 15; 25(18): pp. 1895-908.

31. Hardie D. G. and Sakamoto K. (2006). AMPK: A Key Sensor of Fuel and Energy Status in Skeletal Muscle. Physiology. Feb; 21(1): pp. 48-60.

32. Cork G. K., Thompson J. and Slawson C. (2018). Real Talk: The Inter-play Between the mTOR, AMPK, and Hexosamine Biosynthetic Pathways in Cell Signaling. Front Endocrinol. Sep 6; 9: p. 522.

33. Bhutani S., Klempel M. C., Kroeger C. M., Trepanowski J. F. and Varady K. A. (2013). Alternate day fasting and endurance exercise combine to reduce body weight and favorably alter plasma lipids in obese humans: Alternate Day Fasting and Exercise for Weight Loss. Obesity. Jul; 21(7): pp. 1370-9.

34. Oh M., Kim S., An K.-Y., Min J., Yang H. I., Lee J. *et al.* (2018). Effects of alternate day calorie restriction and exercise on cardio-metabolic risk factors in overweight and obese adults: an exploratory randomized controlled study. BMC Public Health. Dec; 18(1): p. 1124.