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LITERATURE REVIEW

Effect of intermittent fasting on fat mass and fat free mass among obese adult: A literature review

Hadiyati Fudla[1], Ninik Mudjihartini[2], Helda Khusun[3]

1. *Department of Nutrition, Faculty of Medicine, Universitas Indonesia-Dr. Cipto Mangunkusumo General Hospital, Jakarta, Indonesia*
2. *Department of Biochemistry, Faculty of Medicine, Universitas Indonesia-Dr. Cipto Mangunkusumo General Hospital, Jakarta, Indonesia*
3. *Southeast Asian Minister of Education Organization Regional Center for Food and Nutrition (SEAMEO-RECFON)-Pusat Kajian Gizi Regional (PKGR) Universitas Indonesia, Jakarta, Indonesia*

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Abstract

Introduction Obesity is a serious hurdle facing by the world nowadays. Even though so many efforts have been done, yet the prevalence is keep rising. Intermittent fasting is seen as an effective and optimal approach for improving nutrition status without undesirable side effect.
Objective to identify the effect of intermittent fasting on fat mass and fat free mass among obese adult.
Methods: a literature exploration was conducted from January to October 2020 by searching the relevant studies from several databases.
Results: many human clinical trials recommended that IF affects beneficial on body composition and body weight. Consuming calorie only in a certain time frame per day for 4-12 months put the body into a fast metabolism which influence the reduction of fat mass from 0.03–16.4% intervention and increasing of fat free mass for around 0.64 to 0.86%.
Conclusion: intermittent fasting may reduce fat mass and increase fat free mass in obese adult through the reduction of energy intake (fasting) and the benefit to adipose tissue, liver, pancreas, skeletal muscle, and the brain.

Keywords body composition, intermittent fasting, obesity, weight loss

Introduction

Obesity is an increasingly clinical problem and serious socio-economic issue faced by the world today.[1] It is a result of a positive energy balance accumulation from day to day and develops over many years which usually accompanied by wide range of health disadvantages.[2,3] Worldwide data from 1975 shows that obesity has about tripled at 2018, and more than 1.9 billion adults aged above eighteen are overweight; of these, over 650 million are obese.[4] Data from Indonesia basic health survey (*Riskesdas*) 2018 find that the percentage rise by 11.3% only for eleven years (2007–2018). [5]

Fasting in terms of nutritional aspect define in varies scope; moderate reduction of calorie intake (600-800 kcal), stricter reduction of energy intake (200-400 kcal), and zero-calorie fasting.[10] Intermittent fasting (IF) is considered as an energy deficit protocol that leads to lipid profile improve by energy deficit and/ or body weight reduction.[11] IF practice exists in several protocol; complete fasting every other day, 70% energy restriction every other day, consuming only 500-700 kcal for two consecutive days per week, and restricting food intake to a 6-8 hour time period daily.[12] Common form of IF include fasting up to 14 hours once or

Corresponding author:
Hadiyati Fudla
Department of Nutrition, Faculty of Medicine, Universitas Indonesia
Jl. Salemba Raya no.6, Central Jakarta, Indonesia
Email: hadiyati.fudla@alumni.ui.ac.id

twice a week with ad libitum food intake for the remaining days, which is also known as periodic prolonged fasting (PF) or intermittent calorie restriction (ICR), without any requirement of water restriction. Fasting and CR are considered as an optimal intervention for improving health and lifespan without the undesirable side effect.[13,14]

Dietary habit is an important role in developing obese condition, even though the cause of obesity is complicated.[15] Thus, this study aimed to elaborate the effect of IF to fat mass and fat free mass among obese adult.

Methods

This study was designed as a literature review study to analyze the axisting data on the impact of IF on fat mass and fat free mass. Literature exploration was conducted from January to October 2020 by searching the relevant studies from PubMed, Scopus, ProQuest and Google Scholar using a combination of keyword "intermittent fasting", "obesity", "body composition", and "weight loss" as registered in the U.S. National Library of Medicine's MesH.

The result included in this study obtained from articles screened by title and abstract from cohort prospective study, meta-analysis, and systematic review which have fat mass or fat free mass status as the outcome. Study from animal subject was excluded from the review.

The first search recovered 46 results by using keyword 'intermittent fasting' and 'body composition'. Of these, there were 12 articles explained the impact of intermittent fasting on fat mass and fat free mass. Total of the final studies included in this review was 8 articles, because we exclude the article without the exact number or percentage of FM or FFM. Detail article's extraction was depicted in **Figure 1**.

Results

Many human study trials recommend that IF gives beneficial effects on weight, body composition, cardiovascular biomarkers, and aging.[13] Briefly, IF regiments influent metabolic regulation via effects on circadian biology, the gastrointestinal microbiota, and modifiable lifestyle behaviours. IF regiments that limit food intake during the fasting time may leverage circadian biology to improve metabolic health.[16] Consuming calorie only in a certain time frame per day (8 hours, and 10 hours window) puts the body into fast metabolism, and avoiding muscle catabolism during the remaining fasting hours.[12] There are many types of IF.[17] General explanation is provided in the **Table 1**.

Study review done by Mattson et al., 2016 conclude that from several IF study done in human subjects, numerous physiological indicators of health are improve due to IF, such as reduce level of insulin and leptin which parallel increases insulin and leptin sensitivity, reduce body fat, elevated ketone level, reduce resting heart rate and blood pressure, and increase heart rate variability (resulting from increased parasympathetic tone), reduce inflammation, increase resistance of the brain and heart to stress (e.g., reduced tissue damage and improved functional outcome in models of stroke and myocardial infraction), and resistance to diabetes.[18] Many clinical trial studies on human also depict that IF gives a result of weight loss, improvement in some metabolic biomarkers, reduce oxidative stress, reduce anger, confusion, and depression (**Table 2**).

Discussion

Obesity is a complex disease that involves interaction between environmental and genetic factors. Someone's genes define opportunities for their health and susceptibility to disease, while environmental factors determine which susceptible individuals will develop illness.[20]

Control of food intake does not depend on one signal changes, but it is determined by the integration of many inputs that provide body's energy status information.[21] Factors that influence food intake are shown in the **Figure 2**.

The excessive fat is predominantly stored in adipose tissue. Adipose tissue has key function in the secretion of factors, including cytokines, angiogenic factors, immune-related factors, prostaglandins, angiotensinogen, and proteins involved in the regulation of energy balance and carbohydrate metabolism (e.g. resistin, adiponectin).[22] In obesity, the increasing adiposity

with greater adipocyte size and number, leading to a higher leptin concentration, but without reduced food intake (leptin resistance).[1]

Multiple, high integrated and redundant pathway criss-crosses into and out of the arcuate nucleus; indicate that complex system involved in feeding and satiety process. Neuropeptide Y (NPY), one of the most potent appetite stimulators, leads to increase food intake that will promoting weight gain. Leptin is also important for body weight regulation. The amount of leptin in the blood is an excellent indicator of the triglyceride total amount stored in adipose tissue; the larger the fat store, the more leptin released to the blood. Leptin suppresses appetite, thus decreasing food consumption and promoting weight loss by inhibiting output of appetite-stimulating NPY stimulated by ghrelin. PYY_{3-36} is a counterpart of ghrelin which will rise during meals and signal of satiety.[21]

Energy balance can be modified either at the level of food intake or energy expenditure. In part of food intake, leptin controls food intake by the activation of hypothalamic receptors.

Adipose tissue secretes leptin in states of food deprivation (fasting), exercise, sympathetic nervous system (SNS), stimulation, exercise, and cold exposure. Leptin will be inhibited by obesity states, glucocorticoids, glucose and insulin. Leptin will reach hypothalamus and inhibit the secretion of NPY that normally reduce energy expenditure, enhance appetite and stimulate the synthesis and storage of fat. Obesity and insulin resistance negatively regulate adiponectin secretion from adipose tissue, whereas weight reduction increase its secretion.[21]

Plasma leptin in obese subject is usually normal for their fat mass, signing that leptin deficiency is not the primary cause of common obesity. However, there is also study show the linkage for involvement of leptin –or at least leptin gene locus- in the complex determinism of obesity and its related phenotypes in early onset of obesity.[24]

Usually, obesity, insulin resistance, diabetes, dyslipidemia, and fatty liver have a tendency to occur in the same individual as a manifestation of metabolic syndrome. Furthermore, metabolic dysfunction can arise from lipotoxicity caused by the excessive lipid intake and cannot be stored anymore in someone's adipose tissue. Lipid storage capacity that will manifest in individuals body weight from adipose tissue depends on genetic and environmental factors. Lipids are controlled tightly by homeostatic system, and it will become spatial and dynamic complex at multiple levels.[25] Metabolic profile is significantly associated with obesity and its metabolic co-morbidities. The physiological regulation of lipid membrane composition in obesity can be explained by seeing the Figure 4 below.

Lipid membranes adapt as adipocytes expand in size. Given that adaptation seems to involve a relative increase in precursors of pro inflammatory mediators, adaptation might increase vulnerability to inflammation.[25]

Studies recommend that changes in composition and metabolic function of gut microbiota in obese person may enable an 'obese microbiota to harvest more energy from the diet compare to 'lean microbiota', thus will influence net energy absorption, expenditure, and storage. Moreover, microbiota changes due to obesity-related manipulation can alter gut permeability and bacteria translocation to promote systemic inflamation.[16]

Dysfunctional adipose tissue lipid metabolism causes an increasing of circulating free fatty acids which will initiate inflammatory signalling in the population of infiltrating cells. This dysfunctional lipid metabolism accompanies obesity and affect impair insulin signaling.[26]

In term of environmental factors, there are many aspects that can influence individual's BMI. Body weight perception is a strong determinant for nutritional habit and weight management. Some researcher argue that some level of body dissatisfaction may be beneficial for average or above-average weight individuals, as it may lead to a healthy weight management behaviour like changes in diet such as increasing of vegetable and fruit consumption, increase physical activity, or have intention to weight control practice. Study done by Lian at 2009 conclude that students who overestimate their weight status were more likely to try to lose weight, while the revers happened to the students who underestimated their weight status.[27]

A study done by Langellier, 2015 conclude that frequency of fast food consumption is substantively greater among communities in urban and large urban area compare to rural area, and it will increase

dramatically with SES and educational attainment. Moreover, total food expenditure follow a very similar pattern.[28] Food which prepared away from home (e.g. eating at restaurant, vending machines, fast food outlet, or other place providing ready-to-eat food) is important to be documented, because foods prepared away from home tend to has larger portion sizes compare to homemade meals and to be higher in total energy and also energy density but lower in micronutrient density.[28,29]

Correlation between socio-economic status and body composition is still varies among studies globally. Many researches concluded that higher socio-economic status is associated with reduced risk of obesity, while the reverse is also shown to be true in several studies. Dietary shifting into poorer food choice can be caused by the increase of wealth e.g. bigger portion sizes and a more frequent intake of fast food. Yet, the higher economic status can also be the reason to more healthy diet because they can afford the price and they have enough knowledge on it.[28,30]

Sedentary lifestyle also has been shown to be a major contributing factor in increasing of obesity rate. Study done in the South African adults suggest that lack of exercise alone can account for 15% of obesity in that area.[30] In term of intermittent fasting, study from Bhutani et al.[15] found that only subject who did fasting and exercise group experienced decreased in fat mass, while those who are in the fasting or exercise alone are not.[31] Physical activity affects weight directly through energy expenditure, increase sensitivity for satiety signal and increase inhibitory control of the drive to eat may be involved.

Conclusion

In conclusion, some studies showed that doing an intermittent fasting for 6 to 28 months may reduce fat mass (around 0.03–16.4%) and increase fat free mass for about 0.64 to 0.86% in obese adult through the reduction of energy intake (fasting) and the benefit to adipose tissue, and skeletal muscle.

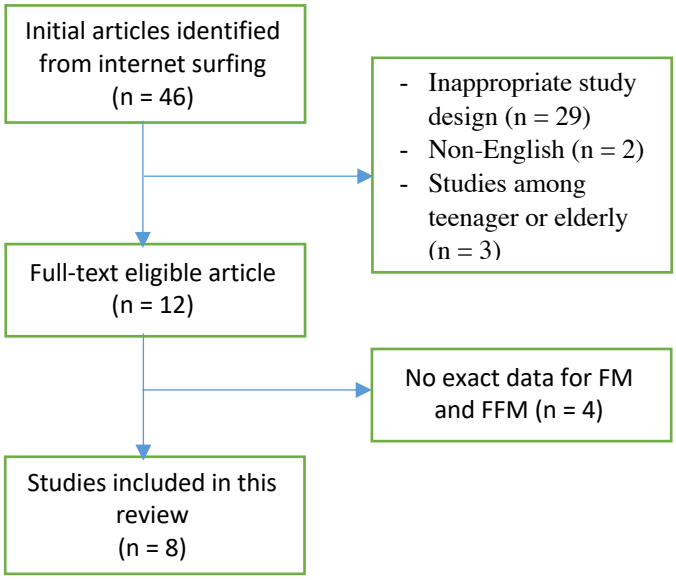

Figure 1. Flow of the study selection

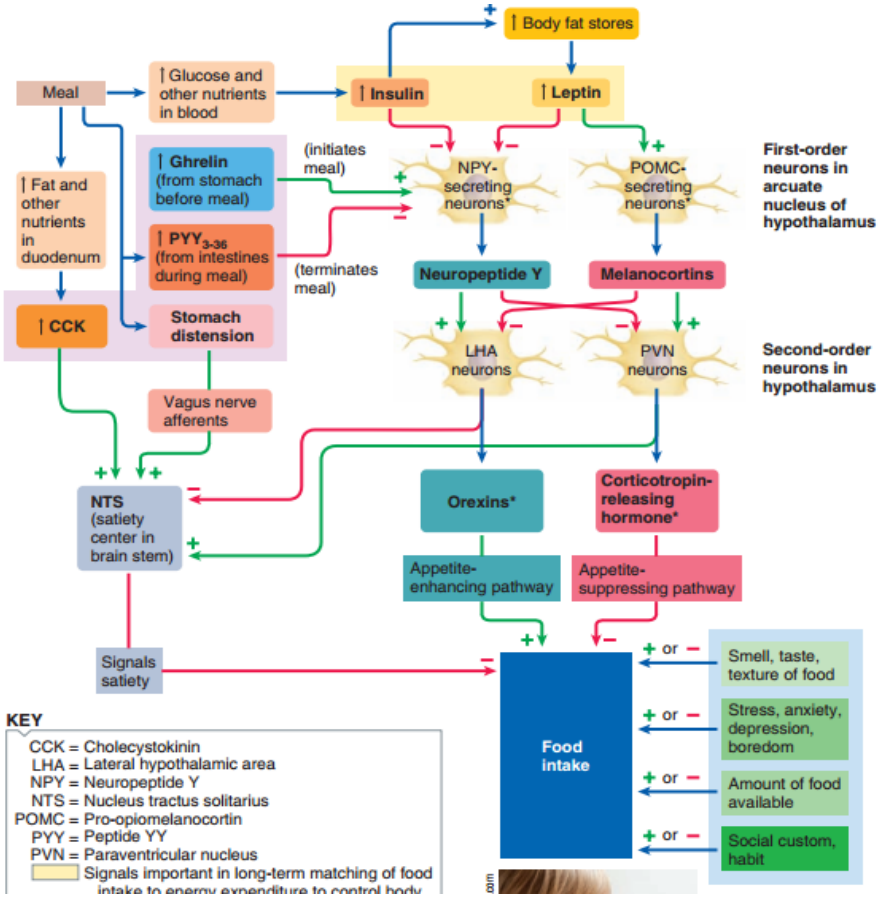

Figure 2. Factors that influence food intake
Figure explanation: CCK: Cholecystokinin, LHA: Lateral hypothalamic area, NPY: Neuropeptide Y, NTS: Nucleus tractus solitaries, POMC: Pro-opiomelanocortin, PYY: Peptide YY, PVN: Paraventricular nucleus.
*reference number [21]

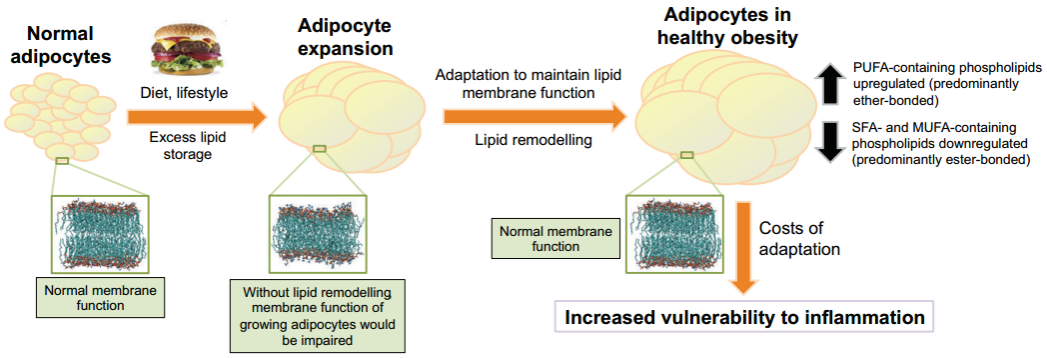

Figure 3. Model of physiological regulation of lipid membrane in obesity
*reference number[25]

Table 1. Type of intermittent fasting

IF Type	Description	Metabolic States Involved
Alternate day fasting	Alternating feast (ad libitum intake) and fast days (≤ 25% of energy needs)	Fed, post-absorptive, fasting (short duration, likely <36 hours between meals)
Modified fasting regiment	Allow for the consumption of 20-25% of energy needs on scheduled fasting days. This regiment is the basis for 5:2 diet	Fed, fasting (2 non-consecutive days a week, and ad libitum eating the other 5 days
Time-restriction fasting	Allows individual to consume ad libitum energy intake within specific windows, which include fasting period on routine basis. Ramadhan is the most common form of time-restriction feeding	Fed, post-absorptive (maximum duration between meals is usually < 16 hours)
Religious fasting	A wide variety of fasting regiments are undertaken for religious or spiritual purposes	Depend on the religious types of fasting
Periodic fasting	Fasting for up to 24 hours once or twice a week with ad lib intake on the remaining days	Fed, post-absorptive, fasting (up to 48 hours between meals depending on whether fast days are consecutive)

*reference number[13,16]

Table 2. Clinical trial studies result on IF regiments

Author	Year	Country	Intervention IF Regiment	Outcome
Harvie	2011	UK	25% energy restriction 2d/wk or 7d/wk on people with BMI 24-40 within 6 months	Comparable ↓ (leptin, free androgen index, total and LDL cholesterol, TG, BP)
Eshghinia	2013	Iran	25-30% energy needs (3d/wk) on overweight and obese population within 6 weeks	↓ BW, NS ↓ for (LDL, HDL, and TG)
Teng	2013	Malaysia	300-500 Cal/d deficit (2d/wk) as muslim sunnah fasting (≈13h) on obese people within 3 months	↓ (BW, %fat, energy intake, fat intake, BP, LDL, and total cholesterol)
Hussin	2013	Malaysia	300-500 Cal/d reduction from baseline + 2d/wk of muslim sunnah fasting + counselling on people with BMI 23-29.9 within 3 months	↓ (anger, tension, confusion, BW, BMI, and body fat), NS changes in mean depression scores
Catenacci	2016	USA	- Intervention: 0% energy needs on fast day, ad lib feast day - Control: 400 Cal/d deficit On people with BMI ≥ 30 within 8 weeks	NS ↓ for BW in both group, intervention group regained more FFM, control group regained more FM
Trepanowski	2017	USA	- 1st group: 25% energy needs on fast days + dietary counselling - 2nd group: 75% daily needs + dietary counselling - Control: 100% need daily On people with BMI 25-39.9 within 28 weeks	↓ BW (6% in 1st group, 5.3% in 2nd group), ↑ FFM and ↓ leptin in 1st and 2nd group (NS), no changes in circulating of adiponectin in any group

Table explanation: BMI: body mass index, BP: blood pressure, BW: body weight, FM: fat mass, FFM: fat free mass, HDL: high density lipoprotein, IF: intermittent fasting, LDL: low density lipoprotein, NS: not significant, TG: triglyceride, *reference number[13,16]

Conflict of Interest

Authors declared no conflict of interest regarding this article.

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