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Intermittent fasting and its influence on health and sports results

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Abstract

Introduction

Intermittent fasting (IF) is most simply defined as periods of eating alternating with periods of not eating. It has become one of the most popular weight-loss diets in recent years. One reason for the rapid growth in popularity of intermittent fasting may be its simplicity, as this dietary regimen does not require a change in a person's current eating patterns, nor a change in foods.

Aim of the study

This review aims to present the current state of knowledge about intermittent fasting and answer the question of what effect this form of diet has on the human body and sports results and its benefits to health.

Materials and methods

The paper was created based on the Pubmed database. The literature was reviewed using the keywords: ”intermittent fasting”, ”16/8 fasting” and ”diet standards”.

The current state of knowledge

It has been shown that intermittent fasting can be helpful in controlling body weight and reducing metabolic diseases as a result of better glucose regulation and reduced inflammation. Weight reduction can also result in improved athletic performance. In addition, IF has positive effects on the cardiovascular system, specifically improving blood pressure, lowering heart rate, and regulating the body's lipid metabolism indicators.

Summary

Although there is evidence of the beneficial effects of intermittent fasting, more research needs to be conducted to evaluate the mechanisms, efficacy in humans, target populations, and safety of intermittent fasting. Undoubtedly, a certain group of people may benefit greatly from this type of diet, as it does not require a change in current eating habits due to the simplicity of this diet.

Keywords: intermittent fasting, 16/8 fasting, diet standards

Introduction

Intermittent fasting is most simply defined as periods of eating alternating with periods of not eating [1]. It has become one of the most popular weight-loss diets in recent years. One reason for the rapid rise in popularity of intermittent fasting may be its simplicity. This diet does not require people to massively change their current eating habits. Moreover, intermittent fasting does not require avoidance of food groups or specific macronutrients, nor does it require participants to vigilantly monitor calories day after day [2]. The two overarching types of intermittent fasting are alternate-day fasting (ADF) and time-restricted fasting (e.g.:16/8 time restricted fasting, 16/8 TRF). Alternate-day fasting consists of 24-hour fasts followed by a 24-hour period of eating. For time-restricted fasting programs, "eating windows" include a 16-hour fast with an 8-hour eating period, a 20-hour fast with a 4-hour eating period, or other similar versions. Although both calorie restriction and intermittent fasting can result in an overall reduction in caloric intake, this is not an integral part of intermittent fasting [3]. Ramadan is the ninth month of the Muslim calendar and one of the basic principles of Islam, which dictates that healthy adult Muslims should abstain from eating, drinking smoking and sexual intercourse from sunrise to sunset for a month. This is one particular form of intermittent fasting, where Muslims can eat as they wish after sunset and before sunrise [4].

Thanks to the growing popularity of this diet, there is a growing body of work pointing to the health benefits of intermittent fasting. It has been shown that fasting can help control weight and reduce metabolic diseases. Some of the mechanisms by which intermittent fasting can improve metabolic health include reduced free radical production, increased resistance to stress, improved glucose regulation and suppression of inflammation [5,6]. Restricting caloric intake as a way to reduce body weight is a commonly used diet; however, it requires a daily consistent reduction in calories and is difficult to adhere to. Also, because of the risk of hypoglycemia, malnutrition and a possible adaptive response through increased appetite, decreased activity and inactivation of the thyrotropic axis resulting in weight gain again, intermittent fasting has recently been proposed as an alternative diet [7]. Importantly, not enough long-term comparative studies have been conducted to indicate whether one of these dietary protocols results in long-term efficacy, but the purpose of this review is to provide what is currently known about intermittent fasting and its effects on health.

Effects on metabolism, diabetes, and insulin resistance

To fully understand the changes that occur in the body during intermittent fasting, it is necessary to discuss the basic physiology of glucose and lipid metabolism that occurs during this type of diet. Glucose is the main component used by most human cells as a source of energy during the day. After a meal is consumed, this compound is used for energy, while fat is stored as triglycerides in adipose tissue. When there is a lack of supplied glucose to produce energy in the form of food, the body converts triglycerides from adipose tissue into fatty acids and glycerol, which are then metabolized for energy. The liver then converts fatty acids into ketone bodies, which during fasting become, instead of glucose, the main source of energy for many tissues, especially the brain. In the fed state, blood levels of ketone bodies are low, and in humans they rise within 8 to 12 hours after the start of a fast, reaching levels of 2 to 5 mM within 24 hours [8]. The main hormone responsible for glucose metabolism after a meal is insulin, while during fasting these functions are taken over by glucagon, which causes the release of glycogen stored in the liver and its use as an energy source. When the liver's glycogen stores are depleted, the body's metabolism switches from using carbohydrates to using fatty acids. This usually occurs 12 hours after the cessation of food intake. Therefore, intermittent fasting induces this metabolic switch, which can result in weight reduction [9,10]. It is also believed that this metabolic switch during intermittent fasting results in improved metabolism, and prolonged health, and may increase longevity through multiple processes [10,11]. Pathways mediating these effects include an increase in AMP (and ADP) and a decrease in cellular ATP, leading to activation of AMP-activated protein kinase (AMPK) - ultimately inhibiting many anabolic pathways and stimulating catabolic reactions of autophagy, thereby eliminating damaged proteins and organelles and improving mitochondrial function. Reducing circulating amino acids and glucose inhibits mTOR and leads to reduced protein synthesis and increased mitochondrial biogenesis and autophagy, resulting in prolonged lifespan in experimental animals [10]. Intermittent fasting has also been shown in animal models to improve insulin sensitivity, prevent obesity caused by a high-fat diet, and alleviate diabetic retinopathy [12].

Visceral adipose tissue in our body functions as a para- and endocrine organ by secreting adipokines that have pro-inflammatory (e.g.: leptin) or anti-inflammatory (e.g.: adiponectin) effects [13]. Leptin is a protein that is involved in regulating food intake through signaling to the hypothalamus. Adiponectin, on the other hand, interacts with various receptors namely: increases fatty acid oxidation in skeletal muscle and liver, decreases hepatic gluconeogenesis, and increases glucose uptake. Its levels decrease in proportion to fat accumulation [14]. Six short-term studies involving overweight or obese adults have shown that intermittent fasting is as effective for weight loss as standard diets. Another study showed that daily calorie restriction or 4:3 intermittent fasting (24-hour fasting three times a week) reverses insulin resistance in patients with pre-diabetes or type 2 diabetes [15-17]. There are several proposed mechanisms for the development of insulin resistance. One of the main theories relates to links between increased obesity and subsequent chronic inflammation, leading to the development of insulin resistance in tissues. Intermittent fasting may reduce obesity and associated insulin resistance by reducing caloric intake and altering metabolism. Another hypothesis is that the reduced energy intake achieved by intermittent fasting will result in a prolonged decrease in insulin production and an increase in AMPK levels, which likely plays a role in improving insulin sensitivity and glucose homeostasis [18]. Since intermittent fasting may be useful in the treatment of obesity, patients may benefit from this by improving leptin and adiponectin levels, resulting in better appetite control [14]. In a study of overweight men with type II diabetes, both caloric restriction and intermittent fasting subjects experienced weight loss, with intermittent fasters losing 1.1% body fat with an average weight loss of 6.5% after 12 weeks [19]. Similar results were observed by Harvie et al. in premenopausal women who were overweight or obese and were randomly assigned to intermittent fasting and calorie restriction for 6 months. The intermittent fasting and caloric restriction groups had comparable results, with the intermittent fasting group losing 6.4 kg (95% confidence interval [CI] 4.8-7.9 kg) and the caloric restriction group losing 5.6 kg (95% CI 4.4-6.9 kg) [20]. The likely mechanism for such an effective effect of alternate fasting is the induction of lipolysis by intense caloric restriction on the day of fasting, which has a particular effect on adipocyte mobilization, thereby promoting fat reduction [7]. The study by Sutton et al. looked at the effect of intermittent fasting on insulin sensitivity. The goal of the study was to see if intermittent fasting could have benefits independent of weight loss. The study used a relatively new form of intermittent fasting called time-limited dieting. It was a five-week, randomized, isocaloric and eucaloric controlled dietary study that tested early time-restricted feeding (eTRF) in men with pre-diabetes. Participants adopted an eTRF schedule (6-hour daily eating period, with dinner before 3 pm) and a control schedule (12-hour eating period) for five weeks each. Primary endpoints were glucose tolerance, postprandial insulin, and insulin sensitivity assessed by a 3-hour oral glucose tolerance test (OGTT). Secondary endpoints were cardiovascular risk factors and markers of inflammation and oxidative stress. Participants had a 3-hour OGTT with baseline measurements in the morning and after the intervention for each arm of the study. Five weeks of eTRF did not affect fasting glucose levels ($p = 0.49$) or glucose levels at any time point during the 3-hour OGTT ($p \geq 0.13$). However, eTRF did affect insulin levels. eTRF lowered fasting insulin levels ($p = 0.05$) and lowered insulin levels at $t = 60$ min and 90 min postload ($p \leq 0.01$). Overall, eTRF lowered mean and peak insulin levels by 26 ± 9 mU/L ($p = 0.01$) and 35 ± 13 mU/L ($p = 0.01$), respectively [17].

Regarding protein metabolism during intermittent fasting, Soeters et al. found that short-term alternate fasting does not alter protein turnover throughout the organism. The energy consumed during the first 2 to 3 days of fasting appears to come from glycogen and fat stores, as protein catabolism does not increase until 36 hours after the start of the fast [21].

Influence on the cardiovascular system

Intermittent fasting improves many indicators of cardiovascular health in animals and humans, including blood pressure; resting heart rate; levels of cholesterol, triglycerides, glucose high and low-density lipoprotein (HDL and LDL) insulin; and insulin resistance [22,23]. James Rochon et al. showed that daily calorie restriction improves many cardiometabolic risk factors in non-obese individuals [24]. In addition, intermittent fasting reduces markers of systemic inflammation and oxidative stress, which are associated with atherosclerosis [25]. Mager et al. report that improvements in markers of cardiovascular health usually become apparent within 2 to 4 weeks after starting intermittent fasting, and then disappear within a few weeks after resuming a normal diet [26].

Mager et al. showed that dietary restriction increases lifespan, delays or prevents age-related diseases, and improves functional and metabolic cardiovascular risk factors in rodents and other species. To investigate the effects of dietary restriction on heart rate variability and diastolic blood pressure (HRV and DPV) in male Sprague-Dawley rats, telemetry transmitters were implanted and the animals were maintained on intermittent fasting (feeding every other day) or on a calorie-restricted diet (40% calorie reduction). The temporal profiles of low- and high-frequency oscillatory components in heart rate and diastolic blood pressure signals were evaluated to assess cardiac autonomic activity. They found that body weight, heart rate, and systolic and diastolic blood pressure decreased in response to dietary restriction [26]. Also, human studies have shown a reduction in both systolic and diastolic blood pressure with intermittent fasting. A small study of men with pre-diabetes showed a mean reduction in systolic blood pressure of 11 ± 4 mm Hg and diastolic blood pressure of 10 ± 4 mm Hg after 5 weeks of 18-hour fasting [27]. Similarly, a prospective observational study of 82 Muslims who celebrated Ramadan, a monthly religious holiday that includes daytime fasting, showed a 3-point reduction in systolic blood pressure, although the diastolic change was not significant. One post-tense explanation for this phenomenon is a reduction in sympathetic tone and an increase in parasympathetic tone [28]. In a randomized controlled clinical trial, Chair et al. examined the effects of alternate-day fasting and time-limited fasting on cardio-metabolic risk factors, such as weight reduction, blood glucose levels, and lipid profile, in overweight and obese subjects with pre-diabetic conditions. The duration of the diet in the two study groups and the control group was 3 weeks. A significant decrease in weight and BMI was observed in both groups; however, the decrease was greater in the alternate fasting group. The effect on waist circumference was also significant, but there was a more significant decrease in the time-limited fasting group compared to the alternate fasting group. Both study groups showed a significant decrease in fasting blood glucose and LDL-C. Both IF regimens resulted in significant decreases in triglycerides and increases in HDL-C. In addition, no serious side effects were identified [7].

Influence on physical ability

Most of the studies on combining sports with intermittent fasting involve endurance training with many of the studies practicing overnight fasting or during Ramadan, and the results have been inconsistent [29]. Improving body composition by increasing the ratio of muscle mass to body fat as a result of physical activity or diet reduces the risk of weight-related diseases [30]. Canadian nutritionists and the American College of Sports Medicine believe that athletic performance is directly dependent on the body composition of athletes [31]. In a study, Martínez-Rodríguez et al. showed that intermittent fasting combined with high-intensity interval training resulted in significant decreases in body fat mass and improvements in performance in high jumps in physically active women. There were no significant changes in the amount of subcutaneous adipose tissue and a significant decrease in waist circumference. The timing of meal consumption was similar to the time of training, and this was associated with better performance in the high jump which could be due to the provision of more energy and nutrients before and after training [32]. In turn, intermittent fasting in Ramadan can negatively affect various aspects of human life and exercise performance, such as motivation, physiological mechanisms (muscle activation), plasma volume and glycogen stores. Not only negative energy balance is the cause of reduced exercise performance but also altered diurnal rhythm, sleep deprivation, increased mental stress, low blood sugar, and dehydration [4]. Even a 3-day fast mimicking that during Ramadan causes a decrease in speed and strength during sprint training [29]. Naharudin et al. in their study on the effects of intermittent fasting on high-intensity training deduced that adaptation to diet to ensure maintenance of training performance occurs when fasting lasts longer than 10 days [33]. More long-term studies should be conducted to evaluate specific intermittent fasting protocols and their effects on athletic performance [29]. Further research is especially needed to identify post-tenure benefits for athletes who wish to practice intermittent fasting [34].

Risks

Despite the promising results of intermittent fasting, it is not without side effects. Unfortunately, evidence documenting the ill effects of intermittent fasting is sparse, mainly because the duration of evaluation of intermittent fasting ranges from weeks to months. Some commonly reported side effects include hypoglycemia, dizziness, and weakness. Overall, hypoglycemia appears to be the most troublesome side effect of intermittent fasting. Beshyah et al. conducted a cross-sectional multi-country observational study to describe the risk of hypoglycemia during periods of intermittent fasting observed during the month of Ramadan. The study showed that intermittent fasting through reduced caloric intake can lead to severe hypoglycemia. This effect was further exacerbated by the concomitant use of antidiabetic drugs [35]. In addition, fasting without adequate protein supplementation is a well-known cause of muscle atrophy and should be avoided. It is not recommended for people with hormonal imbalances, pregnant and lactating women, young children, adults of advanced age, and people with immune deficiencies, including solid organ transplant patients with subsequent immunosuppression [36].

Conclusions

While this review provides a detailed narrative on the benefits of intermittent fasting for metabolic health, whether such dietary adjustments are feasible in everyday life remains an important question. Fasting can be challenging, so its practicality in modern lifestyles can sometimes be debatable. An argument in favor of intermittent fasting may be that because there are different protocols for intermittent fasting, it is more flexible compared to other restrictive dietary behaviors, such as the ketogenic diet, vegan diet, or daily calorie restriction. Moreover, because intermittent fasting correlates with natural diurnal rhythms, it can be a more physiological diet. Further research is needed to evaluate the mechanisms, efficacy and its safety in humans. There are a variety of intermittent fasting regimens, ranging from 12- to 16-hour daily fasting to a 5:2 strategy, and it is still uncertain which strategy is best for cardiovascular health [37]. Human studies show promise for the cardiovascular benefits associated with intermittent fasting. Although the exact mechanisms have yet to be elucidated, intermittent fasting appears to positively affect many cardiovascular risk factors, including obesity, hypertension, dyslipidemia, and diabetes. Future studies should also examine the safety of each intermittent fasting strategy.

Author contributions

Conceptualization: LJ; methodology: LJ, LŁ; software: LŁ; check: LŁ, LJ; formal analysis: KI; investigation: KI, KM; resources: KI,; data storage: L£, LJ, KI; writing - rough preparation: LŁ, LJ, KM, KI; writing - review and editing: KI, LŁ; visualization: LJ; supervision: LJ; project administration: LJ ; All authors have read and agreed with the published version of the manuscript.

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