

Generic Assessment Criteria	Mark s availa ble
1. Engagement with Literature Skills	
	25
2. Knowledge and Understanding Skills	
	25
3. Cognitive and Intellectual Skills	
	30
4. Practical Application Skills	
	10
5. Transferable Skills for Life and Professional Practice	
	10

Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)	Late Submission Penalties (tick if appropriate)	
	Up to 1 week late (40% Max)	
	Over 1 week late (0%)	

**EFFECTS OF INTERMITTENT FASTING DIETS IN
RELATION TO WEIGHT LOSS AND INFLAMMATION:
A NARRATIVE REVIEW**

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Mrs. Alison Connaughton BSc, DipPsy, MSc, FHEA
Senior Lecturer / Programme Manager for BSc. Health
Nutrition and Lifestyle

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YANKI DOLUAY (2100309)

Effects of intermittent fasting diets in relation to weight loss and inflammation: A narrative review

The question is “What is the effectiveness of intermittent fasting diets for weight loss and inflammation?”.

Introduction

Obesity is a medical condition that arises when an individual accumulates excessive body fat, posing significant threats to their overall health. The prevalence of obesity is increasing globally, which is a concerning trend. Recent data from the UK's National Health Service (NHS) reveals that approximately a quarter of adults and one in five 10-11-year-olds are categorized as obese. It is therefore crucial to address this health problem to mitigate the negative consequences associated with obesity, which may include an increased risk of developing various diseases and conditions (NHS, 2023).

The measure used to determine if a person has obesity is known as the body mass index (BMI). The calculation involves dividing the person's weight in kilograms by their height in meters squared. If the resulting number is equal to or greater than 30, then the individual is classified as having obesity (Hall and Cole, 2006, pp. 283-286).

According to Kelly et al., if current trends continue, more than half of the world's population will be overweight or obese by 2030. From 1980 to 2015, the percentage of people with a BMI ≥ 25 kg/m² increased globally from 25.4% to 38.5% in men and from 27.8% to 39.4% in women. The prevalence of obesity increased from 5% in 1980 to 10.1% in 2015 in men and from 8.9% to 14.8% in women (Kelly et al, 2008, pp. 1431-1437). The most significant rise in the prevalence of overweight and obesity occurred between 1992 and 2002, with the rate always higher in women than men, although the gap has been closing in recent years for overweight individuals. However, sex differences in obesity have remained constant over time. By 2025, the NCD Risk

Factor Collaboration estimates that the prevalence of obesity will reach 18% in men and 21% in women (NCD Risk Factor Collaboration, 2016, pp. 1377-1396).

In low-income countries, obesity is more prevalent among middle-aged adults living in urban and wealthy environments, particularly women. In contrast, in high-income countries, obesity affects both sexes and all ages, but disadvantaged groups have a higher prevalence of obesity (Swinburn et al, 2011, pp. 804-814). Regardless of sociodemographic factors, the prevalence of obesity is generally higher in women than men (Bovet et al, 2017, pp. 1495-1496).

These statistics highlight the urgent need for global action to prevent and manage overweight and obesity. If we do not take action, obesity will become an even more significant public health problem. Governments, health organisations, and individuals need to work together to promote healthy lifestyles that include regular physical activity and a balanced diet to prevent and manage overweight and obesity (Chooi et al, 2019, pp. 6-10).

Obesity is a complex health condition that can have several contributing factors, including genetics, lifestyle, and environmental influences. Unhealthy dietary patterns, coupled with a sedentary lifestyle, are major contributors to weight gain and the development of obesity. While medical conditions, certain medications, and psychological factors can also play a role in obesity, they are typically not the primary cause, and addressing them usually does not result in significant weight loss. The health consequences of obesity are numerous, ranging from diabetes, heart disease, stroke, high blood pressure, sleep apnea, to certain types of cancer, and reduced life expectancy and quality of life. Therefore, it is vital to prevent and manage obesity by adopting healthy habits that include regular exercise and a balanced diet. Various interventions, such as diet and exercise, can be employed to manage obesity (Kopelman, 2000, pp. 635-643).

Excessive fat accumulation in the body can trigger a persistent, mild inflammation due to the release of chemicals called adipokines by the fat cells. These adipokines can activate the production of inflammatory cytokines, which can lead to systemic inflammation. This chronic inflammation has been associated with the development of several diseases, such as heart disease, type 2 diabetes, and certain types of cancer (Hotamisligil et al, 1995, pp. 2409-2415, and, De Luca and Olefsky, 2008, pp. 97-105).

Intermittent fasting (IF) is a dietary practice that involves alternating periods of restricted or zero caloric intake. This type of fasting can take on several forms, such as daily fasting for 16 hours, fasting every other day, or fasting for two days per week. During the fasting phase, individuals

may opt to consume no calories or limit their intake to up to 25% of their regular caloric requirements. In contrast, during non-fasting periods, people may have unrestricted access to food or limit themselves to specific foods while consuming up to 125% of their regular caloric needs. This type of dietary intervention is often utilized for weight loss and metabolic health improvement purposes (Fung, 2016).

There are different names for this type of diet, including intermittent fasting, alternate-day fasting, reduced meal frequency, and time-restricted feeding. Intermittent fasting can be used alone or in combination with other dietary interventions (Welton et al, 2020, pp. 117-125).

Intermittent fasting is a different method to reduce calorie intake that can also help in improving body composition and overall health, making it a useful intervention for obesity (Tinsley and Bounty, 2015, pp. 661-674). This approach involves controlling meal times by avoiding eating for a specific period, usually, 16 hours, followed by consuming meals during an 8-hour feeding window (Brown et al, 2013, pp. 68-72). One can adjust the fasting or eating window to suit their preferences. For instance, some people alternate between eating and fasting days, consuming only one meal (usually at lunchtime) on the fasting day, which accounts for no more than 25% of their daily calorie needs. Another approach is to include one or two days of fasting per week (Varady et al, 2013, pp. 1-8).

Intermittent fasting, which involves controlling meal times to improve health, has been found to offer many benefits beyond weight loss, according to several studies (De Cabo and Mattson, 2019, pp. 2541-2551). One of these benefits is reducing inflammation in the body by lowering the production of pro-inflammatory cytokines and increasing anti-inflammatory cytokines. This is achieved by activating cellular responses that improve glucose regulation, increase stress resistance, and suppress inflammation. The mechanism behind intermittent fasting involves reducing inflammation markers and oxidative stress by switching from glucose to ketone utilisation during fasting periods, which may have anti-inflammatory effects (Mattson et al, 2018, pp. 81-94).

Excess body fat stored around organs in the abdomen, known as visceral fat, is linked to inflammation and metabolic problems. Visceral fat cells produce more chemicals that cause inflammation than subcutaneous fat cells located under the skin. This makes individuals with a larger amount of visceral fat more likely to develop inflammation-related diseases (O'Rourke, 2009, pp. 255-259).

In summary, obesity is a complex condition influenced by genetic, lifestyle, and environmental factors that can lead to chronic low-grade inflammation and metabolic dysfunction, increasing the risk of various diseases. Managing and preventing obesity through lifestyle interventions such as a healthy diet and regular exercise is crucial. Intermittent fasting is an alternative approach to reducing calorie intake that has been shown to offer several health benefits, including reducing inflammation and oxidative stress in the body.

Aims

This narrative review examines the effectiveness of intermittent fasting diets for weight loss and inflammation by analysing a wide range of systematic reviews. The goal is to provide reliable recommendations for individuals who are considering intermittent fasting as a weight loss or inflammation management strategy. The review evaluates the strengths and weaknesses of the studies included to determine the overall quality of the evidence and identify gaps or inconsistencies in the literature. The purpose is to present a thorough and trustworthy overview of the current evidence using a rigorous methodology that can inform clinical practice and future research in the area. By doing so, the review aims to improve our understanding of the potential benefits and risks of intermittent fasting diets for weight loss and inflammation, while also providing guidance to individuals and healthcare professionals seeking evidence-based recommendations for weight management and inflammation control. The review emphasises the importance of following a healthy and balanced diet, in conjunction with intermittent fasting, as a safe and effective approach to achieving sustainable weight loss and reducing inflammation.

Methodology

This narrative review aims to provide a comprehensive overview of the current evidence on the effects of intermittent fasting diets on weight loss and inflammation. To achieve this goal, the review will search relevant literature from electronic databases such as PubMed, Google

Scholar, and UWTSD Library, as well as reference lists from relevant articles and systematic reviews.

The selection criteria for this study will prioritise high-quality human studies that investigate the effects of intermittent fasting diets on weight loss and inflammation. The review will also examine various types of intermittent fasting diets, including alternate-day fasting and time-restricted feeding.

After selecting the relevant studies, the review will conduct a narrative synthesis of the evidence to evaluate the effectiveness of intermittent fasting diets for weight loss and inflammation. This synthesis will also assess the potential risks and limitations of these diets and identify any gaps or inconsistencies in the literature.

The review will provide a critical evaluation of the strengths and limitations of the included studies and assess the overall quality of the evidence. Based on this evaluation, the study will establish evidence-based conclusions and recommendations for individuals considering intermittent fasting for weight loss or inflammation management.

The findings of this study will have important implications for individuals who are looking for effective strategies to manage their weight and control inflammation. The review's recommendations can inform clinical practice and guide future research in this area.

In conclusion, this narrative review will offer valuable insights into the effects of intermittent fasting diets on weight loss and inflammation. By using a strong methodology that prioritises accuracy and quality, the review will produce a comprehensive and reliable overview of the current evidence. The study's findings will be of great significance to individuals considering intermittent fasting as a weight loss strategy or for managing inflammation.

Prevalence of Obesity Globally and Nationally

Recent estimates have revealed that overweight and obesity are significant causes of death in the WHO European Region, accounting for over 1.2 million deaths annually, which equates to more than 13% of all deaths. This places overweight and obesity as the fourth leading cause of death after high blood pressure, dietary risks, and tobacco use. In addition, it is the leading factor contributing to the risk of disability, causing approximately 7% of total years lived with disability (YLDs) in the region. These statistics highlight the severe impact of this issue on individuals and public health. As a result, it is imperative to implement effective interventions

and public health policies to address this growing health problem and prevent the adverse outcomes linked to it (World Health Organization, 2022).

Obesity is a global health concern that is more common in affluent countries such as those in Europe, North America, and Oceania. The WHO European Region reports that over half of adults in almost all member states have overweight or obesity. As per the WHO report of 2016, the prevalence of obesity in adults in this region is higher than any other WHO region except the Region of the Americas. Shockingly, an estimated 59% of adults in the WHO European Region live with overweight or obesity. This alarming trend calls for urgent action and intervention to mitigate the associated health risks (World Health Organization, 2018, and, Reilly et al, 2018, pp. 1773-1774).

In Europe, there is a higher prevalence of high levels of overweight or obesity in men than women. Around 63% of men and 54% of women in the WHO European Region have high levels of overweight, which is the highest among all WHO regions, except the Region of the Americas. In the same region, 23% of adults have obesity, and it is more common in women than men. The countries with the highest levels of overweight and obesity are the Mediterranean and Eastern European countries, and people with lower educational attainment are more likely to have obesity. Socioeconomic factors such as income, education, employment status, and place of residence can affect the levels of overweight and obesity differently between men and women, as shown by gender analysis (World Health Organization, 2020).

Obesity and being overweight are significant health concerns worldwide and are among the leading causes of preventable deaths in the UK and globally (Owen et al, 2012, pp. 37-45, and, Greenway et al, 2015, pp. 1188-1196). National health surveys in Wales, England, Scotland, and Northern Ireland in 2017/2018 revealed that more than half of the adult population (16 years and over) in each country was overweight or obese. These trends have enormous health and economic implications as obesity is not only a condition of its own but also a significant risk factor for various chronic diseases. The ongoing COVID-19 pandemic has further highlighted the importance of addressing obesity as people with overweight or obesity are more vulnerable to severe COVID-19 outcomes (Jastreboff et al, 2019, pp.7-9, and, Touray et al, 2022, pp. 428-441).

According to Dobbs et al. the economic impact of obesity worldwide is estimated to be USD 2.0 trillion, which amounts to about 2.8% of the global gross domestic product at 2014 costs (Dobbs et al, 2014). In the UK, the Obesity Health Alliance (2017) estimated that the cost of obesity to

the society is around GBP 27 billion. The projected overweight and obesity attributable costs for the National Health Services (NHS) in the UK are expected to reach GBP 9.7 billion by 2050, while the broader costs to society could reach as high as GBP 49.9 billion per year. The high costs associated with obesity are not only a burden on individuals but also on the broader society (England, 2017).

The text discusses the problem of obesity and overweight, which are major health issues globally and are responsible for a significant number of preventable deaths. Obesity has a significant economic impact, with the estimated cost worldwide being around USD 2.0 trillion, and in the UK, it is around GBP 27 billion. The urgent need for effective interventions and public health policies to tackle this growing health issue is emphasised.

Obesity and Inflammation

Obesity affects many parts of the body and can cause different diseases. It can lead to problems with insulin and cause type 2 diabetes. But it can also increase the risk of cancer and lung diseases, which is surprising. Scientists have been looking for a reason why obesity causes so many diseases, and they have found that it has to do with how the body reacts to too much food (Hotta et al, 2000, pp. 1595-1599). The body's immune system and inflammation response get messed up, causing what's called "meta-inflammation." This is when there is a low-level inflammation in the body all the time because of obesity. (Hotamisligil, 2006, pp. 860-867).

Inflammation is the body's response to protect itself from harmful stimuli. In obesity, the inflammatory response is triggered by many factors and involves the production of inflammatory cytokines and acute phase proteins, leukocyte recruitment to inflamed tissues, activation of tissue leukocytes, and reparative tissue responses (Spencer et al, 2010). However, the inflammatory response triggered by obesity is different from other types of inflammation, such as those caused by infection or autoimmune diseases. The continuous nature of obesity causes a low-grade activation of the innate immune system, which affects metabolic homeostasis over time (Lumeng and Saltiel, 2011, pp. 2111-2117).

Obesity doesn't just affect one part of the body, it impacts many different organs and can cause a variety of health problems. Inflammation is a response that the body has to harmful things and is meant to help return the body to a normal state. When a person is obese, their body's inflammatory response is activated in a way that is different from other situations, like fighting an infection or dealing with an autoimmune disease. The inflammation in obesity is long-lasting and affects the immune system in a way that can lead to problems with metabolism over time. Because of the way obesity affects so many different parts of the body, it can be difficult for researchers to understand exactly how the disease works and what the best ways are to treat it

(Butler and Kozak, 2010, pp. 323-329). However, it's clear that inflammation plays a major role in the link between obesity and disease.

Obesity-induced inflammation is caused by various factors that contribute to metabolic dysfunction. These factors include increased levels of cytokines in the bloodstream, a decrease in protective factors, and communication between inflammatory and metabolic cells. For example, certain macrophages can negatively affect insulin signalling and the formation of adipocytes, while other macrophages do not generate these negative effects. Similarly, signals from activated T cells, such as IFN- γ , can also generate inflammation and impact glucose transport. Dysregulated signalling between macrophages and other cells in the body can also affect insulin sensitivity (Feuerer et al, 2009, pp. 930-939). Unlike other chronic inflammatory diseases, obesity leads to inflammation in multiple organs, including the pancreas, liver, adipose tissue, heart, brain, and muscles (Varma et al, 2009, pp. E1300-E1310). While some inflammatory diseases may affect multiple organs temporarily, obesity is unique in its chronic, multi-organ effects on the body (Huang et al, 2010, pp. 347-357).

In conclusion, obesity-induced inflammation is a complex and chronic condition that affects multiple organs and systems in the body. It involves a unique type of low-grade inflammation that disrupts metabolic homeostasis, leading to metabolic dysfunction and increased risk of diseases such as diabetes, cancer, and pulmonary diseases. The inflammatory response triggered by obesity involves various components of the classical inflammatory response, but its nature is distinct from other inflammatory paradigms. Multiple inflammatory inputs contribute to metabolic dysfunction, and dysregulated macrophage signalling can influence insulin sensitivity (Lumeng et al, 2008, pp. 3239-3246). Overall, understanding the link between inflammation and obesity is crucial for developing effective strategies to prevent and treat obesity-associated diseases.

Intermittent Fasting and Other Interventions for Obesity

The issue of obesity is becoming more prevalent around the world, and one of the most recommended interventions for it is exercise and diet. Eating healthy foods, paired with frequent physical activity, can aid people in losing weight, enhance their general health, and decrease their risk of developing chronic diseases. By eating fewer calories and increasing exercise levels, individuals can create a calorie deficit that can lead to weight loss over time (Kopelman, 2000, pp. 635-643). Nevertheless, it's important to remember that a sustainable and balanced approach is necessary for long-term weight management success. This can involve small, manageable lifestyle changes such as eating more fruits and vegetables, decreasing portion sizes, and engaging in physical activities that are both enjoyable and realistic for each individual (Hsu et al, 2019, pp.2163).

For individuals with severe obesity, lifestyle changes and medications may not result in significant and sustainable weight loss. Bariatric surgery is a more effective option that can lead to sustained weight loss and improve related health conditions. The surgery has been shown to reduce excess weight by 50% to 70% and improve glycemic control, blood pressure, lipid levels,

and sleep apnea. Moreover, it can have psychological benefits, such as improving self-esteem and overall quality of life. However, bariatric surgery is a major procedure that carries risks and potential complications, and therefore, a thorough medical evaluation, preoperative counseling, and postoperative follow-up are necessary (Arterburn and Courcoulas, 2014, pp. 349).

Bariatric surgery is an option recommended for those who have a body mass index (BMI) of 40 kg/m² or higher, or those with a BMI of 35 kg/m² or higher and at least one obesity-related comorbidity like hypertension, sleep apnea, or type 2 diabetes. The surgery involves altering the digestive system to limit food intake and/or nutrient absorption using various techniques like gastric bypass, adjustable gastric banding, or sleeve gastrectomy. However, bariatric surgery is a major surgery that carries risks and complications, such as bleeding, infection, bowel obstruction, and nutrient deficiencies. Therefore, it is important that individuals considering bariatric surgery undergo a comprehensive medical evaluation to determine their suitability for the procedure, receive thorough preoperative counselling, and have an ongoing postoperative follow-up to ensure the best possible outcomes (Maggard et al, 2005, pp. 547-559).

Obesity management protocols should include preventing weight gain, maintaining weight, managing comorbidities, and weight loss when needed. It's important to pay special attention to weight management during vulnerable ages and life stages, as well as for patients at higher risk due to genetic, social, or behavioural factors. Preventing and managing obesity in children is especially important because obese children are likely to become obese adults. However, interventions for children should be cautious, taking into account their physical, psychological, and social development. Family involvement in weight management efforts is crucial for success and preventing the social exclusion of individual children. Healthcare professionals play an important role in monitoring children's weight and offering advice and support for diet and lifestyle changes. Effective prevention of obesity requires public health programs that address societal and environmental factors that contribute to reduced physical activity and increased energy intake. The medical profession should advocate and support such programs (Gill, 1997, pp. 359-388).

Behavioural obesity treatment guidelines suggest reducing calorie intake by 25-30% or aiming to consume 1200-1800 calories per day, depending on initial weight, to achieve continuous energy restriction (CER) (Jensen et al, 2014). These interventions can lead to an average loss of 5-10% of initial body weight over 6 months, while also improving cardiometabolic risk factors and mental well-being (Look AHEAD Research Group, 2014, pp. 1544-1553). However, without ongoing support, adults tend to regain about a third of their lost weight within a year of completing the treatment, with an increasing risk of regaining weight and experiencing metabolic and mental health problems over time (Wadden et al, 2012, pp. 1157-1170).

Losing weight in the long term is difficult because it involves a mix of psychological, behavioural, and biological factors (Montesi et al, 2016, pp. 37-46). While there are many benefits to losing weight over a long period, it's hard to do so without effective strategies. People who struggle with obesity often see weight management as a continuous and challenging process. However, many of them struggle to stick to daily calorie restrictions over time, making it harder to maintain weight loss (Alhassan et al, 2008, pp. 985-991). This is because adherence to daily calorie

restrictions often decreases over time, leading to weight regain (Moreira et al, 2011, pp. 309-315).

To help with weight loss and management, new approaches are needed that can make it easier for people to stick to a plan. One approach is called intermittent energy restriction (IER), which involves restricting calorie intake only during specific times, instead of every day. With IER, people have "fast" days where they eat only 25% of their energy needs, followed by "feast" days where they can eat normally. Studies have shown that IER can result in weight loss of 4-8% over three months, along with improvements in heart health. This is similar to the results achieved with daily calorie restriction, but IER may also help to prevent the biological changes that can lead to weight regain. (Harris et al, 2018, pp. 507-547).

Some experts have proposed that intermittent energy restriction (IER) is beneficial not only because of reduced calorie intake but also because it promotes metabolic switching between fed and fasting states. Metabolic switching involves the body shifting from using glucose to utilising fatty acids and ketones, which can improve body composition and maintain muscle mass during weight loss (Cabo and Mattson, 2019, pp. 2541-2551). Previous research on IER mainly focused on short-term weight loss and cardiometabolic outcomes, such as blood pressure and glucose levels. However, recent studies suggest that IER can lead to a loss of 4-8% of initial body weight over 3 months, which is comparable to the results achieved with daily calorie restriction (Lima et al, 2020, pp. 222-226).. Additionally, IER may help prevent the biological changes that can lead to weight regain after weight loss (Cioffi et al, 2018, pp. 1-15). The texts highlight the importance of effective weight management strategies to address obesity, which is a complex health issue influenced by multiple factors.

Intermittent Fasting Protocols

Intermittent fasting refers to a variety of eating patterns that involve periods of food restriction or abstinence. While religious fasting is a well-known example, this article focuses on non-religious forms of intermittent fasting. It's important to examine each approach individually to assess its effects on weight loss, metabolism, inflammation, antioxidant activity, and production of ketone bodies. Long-term adherence to these patterns is also important to consider. Additionally, the timing of the feeding window in relation to the body's circadian rhythm may have varying impacts on cardiovascular and metabolic health (Wilkinson et al, 2020, pp. 92-104, and, Asher and Sassone-Corsi, 2015, pp. 84-92).

While there are several types of intermittent fasting (IF) that have been studied, this article will focus on specific protocols.

Any attempt to generalize the effects of different types of fasting can be inadequate. There are different forms of intermittent fasting that have been studied, and they do not necessarily produce similar results. Three of the most researched protocols are complete alternate-day fasting (ADF), modified alternate-day fasting (MADF), and time-restricted feeding (TRF) (Patterson and Sears, 2017).

ADF involves fasting every other day with no energy intake, alternating with ad libitum eating days. MADF is a modified version of ADF, and the most popular form is the 5:2 diet, which allows for five days of normal eating and two days of absolute fasting or restricted calorie intake (Hoddy et al, 2020, pp. S29-S37).

TRF, on the other hand, allows for ad libitum eating within specific time windows, with a prolonged fasting period every day. Another variation is restricting food intake during the night, according to the circadian rhythm. Each of these methods has its own specific rules and benefits, and they should be evaluated independently in terms of their effects on weight loss, metabolic profile, and other health outcomes (Stockman et al, 2018, pp. 172-185).

Specific protocols for intermittent fasting are outlined in detail in Table 1, providing a comprehensive overview of the various approaches to fasting that have been studied and their associated benefits and potential drawbacks.

Table 1

Complete alternate-day fasting (ADF)	Alternate-day fasting involves alternating between days of no-energy food intake and days of unrestricted eating
Modified alternate-day fasting (MADF)	One of the variations of alternate-day fasting is the 5:2 diet, which has gained popularity. This diet involves restricting calorie intake to no more than 25% of daily requirements on two non-consecutive days of the week, while the other five days involve unrestricted eating.
Time-restricted feeding (TRF)	This approach of intermittent fasting involves consuming food within specific hours of the day, and then fasting for an extended period. Another variation of this method is limiting food intake only during the night hours, in accordance with the body's circadian rhythm.

(Patterson and Sears, 2017, and, Hoddy et al, 2020, pp. S29-S37, and, Stockman et al, 2018, pp. 172-185).

The Effects of Intermittent Fasting: Mechanisms of Action

Intermittent fasting has been suggested to modulate the body's circadian rhythm (Jamshed et al, 2019, pp. 1234, and, Manoogian and Panda, 2017, pp. 59-67) and promote adipose tissue

plasticity (Li et al, 2017, pp. 672-685). It may also affect the production of adipokines (Cignarella et al, 2018, pp. 1222-1235) and the gut microbiome (Frank et al, 2021, pp. 584) by increasing the production of short-chain fatty acids (SCFA) and promoting autophagy (Zhang et al, 2020, pp. 101535). These effects have the potential to reduce inflammation, metabolic dysfunction, and impaired immune system regulation associated with nonalcoholic fatty liver disease (NAFLD) (Chen et al, 2015, pp. 12115).

Circadian Rhythm

The amount of food we consume has a significant impact on how we eat and the decisions we make about food. This is because our body's central homeostatic and non-homeostatic (hedonic) systems interact to regulate our appetite and satiety. These systems work together to help us maintain a balance between satisfying our hunger and enjoying the pleasurable aspects of eating (Liu and Kanoski, 2018, pp. 223-231). The interplay between the body's homeostatic and hedonic systems, which regulate the balance between eating for survival and eating for pleasure, is influenced not only by the quantity and quality of food consumed but also by the timing and regularity of meals. Additionally, the circadian rhythm, which governs bodily processes over a 24-hour period, has an impact on the functioning of the gut and the complex interplay between gut bacteria and the body (Frank et al, 2021, pp. 584). The circadian rhythm refers to the natural processes that occur in our body over a 24-hour period, including sleep, hormone production, cognitive function, and mood. Interestingly, research suggests that restricting the time period during which we eat may have an impact on our circadian clock, which in turn affects our metabolism (Almoosawi et al, 2016, pp. 487-500). The circadian system regulates the production and secretion of both insulin and glucagon, but it is influenced by many factors, including food intake. Although insulin production and secretion peak in the evening and are lowest in the early morning, eating patterns can change blood nutrient levels and disrupt the normal hormonal release pattern, potentially affecting various physiological processes (Manoogian and Panda, 2017, pp. 59-67). For instance, a small study of 23 adults who fasted during the day for the month of Ramadan found that their evening cortisol levels were higher compared to a non-fasting month (Bahijri et al, 2013, p. e60917).

In another study of 11 overweight adults who followed a time-restricted feeding (TRF) diet, where they consumed food only between 8 a.m. and 2 p.m. (early fasting) or between 8 a.m. and 8 p.m. (control), it was found that the early fasting group had improved glucose levels over 24 hours and changes in circadian clock gene expression, as well as expression of hormones and genes related to longevity and autophagy. These results suggest that early fasting may have anti-ageing effects (Jamshed et al, 2019, pp. 1234). A recent study delved into the molecular mechanisms behind intermittent fasting (IF) and found that the hepatic macrophage glucocorticoid receptor plays a crucial role in the secretion of inflammatory cytokines by macrophages during fasting. The study also revealed the relationship between the receptor's influence on ketogenesis in hepatocytes (Loft et al, 2022, pp. 473-486).

White Adipose Tissue Browning

In the past, fat cells were believed to only store energy passively without any other significant role. However, it is now known that adipose tissue also has endocrine functions, meaning it can secrete hormones and other substances into the bloodstream. These bioactive peptides are known as adipokines and can have important effects on metabolism and other physiological processes. (Kershaw and Flier, 2004, pp. 2548- 2556).

Adipose tissue is not just a passive energy storage organ but also has endocrine functions. It produces and releases bioactive peptides known as adipokines, which include leptin, adiponectin, TNF- α , IL-6, and resistin, among others. Adipokines can act locally or systemically through various signalling pathways. Adipose tissue can be classified into white adipose tissue (WAT) and brown adipose tissue (BAT), which have different functions. WAT stores energy as triglycerides while BAT is involved in thermogenesis, which can help counteract the effects of excess energy intake and promote weight loss (Saely et al, 2012, pp. 15-23, and, Cannon and Nedergaard, 2011, pp. 242-253).

Adipose tissue is no longer considered just a passive energy storage site, as it has been shown to produce and release bioactive peptides called adipokines. Some examples of adipokines include leptin, adiponectin, TNF- α , IL-6, and resistin, which can act locally or systemically through various signalling pathways. Adipose tissue is divided into different types, including white adipose tissue (WAT) and brown adipose tissue (BAT), which play different roles in the body. WAT stores energy as triglycerides, while BAT is involved in thermogenesis and can promote weight loss. In a recent pre-clinical study, intermittent fasting was shown to improve metabolic homeostasis by activating M2 anti-inflammatory macrophages and increasing vascular endothelial growth factor expression, which led to WAT browning and adipose thermogenesis (Kim et al, 2017, pp. 1309-1326).

Adipokines

Adipose tissue consists of various cell types, such as fibroblasts, endothelial cells, and immune cells. In cases of obesity, the immune cell composition of adipose tissue experiences significant alterations, leading to abnormal production of adipokines and chemokines and activation of inflammatory signalling pathways (Maurizi et al, 2018, pp. 88-97). Adipokines can have various effects on inflammation in different parts of the body. Adipokines that promote inflammation include leptin, visfatin, IL-6, TNF- α , resistin, and fatty acid binding protein 4, while adipokines that have anti-inflammatory properties include adiponectin, IL-10, omentin-1, vaspin, and apelin (Sahu and Bal, 2022).

In obesity, increased production of pro-inflammatory adipokines, such as leptin, IL-6, TNF- α , and resistin, was observed. This leads to disruptions in satiety and lipid metabolism and a reduction in anti-inflammatory and insulin-sensitizing cytokines like adiponectin and IL-10. Among the different types of adipose tissue, visceral adipose tissue (VAT) has been identified as the main source of inflammatory cytokine secretion. Therefore, a decrease in VAT is associated

with improvements in inflammatory outcomes (Le Jemtel et al, 2018, pp. 1-14). A reduction in weight as little as 2.5% was observed in individuals without obesity after 3 weeks of IF, resulting in a decrease in fat mass (Heilbronn et al, 2005, pp. 63-73). In individuals with obesity, an 8-week IF intervention resulted in a reduction in visceral adipose tissue (VAT) area (Klempel et al, 2012, pp. 1-9).

In the case of non-alcoholic fatty liver disease (NAFLD), the size of visceral adipose tissue (VAT) is strongly linked to an increased risk of developing the disease. Additionally, having a larger VAT area has been associated with a higher likelihood of fibrosis and a lower chance of disease improvement (Kim et al, 2016, pp. 132-138).

A recent review has discussed the connection between adipokines and NAFLD, as well as the progression to NASH and cirrhosis. The review noted that low levels of leptin, along with high levels of adiponectin, were beneficial in protecting against hepatic steatosis, while high levels of leptin and resistin contributed to increased hepatic fibrosis (Acierno et al, 2020, pp. 287-306). The potential impact of altering adipokine secretion through interventions such as IF on limiting the progression of liver disease has been emphasized. Some studies have suggested that adipokines released from VAT, particularly leptin, may increase the permeability of the intestinal mucosa. This, in turn, may facilitate the process of bacterial translocation and inflammation (Paeschke et al, 2017, pp. 53-58).

An observational study conducted on humans who followed alternate-day fasting for a period of 12 weeks reported a reduction in leptin levels, coupled with an elevation in adiponectin levels (Varady et al, 2013, pp. 1-8). In contrast, another study found that while leptin levels decreased in overweight or obese individuals following an alternate-day fasting (ADF) protocol, adiponectin levels and other inflammatory biomarkers such as resistin, IL-6, and TNF- α remained unchanged (Trepanowski et al, 2018, pp. 1871- 1878).

In another study involving patients with multiple sclerosis, a pilot randomized controlled trial compared ADF with energy intake restricted to 500 kcal/day on fasting days to an ad libitum diet for 15 days. They found a reduction in leptin levels after ADF, but no changes were observed in adiponectin levels between IF and ad libitum diet. The divergent results could be attributed to differences in sample size, adherence, and dropout rates. Further studies are needed to fully understand the specific effects of fasting on adipokines and how they can be utilized as potential biomarkers for fasting and inflammation in clinical settings (Cignarella et al, 2018, pp. 1222-1235).

Adipose Tissue–Gut Microbiome Axis

There is growing recognition of the gut microbiome's impact on overall metabolism. Specifically, the gut microbiota has been shown to affect the production of triglycerides in the liver and the storage of triglycerides in adipocytes, as they suppress the expression of lipoprotein lipase inhibitors (Backhed et al, 2004, pp. 15718-15723)..

Individuals with obesity were found to have a disruption in their gut microbiota, which was manifested as a reduction in the diversity of microbial genes and changes in the distribution of microbial groups compared to individuals with normal weight (Lee et al, 2020, pp. 37-52). In people with obesity, an imbalance in the types and amounts of gut microbes present, known as gut microbial dysbiosis, has been observed. This dysbiosis is characterized by an elevated ratio of Firmicutes to Bacteroidetes, as well as a higher prevalence of *Lactobacillus* and *Bifidobacterium* and a lower prevalence of *Akkermansia muciniphila* (Ozdemir et al, 2021). It is worth noting that changes in gut microbiota were found to play a role in the breakdown of choline into methylamines and in the alteration of bile acid metabolism, which could lead to the development of hepatic inflammation and subsequently, NAFLD (Rinaldi et al, 2021, pp. 270). Hence, correcting gut microbial dysbiosis could be a crucial method for reducing inflammation in the liver and restricting the advancement of NAFLD. Moreover, there have been observations of alterations in the microbiome during intermittent fasting in humans. A preliminary observational investigation of Ramadan fasting revealed an upsurge in *A. muciniphila* and *Bacteroides fragilis*, accompanied by an improvement in lipid and glucose profiles (Ozkul et al, 2019, pp. 1030). A recent review of clinical research reported a positive correlation between the presence of *A. muciniphila* and the beneficial effects of IF on the energy metabolism and circadian rhythm of the host (Rong et al, 2021, pp. 1283- 1295).

The gut microbiota may play a role in the development of obesity by affecting energy metabolism. They can help extract energy from foods that would normally not be digested, providing up to 10% of the daily energy requirement (Rosenbaum et al, 2015, pp. 493-501). Additionally, lipopolysaccharide (LPS) present in the outer membrane of Gram-negative bacteria can cross the intestinal barrier and lead to inflammation throughout the body (Cani et al, 2008, pp. 1470-1481). Research has demonstrated that metabolic endotoxemia can have an impact on the development and advancement of insulin resistance and metabolic disorders, which is pertinent to the pathogenesis of NAFLD (Nier et al, 2020, pp. 699).

Autophagy

Autophagy is an essential cellular process that involves breaking down and recycling both internal and external components to maintain the proper functioning of cells (Galluzzi et al, 2017, pp. 1811-1836). Autophagy is an essential cellular process that breaks down and recycles both internal and external components to maintain a stable environment inside the cell. It plays a crucial role in eliminating damaged cell organelles and excess proteins and can be activated by various types of stress, including nutrient deprivation. When a cell lacks the necessary components to function, autophagy is necessary for its survival. Calorie restriction is the most potent way to induce autophagy, and it's noteworthy that nutrient depletion or restriction is linked to increased lifespan (Kroemer et al, 2010, pp. 280-293). Irregular or improper functioning of autophagy has been linked with various persistent conditions, such as metabolic disorders (Glick et al, 2010, pp. 3-12). As calorie restriction is known to strongly trigger autophagy, it's

possible that IF may help regulate this process. Studies have suggested that IF could potentially alleviate autophagy dysregulation. For instance, research conducted on mice with Alzheimer's disease has shown that fasting can boost the quantity and size of autophagosomes in neurons (Chen et al, 2015, pp. 12115).

Results

This narrative review provides an overview of the current research on the impact of intermittent fasting on weight loss and inflammation. Specifically, it draws from five systematic review papers that have comprehensively examined this topic.

Table 2

Study	Population	Intervention	Result
(He et al, 2023, p. 269)	The population criteria were: age above 18 years.	The intervention criteria were: implementation of a specific type of IF, and analysis of at least one immunomodulatory marker.	This systematic review analyzed 28 studies and found that intermittent fasting not only promotes weight loss but also enhances circadian rhythms, promotes the migration of immune cells, reduces inflammatory factors, and enriches gut microorganisms.
(Wei et al, 2022, pp. 410-428)	This review included randomized controlled trials (RCTs) conducted on humans with a body mass index of 25 kg/m ² or higher.	Included studies that compared an IER intervention group to either a control group that did not receive any intervention or to a group that followed an ad libitum dietary pattern, CER, other forms of IER interventions that included exercise.	No significant long-term differences were observed in anthropometric, cardiometabolic, inflammatory, or appetite outcomes in the studies included in this review.
(Morales et al, 2021, p. 3179)	The paper included human	To be included, articles needed to	IF has been found to have favorable effects on lipid levels,

	randomized controlled trials.	have data on the effects of intermittent fasting on obesity, type 2 diabetes, and/or multiple sclerosis. They also needed to be reviews published between 2015 and 2020.	weight loss, and alteration of abdominal fat distribution in individuals with obesity and type 2 diabetes. It also improves glycemic control. However, there is limited evidence on the impact of IF on multiple sclerosis patients, but it seems to be a safe and feasible approach.
(Pinto et al, 2022, pp. 613-628)	Adults aged 18 and older.	Alternate-day fasting and time restricted feeding.	Alternate-day fasting and time-restricted feeding can improve insulin sensitivity and other metabolic changes associated with obesity. These protocols also positively impact the remodeling of the intestinal microbiota and may be effective for controlling body adiposity.
(Yuan et al, 2022)	Human randomized controlled trials.	Intermittent fasting protocols.	The study suggests that the IF diet can be an effective therapy for patients with impaired glucose and lipid metabolism. It may improve glucose and lipid metabolism, reduce weight, and improve insulin resistance.

According to a recent systematic review conducted by Yuan and colleagues, intermittent fasting diets have been found to have positive effects on blood glucose and lipids in people with metabolic syndrome. This type of diet has also shown the potential to improve insulin resistance and prevent the development of chronic diseases. Additionally, these diets have been linked to significant weight loss, including an average reduction of 2.51 kg in weight, a decrease of 2.25 cm in waist circumference, and a decrease of 0.82 kg/m² in BMI (Yuan et al, 2022).

According to a systematic review conducted by Pinto et al., there is limited research available on the long-term effects of intermittent fasting (IF). However, preliminary findings suggest that IF may aid in weight loss and improve inflammation levels through changes in the gut microbiome (Pinto et al, 2022, pp. 613-628).

Morales et al. conducted a study that showed intermittent fasting can improve lipid profile, reduce weight and change the distribution of abdominal fat in people with obesity and type 2

diabetes. Additionally, it can improve control of glycemic levels. However, the available data on the effect of intermittent fasting in patients with multiple sclerosis is limited (Morales et al, 2021, p. 3179).

Wei and colleagues conducted a systematic review of 42 articles reporting on 27 randomized controlled trials (RCTs) that evaluated intermittent energy restriction (IER) for weight loss. Their analysis showed that IER led to significant improvements in weight loss in 8 out of 9 studies that measured weight changes. However, when compared to continuous energy restriction (CER), IER did not show any significant long-term differences in outcomes related to body measurements, heart health, inflammation, appetite or other metabolic parameters in the included studies (Wei et al, 2022, pp. 410-428).

The analysis of Hei et al.'s study on intermittent fasting in different populations suggests that this dietary approach may have beneficial effects on the immune system and promote weight loss. These effects were observed in healthy individuals, as well as those with obesity or certain physiological and pathophysiological conditions (He et al, 2023, p. 269).

Discussion

This narrative review explores the effects of intermittent fasting (IF) protocols on weight loss and inflammation. Various studies in the literature have investigated the impact of IF on these two parameters, and the results of systematic reviews analyzed in the review section indicate a positive correlation between IF and weight loss, as well as a reduction in inflammation in the body.

Intermittent fasting (IF) and short-term calorie-restricted diets (CR) have been found to produce comparable weight loss in people with obesity (Li et al, 2017, pp. 618-624, and, Kim et al, 2020, p. 638). However, limited long-term clinical trials have suggested that IF is more effective than CR in reducing waist circumference and central fat distribution. These findings are significant as these parameters are crucial in reducing cardiovascular risk (Park et al, 2020, p. 154336, and, Fitzgerald et al, 2018, pp. 33-39).

Further long-term studies are necessary to determine the effects of IF on obesity and type 2 diabetes. In addition, IF has demonstrated benefits in slowing down the progression of atherosclerosis by reducing the levels of inflammatory markers, such as IL-6, homocysteine, and C-reactive protein (Welton et al, 2020, pp. Pp. 117-125, and, Washburn et al, 2019, p. 246).

However, there may be some adverse effects associated with fasting, including headaches, which can be alleviated by staying hydrated, as well as low mood, slight dizziness, and fatigue (Malinowski et al, 2019, p. 673).

The potential relationship between bacterial richness and leptin levels has been suggested, as IF may increase bacterial richness and decrease leptin levels (Jospe et al, 2020, pp. 503-514). Previous studies have shown that lower bacterial richness is linked to higher levels of leptin and lower levels of adiponectin, indicating a proinflammatory phenotype. IF can have a positive impact on the intestinal microbiota composition by increasing the abundance of Bacteroidaceae, Lactobacillaceae, and Prevotellaceae families (Morales et al, 2021, p. 3179). This enrichment of lactobacilli through intermittent fasting has potential benefits as they are often used as probiotics and can decrease inflammatory immune responses. In the context of EAE, the modulation of inflammation and demyelination can be influenced by changes in the intestinal microbiota or its metabolites. Further studies are needed to investigate the relationship between IF, bacterial richness, and leptin levels, as well as its potential therapeutic effects (Morales et al, 2021, p. 3179, and, Cignarella et al, 2018, pp. 1222-1235). Additionally, some of the studies reviewed suggest that IF may be a promising approach for weight loss in individuals who struggle to adhere to conventional dietary recommendations, and that it may have immune-modulating effects. However, the available evidence on the long-term effects of IF is limited, and more research is needed to fully understand its impact on weight loss and inflammation, as well as other potential health benefits.

Conclusion

Based on an extensive literature review, it can be concluded that intermittent fasting (IF) protocols can have positive impacts on weight loss and inflammation levels in various populations, including those who are healthy, obese, or with specific physiological or pathophysiological conditions. The studies analyzed in this dissertation demonstrate that IF can improve lipid profiles, decrease waist circumference, and reduce central fat distribution. Furthermore, IF shows promise in regulating inflammatory markers like IL-6, homocysteine, and C-reactive protein.

Firstly, the studies reviewed in this review vary in their sample sizes, duration of intervention, and the protocols used for intermittent fasting. This heterogeneity makes it difficult to draw conclusive results or make generalizations. Additionally, some studies lack proper control groups, which could lead to biased results.

Secondly, most of the studies included in this review were short-term, meaning that the long-term effects of intermittent fasting on weight loss and inflammation are not well understood. Further research with longer follow-up periods is needed to understand the true impact of intermittent fasting on these outcomes.

Lastly, while this review focused on the effects of intermittent fasting on weight loss and inflammation, other important health outcomes such as metabolic health, gut microbiome, and cardiovascular health were not fully explored. Future research should consider a broader range of health outcomes when investigating the potential benefits and limitations of intermittent fasting.

In summary, this review provides valuable insights into the effects of intermittent fasting on weight loss and inflammation. However, future research with larger sample sizes, longer follow-up periods, and a broader range of health outcomes is needed to fully understand the potential benefits and limitations of intermittent fasting.

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