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Intermittent Fasting in Weight Management

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Abstract

Obesity is associated with a variety of medical conditions that adversely affect metabolic and cardiovascular health. In order for health care providers to adequately educate and promote weight management, they need to be aware of the various dietary regimens and the efficacy and adverse effects associated with each. The purpose of this study is to analyze research assessing the efficacy and health benefit of intermittent energy restriction and compare to the efficacy and health benefits of continuous energy restriction. This literature review assesses the efficacy, metabolic benefits, and cardiovascular benefits of both intermittent energy restriction and continuous energy restriction from ten articles found on various databases within the past five years. The findings indicate that although not proven superior or inferior, intermittent energy restriction provides statistically similar results to continuous energy restriction when assessing efficacy of weight loss. There are also similar metabolic and cardiovascular benefits when comparing intermittent energy restriction and continuous energy restriction, although continuous energy restriction may have a benefit in the diabetic population due to potential adverse side effects in diabetics adhering to intermittent energy restriction. The result of this literature review allows providers to recommend an alternative weight management technique in patients who are unsuccessful or unable to adhere to a continuous energy restriction diet.

Keywords: intermittent fasting, intermittent energy restriction, continuous energy restriction, efficacy, weight loss, metabolic benefits, cardiovascular benefits

Introduction

Obesity is defined as a weight that is higher than what is considered healthy for a specific height and is measured by using an adult body mass index, or BMI. Body mass index is calculated by taking a person's weight in kilograms divided by the square of their height in meters. A normal BMI falls between 18.5 and <25, with anything below 18.5 being considered underweight and a BMI from 25-30 defined as overweight. A BMI of 30 or above is determined to be obese and is further divided into categories of obesity based on BMI. (Center for Disease Control and Prevention, 2018)

The prevalence of obesity in United States adults was around 39.8% in 2015-2016 (Center for Disease Control and Prevention, 2018). Obesity is a difficult health condition to treat due to a variety of contributing factors. Although genetics have been shown to play a role, individual behaviors provide the most significant influence on weight management. In order to obtain successful weight loss, patients need to make both physical and mental changes in order to adhere to a healthy diet and participate in regular physical activity.

Medical conditions associated with obesity are some of the leading causes of preventable early death (Center for Disease Control and Prevention, 2018). Associated conditions include but are not limited to heart disease, stroke, diabetes, cancer, mental illness, and increased mortality (Center for Disease Control and Prevention, 2018). Obesity related medical costs were calculated to be $147 billion in 2008 (Center for Disease Control and Prevention, 2018). Weight loss using any technique decreases cardiovascular and diabetic risk factors including plasma glucose, insulin, triglycerides, and leptin (National Institutes of Health, 2016). These parameters continue to improve with further weight loss, along with improved insulin sensitivity (National Institutes of Health, 2016). In order to help prevent obesity and the associated health conditions

along with improving health parameters, providers need to be aware of effective and safe weight management techniques that would be most beneficial for their individual patients.

The most common and most researched dietary method has continued to be daily caloric restriction. Daily calorie restriction, or continuous energy restriction (CER), consists of limiting calories consumed throughout the day. This can be done through counting calories, portion control, and/or increasing calories burned throughout the day. Although effective if done consistently, CER remains difficult for some patients to adhere to and therefore patients continually seek new methods for weight loss. Clinicians are often referring patients to specialists for weight management due to the varying treatment options with unknown efficacy and lack of patient adherence or results.

Intermittent fasting, or intermittent energy restriction (IER) consists of intermittent periods of energy consumption, or intake of calories, alternating with intermittent periods of complete energy restriction, or lack of calorie intake. There are varying timelines that may be followed for adhering to this diet regimen although most consist of energy consumption for a shorter period during the day with complete energy restriction the rest of the day. There are also intermittent energy restriction diets that consist of alternating days of complete energy restriction and no energy restriction. Similar to a continuous energy restriction diet, total daily calories are limited although in an intermittent energy restriction diet these calories can all be consumed in a single meal or shorter time period.

The purpose of this review is to determine the efficacy and safety of intermittent energy restriction when used in weight management and compare intermittent energy restriction to continuous energy restriction.

Statement of the Problem

There continues to be a variety of new weight loss mechanisms that are utilized despite lacking research on the efficacy and safety. Many of these dietary regimens also provide unrealistic goals for long term adherence. Studies are needed to analyze the efficacy and safety of newer weight management methods that can treat or prevent obesity and improve health parameters.

Research Questions

In overweight or obese adults, is intermittent fasting versus control more effective in decreasing body mass index and promoting health?

In overweight or obese adults, does adherence to an intermittent energy restriction diet compared to a continuous energy restriction diet provide greater efficacy regarding weight loss and health benefit?

Research Methods

For the purpose of this review, multiple databases were searched, including PubMed, CINAHL, and Cochrane to provide a broad overview of the intended topic. In each database, the search was limited to studies that were published in the past five years and those that involved human subjects. The following words and MeSH terms were included in the search for each database: intermittent fasting, intermittent energy restriction, continuous energy restriction, daily calorie restriction, efficacy, weight loss, metabolic effects, and cardiovascular effects. Clinical trials and systematic reviews were selected from peer reviewed journals that were deemed applicable to the focus of this research paper. Also included were articles and systematic reviews on intermittent fasting efficacy or health benefits that included cardiovascular or metabolic

health. Articles and systematic reviews were also included that compared and analyzed continuous energy restriction to intermittent energy restriction. Opinion or perspective articles or articles from non-peer reviewed journals were not included in this review. Clinical trials focusing on a population not pertinent to primary care weight management or analyzing effects not relating to efficacy, metabolism, or cardiovascular health were also not included for the purpose of this study.

Literature Review

A review of the literature showed that intermittent energy restriction provides similar weight loss when compared to continuous energy restriction although there is no significant evidence that shows that one weight loss mechanism is superior or inferior to another. The benefits on health parameters are likely linked to decreased adipose tissue rather than associated with a specific weight loss mechanism.

Theme One: Intermittent Fasting in Weight Management and Health

A clinical trial conducted by Antoni., Johnston, Collins, and Robertson (2016) consisted of ten healthy adults that were either overweight or obese who participated in a day of isoenergetic, partial (75%) energy restriction, and then total (100%) energy restriction, each with a week break in between. The results, when compared to the isogenic control, showed a 142% increase in postprandial glucose following total energy restriction ($p = 0.015$) and a 76% increase in postprandial glucose following partial energy restriction ($p = 0.051$). Both total and partial energy restriction resulted in a 30% decrease in energy intake over three days and similar decreases in postprandial triacylglycerol (TAG). Energy restriction resulted in decreased

carbohydrate oxidation ($p = 0.023$) and increase lipid oxidation ($p = 0.08$), total energy restriction more than partial, in comparison to the isogenic control. (Antoni et al., 2016)

This clinic trial provided comparison of partial or total energy restriction that are often utilized in intermittent fasting diets. The study analyzed the acute effects of energy restriction on metabolism following energy intake. There were only ten subjects in the clinical trial, which limits applicability to larger population sizes, although the subjects served as their own controls which limited individual variation. The study consisted of only healthy adults so data regarding those with comorbid conditions is not available. Long term effects of partial and total energy restriction were not analyzed and thus are unknown at this time.

A systematic review performed by Horne, Muhlestein, and Anderson (2015) analyzed three randomized controlled trials in order to provide evidence of potential health benefits of intermittent fasting dietary regimens. All three clinical trials consisted of intermittent energy restriction in comparison to a control group. One clinical trial consisted of 32 nonobese adults and reported a 6.5% weight loss over the 12-week study. There was also reported improvement in cardiovascular risk factors such as blood pressure, cholesterol, and weight. Overall mood also showed improvement following intermittent energy restriction. Another trial noted that individuals adhering to intermittent energy restriction had a lower risk of developing diabetes ($p = 0.044$), with two studies noting an overall decrease in coronary artery disease ($p = 0.007$; $p = 0.019$). One trial did note an increase in low density lipoproteins and high-density lipoproteins following fasting upon evaluation of one day of fasting, with another study noting lower low-density lipoprotein cholesterol following six weeks of fasting. Another trial provided evidence that intermittent energy restriction significantly increases HGH, increasing lipolysis and fat metabolism. (Horne et al., 2015)

This systematic review provided evidence towards a variety of potential health benefits for the implication of an intermittent energy restriction diet for weight management. This review showed significant evidence for metabolic and cardiovascular benefits with the adherence to intermittent energy restriction, although further randomized controlled trials are needed. Much of the data on intermittent energy restriction has been done by observational studies, which is limited by lack of comprehensive history and evaluation. This review also noted that upon evaluation of effects of intermittent energy restriction, data regarding the safety and potential adverse effects of intermittent energy restriction were lacking. Data was also lacking on which intermittent energy restriction regimen is most effective and provides the greatest health benefits. Another limitation was the smaller sample sizes of the studies, with many studies not providing evaluation of subjects with pre-existing risk factors or diagnoses.

A randomized controlled explorative study conducted by Li et al. (2017) analyzed 32 individuals with type II diabetes mellitus that are currently on oral hypoglycemic therapy in addition to insulin therapy. Participants were assigned to either an intermittent energy restriction group or a control group and participated in a seven-day program. They were then assessed at baseline and then four months following. The results of the study concluded that intermittent energy restriction resulted in a 3.5 kg weight loss compared to a 2.0 kg weight loss in the control group ($p = 0.03$). Fasting also showed a significant decline in systolic and diastolic blood pressure ($p = 0.01$; $p = 0.003$). A slight improvement in hemoglobin A1C was noted in fasting although this result was not statistically significant. No side effects were noted in participants adhering to either dietary regimen. (Li et al., 2017)

The study was controlled and provided evidence of the efficacy along with metabolic and cardiovascular effects of intermittent energy restriction in weight management in the diabetic

population. Various effects of intermittent energy restriction were assessed to include common associated health concerns in diabetics, such as associated hemoglobin A1C, weight, and blood pressure, in order to provide a more thorough investigation into the effects of intermittent fasting in subjects with comorbid conditions. The study was limited by the smaller sample size and high dropout rate, as only 32 of the 46 participants enrolled in the study adhered to their diet and completed the study. The full text of the study was not available and thus reasons for lack of adherence were unknown along with further statistical findings of the study.

Theme Two: Comparison of Intermittent Energy Restriction and Continuous Energy Restriction

A systematic review conducted by Harris et al. (2018) analyzed six clinical trials to determine the effectiveness of intermittent energy restriction in the treatment of obesity in adults. Included studies consisted of subjects over the age of 18 with a body mass index of greater than or equal to 25. The studies included had a duration of at least 12 weeks and were either randomized or pseudo-randomized controlled trials. Participants participated in either intermittent energy restriction, continuous energy restriction, or a control group, with various intermittent energy restriction diets being utilized in different trials. The results of the analysis showed that weight loss between intermittent energy restriction and continuous energy restriction subjects were not significantly different ($p = 0.156$), with approximately seven kilograms of weight loss noted. In addition, intermittent energy restriction showed statistically significant weight loss in comparison to control groups ($p = 0.001$). (Harris et al., 2018)

This review provided an analysis of various intermittent energy restriction diets, ranging from fasting (<800 kcal/day) two days a week to every other day. Due to this variation, it is unclear how many days of the week intermittent energy restriction needs to be adhered to in

order to provide a certain amount of benefit in regard to weight loss. Of the six studies analyzed, only four compared intermittent energy restriction directly to continuous energy restriction, limiting the amount of research available to determine whether intermittent energy restriction has any inferiority or superiority over continuous energy restriction. The authors were reputable although the full text of this systematic review was unavailable, limiting analysis on content and methods.

A systematic review performed by Headland, Clifton, Carter, and Keogh (2016) analyzed nine clinical trials involving intermittent energy restriction, six of which directly compared intermittent energy restriction to continuous energy restriction. The review was performed to assess the long-term effects of intermittent energy restriction, with all studies lasting a minimum of six months. A total of 981 healthy obese participants were randomized into intermittent energy restriction, continuous energy restriction, or control groups. The results of the study showed weight loss in all intermittent energy restriction groups regardless of length of study, with no significant difference noted upon comparison to continuous energy restriction weight loss ($p = 0.458$). (Headland et al., 2016)

The review of clinical trials assessed a large sample size of 981 subjects, allowing for increased specificity of results and more accurate generalization of the healthy public. This review also selected only studies with analysis of long-term effects and maintenance, allowing for further assessment of long-term effects and adherence to intermittent energy restriction. As only healthy subjects were used, there is no research provided in efficacy of intermittent energy restriction in those with comorbid health conditions. In addition, there were differences in intermittent energy restriction regimen or study design between those trials analyzed, which does not allow for analysis of efficacy of different forms of intermittent energy restriction.

Another systematic review of clinical trials was performed by Seimon et al. (2015) to assess the efficacy of intermittent energy restriction and compare the physiological benefits of intermittent energy restriction to the proven benefits of continuous energy restriction. This review assessed 40 scientific studies of subjects who underwent intermittent energy restriction, 12 of which directly compared intermittent energy restriction to continuous energy restriction. Subjects consisted of any age and body mass index and at least one body mass parameter had to be assessed both prior to and upon completion of energy restriction. The results of the study provided clear evidence that intermittent fasting is an effective weight loss mechanism, with the most common weight loss of three to five kilograms after ten weeks of participation. In the studies comparing intermittent fasting to daily caloric restriction, the results showed no significant difference in efficacy regarding weight loss. In addition, the dropout rate between the two groups were similar. (Seimon et al., 2015)

The systematic review provided significant evidence analyzing numerous clinical trials to determine the efficacy of intermittent energy restriction in weight management. Numerous clinical trials were addressed that evaluate intermittent energy restriction although only 12 of the studies were directly compared to continuous energy restriction, limiting the evidence for comparison between the two weight loss techniques. Furthermore, the diets were classified into either intermittent energy restriction or continuous energy restriction but consisted of various levels of dietary intake along with different timing for periods of fasting, making it hard to assess which intermittent/continuous energy restriction method is providing the greatest benefit. The clinical trials also lacked long-term follow up, making it difficult to assess the long-term impact of the two dieting techniques. Further research studies with controlled parameters are needed to

determine the numerous effects of intermittent energy restriction compared to continuous energy restriction and their role in weight management.

Another clinical trial performed by Carter, Clifton, and Keogh (2016) consisted of 63 overweight or obese subjects that had been diagnosed with type II diabetes mellitus and were randomized into either intermittent energy restriction or continuous energy restriction groups. The study aimed to analyze the effect of intermittent energy restriction in comparison to continuous energy restriction in relation to body mass index and glycemic control. After 12 weeks of assessment, the results of the study provided evidence of similar body weight reduction between the intermittent energy restriction and continuous energy restriction groups ($p < 0.001$). There was also a similar comparison in hemoglobin A1C, indicating similar glycemic control between the intermittent energy restriction and continuous energy restriction groups ($p < 0.001$). Throughout the study, no side effects were noted although diabetic medications needed adjustment. (Carter et al., 2016)

The study provided an adequate sample size and was able to account for both gender and body mass index upon evaluation of results. There was a high dropout rate as only 50% of the 63 participants were able to finish the 12 weeks with adherence to their energy restriction regimen. The authors noted a challenge in medication management of the diabetic participants as many required alterations in medication to prevent hyperglycemia or hypoglycemia. Applying this data to clinical practice would be difficult as you would need increased monitoring of blood glucose levels and adjustments in medication during intermittent energy restriction in order to maintain glycemic control during that time.

Theme Three: Impact of IER and CER on Health

A randomized controlled clinical trial done by Coutinho et al. (2018) consisted of 35 obese adults that were assigned to either intermittent energy restriction or continuous energy restriction diet with the same daily caloric intake and assessed over the period of 12 weeks. The study aimed to determine the effects of intermittent energy restriction on body composition and compensatory mechanisms in comparison to the effects of continuous energy restriction. The results of the clinical trial approximated a 12.5% loss in body weight in both the continuous energy restriction and intermittent energy restriction groups. In both intermittent energy restriction and continuous energy restriction, postprandial cholecystokinin decreased, and exercise efficiency increased at 10 weeks. In the intermittent energy restriction group, basal and postprandial active ghrelin increased ($p < 0.05$) with a decrease in resting metabolic rate and increase in exercise efficiency noted in long term assessment of 25 and 50 weeks ($p < 0.001$). In the continuous energy restriction group only, basal active GLP-1 decreased ($p = 0.033$). In conclusion, the trial determined that there was no significant difference in compensatory mechanisms that are activated through continuous or intermittent energy restriction. (Coutinho et al., 2018)

This trial provided an adequate analysis of compensatory mechanisms activated by continuous energy restriction in comparison to intermittent energy restriction due to weight loss. These mechanisms consist of reduced resting metabolic rate, increased exercise efficiency, and increased appetite. The clinical trial had a decent sample size but showed variation in results, which did not match the conclusion of no difference in compensatory mechanisms. The full text was not available and thus further evaluation of methods and results could not be completed. The study also only consisted of young adults, not considering any comorbid conditions, with a wide range of body mass indices reported prior to the study. This variation in body mass index was not

accounted for and could have caused variation in compensatory mechanisms or overall results of the study.

A clinical trial conducted by Sundfør, Svendsen, and Tonstad (2018) was performed to assess the impact of intermittent fasting compared to continuous energy restriction in regard to weight loss, adherence, and cardiometabolic risk. The study consisted of 112 adults aged 21-70 with a body mass index of 30-45 who displayed abdominal obesity along with one addition metabolic syndrome component and were randomized into either the intermittent energy restriction or continuous energy restriction group. The results of the study showed a similar impact on weight loss ($p = 0.6$) and waist circumference between the two groups, proving that intermittent energy restriction is as effective but not superior to continuous energy restriction in weight management. In addition, both groups showed similar improvement in blood pressure, triglycerides, and high-density lipoprotein cholesterol. In a six-month maintenance phase, weight regain was similar between the two groups ($p = 0.6$). When assessing hunger scores between the groups, intermittent energy restriction participants scored higher and showed increased hunger scores ($p = 0.002$) which could potentially play a role in long-term adherence. (Sundfør et al., 2018)

This clinical trial provided information regarding long-term adherence, which many other studies assessing intermittent energy restriction have not done. In addition, the dropout rate for participants was five to seven percent, which the authors described as one of the greatest strengths of the study design. The study also provided assessment of the weight management techniques in individuals who are at a higher risk of adverse health outcomes due to having multiple metabolic syndrome components. The authors discussed limitations of the study to include the scheduled visits not always being on the same day as fasting, which may have an

impact on glucose and triglycerides. The study also did not encompass those that did not meet the obesity and metabolic syndrome requirements, providing evidence for only a smaller population of individuals with specific health status.

A clinical trial by Aksungar, Sarikaya, Coskun, Serteser, and Unsal (2016) was performed to assess intermittent energy restriction in comparison to the known health benefits of continuous energy restriction. The clinical trial consisted of 23 obese non-diabetic females between the ages of 28 and 42 years who had a body mass index of 29-39. The same subjects participated in both a continuous energy restriction and intermittent energy restriction diet, with intermittent energy restriction being analyzed without daily calorie restriction. The results of the study showed that continuous energy restriction provided increased weight loss and a beneficial effect on insulin resistance, although both diets had a decrease in body mass index. The intermittent energy restriction diet was shown to have a positive effect on health and resistance to disease, with higher urinary acetoacetate levels confirming a more constant lipid catabolism than that during continuous energy restriction. The study concluded that both continuous energy restriction and intermittent energy restriction provide significant health benefits, although continuous energy restriction may be more beneficial for those who are pre-diabetic or show insulin resistance. (Aksungar et al., 2016)

The clinical trial provided evidence that intermittent energy restriction may have health benefits despite daily calorie restriction. The intermittent energy restriction diets were restricted to a month during the 24-month trial, which limits results the provide further information on the effects of intermittent energy restriction. There was also no control group for comparison, although by comparing the same subjects using both dietary methods, individual variation was avoided. Another limitation of the study was the small sample size, with seven participants not

adhering to the diet and thus were dismissed from the study. The study was proficient in analyzing multiple effects of both dietary methods while limiting individual variation by using the subjects as their own controls.

Discussion

Maintaining a healthy body mass index promotes metabolic and cardiovascular health by decreasing risk factors (National Institutes of Health, 2016). Continuous energy restriction remains the most widely used weight management technique although intermittent energy restriction has become increasingly popular as people struggle to get results or adhere to a continuous energy restriction diet. As health benefits are positively correlated with weight loss, it is important to analyze which weight management technique provides the most significant weight loss and health benefit. A review of the data provided significant evidence that intermittent energy restriction has similar efficacy when compared to continuous energy restriction in regard to weight loss and health benefits, although neither technique was proven superior or inferior to the other. Improved health parameters are likely strongly correlated to a decrease in adipose tissue rather than a specific weight management technique.

In overweight or obese adults, is intermittent fasting versus control more effective in decreasing body mass index and promoting health?

The clinical trials and systematic reviews analyzed provided substantial evidence that intermittent energy restriction is superior to a placebo in regard to efficacy in weight loss. A study by Harris et al. (2018) showed statistically significant increased weight loss when adhering to an intermittent energy restriction diet as compared to a control ($p = 0.001$). Another study by Li et al. (2017) also supported this finding by showing increased weight loss in those adhering to

an intermittent energy restriction diet rather than an isogenic control ($p = 0.03$). This study also showed a decline in both systolic and diastolic blood pressures ($p = 0.01$; $p = 0.003$) and no side effects in participants adhering to either dietary regimen. A systematic review performed by Horne et al. (2015) analyzed multiple trials comparing intermittent energy restriction to control groups and the results showed an overall decrease in diabetes ($p = 0.044$) and a decrease in various cardiovascular risk factors such as low-density lipoproteins, blood pressure, cholesterol, and coronary artery disease ($p = 0.007$; $p = 0.019$). This systematic review also showed an increase in fat metabolism and lipolysis with intermittent energy restriction although there were mixed results regarding lipoprotein levels following fasting periods. A study performed by Antoni et al. (2016) supported these health benefits by suggesting that intermittent energy restriction resulted in a decreased energy intake and increased lipid oxidation ($p = 0.08$), although these results were not statistically significant. This study also showed a decrease in energy intake following fasting with similar decreases in TAG, although postprandial glucose following energy restriction was increased.

There was limited data regarding side effects in patients adhering to an intermittent energy restriction diet although there were no trials noting adverse effects. Potential side effects could have occurred in the diabetic population, although due to diabetics being closely monitored throughout each trial, medication adjustments were able to be made in order to prevent adverse effects related to blood glucose, including hypoglycemia and diabetic ketoacidosis. Although all the studies analyzing intermittent energy restriction showed increased weight loss and health benefits when compared to a control, they all had relatively small samples sizes and therefore may not be adequately applied to the general population. In addition, more research is needed to

determine whether intermittent energy restriction is a safe and effective weight loss mechanism in those with various types of additional medical conditions or comorbidities.

In overweight or obese adults, does adherence to an intermittent energy restriction diet compared to a continuous energy restriction diet provide greater efficacy regarding weight loss and health benefit?

A clinical trial by Harris et al. (2018) showed no significant difference between weight loss when adhering to a continuous energy restriction diet compared to an intermittent energy restriction diet ($p = 0.156$). Headland et al. (2016) supported this by finding no significant difference in weight loss between continuous and intermittent energy restriction regardless of length of study ($p = 0.458$). There was also no significant difference in weight loss between continuous and intermittent energy restriction ($p = 0.6$) in a trial completed by Sundfor et al. (2018). Similar weight reduction between intermittent and continuous energy restriction participants ($p < 0.001$) was found in a 12-week study by Carter et al. (2016). Similar weight loss was also supported by clinical trials by Coutinho et al. (2018), Seimon et al. (2015), and Aksungar et al. (2016), although no statistical data was available.

In a study by Coutinho et al. (2018), metabolic factors were analyzed in both dietary regimens. The results showed an increase in postprandial active ghrelin ($p < 0.05$) and a decrease in resting metabolic rate and increase in long term exercise efficiency in the intermittent energy restriction group ($p < 0.001$). In addition, continuous energy restriction showed a decrease in basal active GLP-1 ($p = 0.033$) while both continuous and intermittent energy restriction showed a decrease in postprandial cholecystokinin and increase in short term exercise efficiency, although no statistical data was provided. In addition, a more constant lipid catabolism was shown in intermittent energy restriction groups in a study done by Aksungar et al. (2016). In

regard to cardiovascular health, a study performed by Sundfor et al. (2018) showed a similar improvement in blood pressure, triglycerides, and HDL cholesterol between intermittent and continuous energy restriction.

Analysis of efficacy in side effects in the diabetic population suggested a potential benefit to using a continuous energy restriction diet rather than an intermittent energy restriction diet, although this benefit is mostly due to convenience and safety as both diets showed efficacy in weight loss and health promotion. Carter et al. (2016) showed similar glycemic control between the two dietary regimens ($p < 0.001$), although diabetic medication adjustments were needed throughout the study. A study by Aksungar et al. (2016) also suggested that continuous energy restriction may be more beneficial for those who are diabetic or have insulin resistance, although no statistical data was available.

In regard to safety and adherence, a study by Carter et al. (2016) showed no side effects from either dietary regimen. A trial by Seimon et al. (2015) showed similar dropout rates between intermittent and continuous energy restriction diets. Hunger ratings were analyzed by Sundfor et al. (2018), which were shown to be increased in intermittent energy restriction in comparison to continuous energy restriction ($p = 0.002$), posing a possible factor that could influence adherence. This study also showed similar regain of weight between the two diets ($p = 0.6$), suggesting neither intermittent or continuous energy restriction are superior for long term weight management.

The results of the various clinical trials and systemic reviews provide significant evidence that intermittent energy restriction has similar efficacy to continuous energy restriction in regard to weight loss. No evidence was found that states intermittent energy restriction is superior or inferior to continuous energy restriction. Upon analysis of health benefits, there were similar

effects on metabolic and cardiovascular health. The impact on health being similar in both intermittent energy restriction and continuous energy restriction suggests that health benefit is correlated to weight loss and decreased adipose tissue as compared to being correlated to a certain type of dieting technique.

Clinical Application

There is significant evidence that intermittent energy restriction has similar efficacy to continuous energy restriction in regard to weight loss, thus providing an alternative weight management technique for patients who have struggled to lose weight or adhere to daily calorie restriction. The research also shows similar health benefits and limited adverse effects in those adhering to an intermittent fasting diet, providing evidence that intermittent energy restriction is a safe and beneficial alternative. The information provided in the literature review will allow clinicians to recommend an alternative weight management technique for overweight or obese patients based on clinical evidence from various research studies. Intermittent energy restriction provides a beneficial alternative for weight management in those with limited health concerns and those with cardiovascular or other risk factors or diseases.

Although beneficial for most patients, there is limited evidence about the efficacy and safety of intermittent energy restriction in diabetic patients. There remains concern about adverse effects and hypoglycemia in patients on insulin therapy and thus should be referred to a weight management specialist and diabetes educator for weight management in this patient population until further research is provided.

Further research continues to be required to completely analyze the various effects of intermittent fasting and understand the physiology behind intermittent energy restriction and the

comparison to daily calorie restriction. Additional research should be focused on the health benefits and adverse effects in individuals with comorbid conditions as many patients who are overweight or obese are at higher risk of varying health conditions and diseases. Research involving greater sample sizes is also needed in order to get a more accurate generalization of the patient population.

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