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The Effect of High-Protein and Low-Calorie Diets on Sleep Quality in Individuals with Obesity

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ABSTRACT

Obesity, defined as excess body fat, has become a global epidemic, especially in low- and middle-income countries. Sleep problems are among the complications faced by obese individuals, although such problems are not very common. Previous studies indicate that obese individuals have a significantly greater likelihood of developing insomnia and other sleep disorders. Meanwhile, there is growing scientific evidence that diet and sleep may be related, and that weight loss can improve sleep quality and sleep-related indices. In order to improve sleep quality and alleviate sleep disorders, this study examined the effects of weight loss diets on sleep quality in obese individuals. The literature indicates that sleep quality and sleep-related indices are improved by weight loss. Compared with a low-fat diet, a very low-carbohydrate diet (VLCD) does not adversely affect cardiovascular risk factors for short-term weight loss. When weight loss is combined with VLCD, obstructive sleep apnea (OSA) can be improved.

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Introduction

Obesity represents a global health crisis given its rapidly increasing prevalence, especially in low- and middle-income countries. The World Obesity Federation (WOF) predicts that by 2030, nearly one billion people will be living with obesity worldwide. Obesity is an epidemic disease that is defined as excess body fat. According to the definition proposed by WHO, BMIs greater than or equal to 25 and 30 kg/m^2 indicate overweight and obesity, respectively (1).

One of the complications faced by obese individuals is sleep problems, which has received limited attention. Sleep is a basic human needs and is necessary to maintain the energy of appearance, coordination of body rhythm, and physical health (2, 3). Studies have shown that sleep deprivation leads to a decrease in daily performance, impairment of metabolic function, disruption of the immune system and cortisol and insulin levels, and increased mortality. Obese people are more likely to report insomnia or trouble sleeping (4). Also, obesity contributes to the development and severity of obstructive sleep apnea (OSA) through effects on the upper airway (e.g., neuromuscular control of breathing and adipokine production) (5). Insomnia and its underlying pathophysiology may also play a role in predisposing a person to excessive energy consumption. Therefore, nutrition can simultaneously contribute to weight loss and improve sleep in patients with obesity and sleep disorders (5, 6).

Obesity is caused by long-term energy imbalance. Therefore, researchers have sought to identify factors related to positive energy balance (7). Rastrollo et al. showed that increasing the energy density (ED) of the diet over a period of 8 years was significantly associated with weight gain (7). In another study, women who consumed a high-ED diet gained nearly three times as much weight as women whose diets had lower ED. A diet with

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lower ED allows people to eat more food while lowering their energy intake (8). Comparison of the effects of dietary energy density on body mass index (BMI) has confirmed the positive relationship between dietary energy density and BMI in all gender and racial groups (9).

Very low calorie diets (VLCDs) were introduced to help obese people lose weight quickly without losing too much Muscle tissue (10). Further studies have shown that the inclusion of even small amounts of protein in severely calorie-restricted diets results in a significant reduction in the utilization of body nitrogen and protein stores (11). Therefore, due to concerns that low-quality protein intake or inadequate micronutrient supplementation may contribute to early mortality, VLCDs containing high-quality protein along with vitamins, minerals, trace elements, and essential fatty acids were introduced to treat obesity. Widespread use of formulated VLCDs has been repeatedly shown to be safe and highly effective when used for a limited period of time under close medical supervision (11, 12).

Materials & Methods

In this review study, all studies related to keywords study regarding to the effect of high-protein and low-calorie diets on sleep quality in individuals with obesity, were collected from electronic databases. We searched PUBMED-Medline, Scopus, Web of Science Core Collection, and Google Scholar databases to identify the studies based on the Medical Subject Headings (MeSH) with full texts in English. All studies in regarding to the keywords "High-protein", "Low-calorie diet", "Obesity" and "Sleep quality" carefully reviewed and their results were critically discussed according to their impact on dimension of sleep quality.

Results & Discussion

Obesity and Its Complications

There has been a significant increase in obesity rates in the world in the past 50 years. Obesity and overweight are defined as a person having a BMI greater than or equal to 30 and between 25.0 and 29.9, respectively. Overweight and obesity are more strongly associated with increased mortality than underweight and are more common on the global scale, having been reported from all regions of the world (13, 14).

Obesity increases the risk of various diseases and conditions, including type 2 diabetes (T2DM), cardiovascular diseases (CVD), metabolic syndrome (MetS), chronic kidney disease (CKD), hyperlipidemia, hypertension, non-alcoholic fatty liver disease (NAFLD), certain types of cancer, OSA, osteoarthritis, and depression, as well as increased mortality (15). Treating these conditions can place an additional burden on healthcare systems. For example, it is estimated that obese individuals have 30% higher medical costs than individuals with a normal BMI (16).

Increasing Energy Density (ED)

Obesity occurs as a result of long-term energy imbalance. Therefore, researchers have sought to identify factors related to positive energy balance. One of these effective factors is energy density. The energy density of food refers to the amount of energy obtained from each gram of food; foods with high energy density provide more energy in fewer grams. According to WHO, increased consumption of foods with high energy density in the isocaloric state has contributed to the obesity epidemic (7).

Consuming a diet with a lower ED allows individuals to consume more food (in terms of weight) while reducing their energy intake (8). Comparison of the effect of diet ED on BMI among racial and gender groups has confirmed the general positive relationship between diet ED and BMI (9).

Sleep and Obesity

Obese individuals' sleep problems often go unnoticed and untreated. Sleep is a basic human needs and is necessary to maintain the energy of appearance, coordination of body rhythm, and physical health (2). Studies have shown that sleep deprivation leads to a decrease in daily performance, impairment of metabolic function, disruption of the immune system and cortisol and insulin levels, and increased mortality (4).

Sleep disorders are common issues, with 30% of the population suffering from them sometime in their lives and 10% of the population being permanently affected. Sleep disorders are divided into three general categories: 1- problems with falling sleep such as having disturbed and confused thoughts, 2- problems with the continuation phase of sleep such as sleepwalking, nocturnal enuresis, and 3- problems with waking up from sleep such as waking up earlier than the scheduled time (17).Poor sleep causes adverse consequences

such as increased overall mortality, increased obesity, type 2 diabetes, blood pressure disorders, and respiratory disorders in adults and children (18).

In general, most physical diseases that cause considerable pain or discomfort or are caused by metabolic disorders can negatively affect the quality and quantity of sleep, including obesity. Various studies have reported a relationship between sleep disturbance and obesity. For example, Gangwisch et al. showed that people who sleep less than 7 hours are more likely to be obese and overweight (19).

Result Category	Measurement/Outcome	Details	Description of Findings
Impact on Obstructive Sleep Apnea (OSA)	Apnea-Hypopnea Index (AHI)	Reduction in AHI scores, a primary measure of OSA severity, tracking frequency and severity of apnea events.	Significant decrease in AHI scores, reflecting fewer breathing interruptions and better oxygenation during sleep. Participants experienced fewer apneic events, improving sleep quality.
Sleep Quality Indices	Sleep Efficiency	Measures the percentage of time spent asleep while in bed, a key indicator of sleep quality.	Improvement in sleep efficiency noted, indicating participants spent more time asleep relative to total time in bed, reducing periods of wakefulness and enhancing restorative sleep.
	Sleep Latency	Duration of time required to fall asleep after going to bed.	Decreased sleep latency, showing faster sleep onset, likely due to increased satiety and stable blood glucose from high-protein intake, supporting more regular sleep patterns.
Blood Pressure & Baroreflex Sensitivity	Blood Pressure	Measurement of arterial pressure levels, often elevated in OSA and obesity, which are risk factors for cardiovascular diseases.	Lower blood pressure levels observed, reducing cardiovascular risks commonly associated with OSA and obesity, and indicating improved autonomic function.
	Baroreflex Sensitivity	Indicator of autonomic nervous system response, assessing body's regulation of blood pressure.	Enhanced baroreflex sensitivity, suggesting improved cardiovascular health, as baroreflex aids in stabilizing blood pressure during sleep and wakefulness.
Metabolic and Hormonal Adjustments	Leptin Levels	Leptin is a hormone regulating satiety and fat storage; higher levels support appetite control.	Increased leptin levels, which help control appetite and reduce late-night eating, minimizing sleep disruptions and enhancing overall sleep quality.
	Ghrelin Levels	Ghrelin, a hormone associated with hunger, typically rises during sleep deprivation and may contribute to night eating.	Reduced ghrelin levels observed, helping to limit nocturnal hunger and cravings, which may lead to a more undisturbed sleep cycle and improved sleep patterns.
Chronic Insomnia Intervention	Insomnia Severity, Sleep Duration	Severity of insomnia symptoms and total sleep duration measured; short sleep duration is often linked with weight gain and poor sleep quality.	Participants with chronic insomnia showed decreased insomnia severity and increased sleep duration, suggesting dietary intervention as a non-invasive treatment for insomnia in obesity.
	Sleep Onset	The time it takes to fall asleep, which is often delayed in individuals with high BMI or metabolic dysfunctions.	Faster sleep onset observed in high-protein diet group, likely due to the thermogenic effect of protein and reduced metabolic disruptions, supporting improved overall sleep health.

Sleep Disorders and Obesity

The International Classification of Sleep Disorders currently lists more than 80 distinct sleep disorders divided into eight categories, including insomnia, sleep-disordered breathing, and sleep-related movement disorders. The relationship between sleep disturbance and obesity is likely an important mediating factor in emerging research linking sleep disturbance and other chronic diseases, including cardiovascular disease (CVD) and diabetes mellitus (20).

Insomnia and Obesity

Previous studies have shown that obese individuals are significantly more likely to report insomnia or difficulty sleeping (21). In addition, obese subjects were significantly more likely to develop chronic insomnia over a median follow-up of 7.5 years. Although this effect was partially negated when controlling for sociodemographic and behavioral factors (22). Finally, in obese individuals, complaints of chronic emotional stress or sleep disturbance have been reported to predict short sleep duration, rather than voluntary sleep reduction as previously thought. On the other hand, Vgontzas et al. showed that in obese people without sleep disorders or emotional stress, sleep duration was similar to the non-obese controls. This may indicate the importance of diagnosing and treating sleep disorders as a potential therapeutic intervention for obesity (23).

Insomnia and its underlying pathophysiology may play a role in predisposing a person to excessive energy consumption and thus lead to weight gain. In a study of over 1000 volunteers from the Wisconsin Sleep Cohort Study, Taheri et al. found that shorter sleep duration (5 hours per night vs. 8 hours per night) was associated with 15.5% lower leptin levels and 14.9% higher ghrelin levels. Reduced sleep duration was independently associated with BMI, which may indicate that chronically short sleep duration can increase appetite and lead to overeating (6).

In addition, Dalman et al. have suggested that chronic elevation of glucocorticoids, such as cortisol, similar to the proposed mechanism for insomnia, may contribute to an individual's increased desire to consume high-fat and high-sugar foods as well as their tendency to store fat. They proposed that chronic elevation of glucocorticoid hormones increases CRF activity in the central nucleus of the amygdala and increases abdominal obesity, which then acts as a means to increase metabolic inhibitory feedback on catecholamines in the brain and CRF. This suggests that the same pathway associated with hyperactivity in insomnia may promote the overconsumption of high-fat and high-sugar foods as well as the deposition of abdominal fat stores in an attempt to counter the hyperactivity occurring in the brain (24).

Obstructive Sleep Apnea (OSA) and Obesity

Knowledge of the fundamental association between OSA and obesity is evolving and involves a bidirectional relationship that affects both the contribution of obesity to OSA and the consequences of OSA for obesity. Obesity contributes to the development and severity of OSA by influencing the upper airway, including respiratory neuromuscular control and adipokine production. Independently, obesity appears to affect upper airway control through several mechanisms, including changes in upper airway structure and function, reduced resting volume, and negative effects on respiratory drive and load compensation (5).

In addition, neuromuscular control of the upper airway is affected by changes in several key cytokines associated with obesity, including leptin, tumor necrosis factor-alpha, and interleukin-6. Independently, leptin can inhibit respiratory drive. Meanwhile, OSA is associated with elevated leptin levels (25). Insulin resistance is also associated with OSA severity independent of body weight and may be related to sleep deprivation or sympathetic activation (26).

Mechanisms Leading to Obesity

The traditional view regarding the cause of obesity is that obesity is mainly caused by the storage of excess energy, exceeding the energy used by the body. Excess energy is stored in fat cells and as a result the pathology of obesity is determined. Pathological enlargement of adipocytes alters the nutritional signals responsible for obesity (27). However, recent research has shown that food sources and quality of nutrients are more important than their amount in the diet for weight control as well as for disease prevention. In addition, genetic factors play an important role in determining a person's tendency to gain weight.(28).

Pathogenesis of Obesity

The pathogenesis of obesity involves the regulation of caloric intake, appetite, and physical activity, but has complex interactions with the availability of health care systems, the role of socioeconomic status, and underlying genetic and environmental factors (29).

Balance of Food and Energy Consumption

The main causes of obesity are somewhat controversial. Current health recommendations for obesity management are based on the underlying physiological reasoning holding that fat accumulation is due to an energy imbalance between absorbed and consumed calories. The obesity epidemic has been fueled in large part by increased energy from the greater availability of highly-nutritious and energy-dense foods. Diet and various social, economic and environmental factors related to food supply have a great effect on a person's ability to achieve balance (30).

In a 13-year follow-up study of 3,000 young people, it was found that those who ate the most fast food weighed an average of 6 kilograms more and had a larger waistline than those who consumed the least amount of fast food. It was also found that those consuming more fast food had a higher incidence of weight-related health problems such as increased triglycerides and were twice as likely to develop metabolic syndrome (31).

Accumulation of lipid metabolites, inflammatory signaling, or other impaired hypothalamic neuronal mechanisms may also lead to obesity, which may explain increased body fat mass as a form of biological defense (32).

Family History and Lifestyle

Family history, lifestyle and psychological factors all play a role in obesity. The likelihood of becoming obese can be influenced by family genetics (tendency to accumulate fat) or lifestyle (poor diet or exercise)(33). A child with one obese parent has three times the risk of becoming obese as an adult, while when both parents are obese, the child's risk of obesity in the future is 10 times greater. A cross-sectional observational study on 260 children (139 females, 121 males, 2.4-17.2 years old) showed that a family history of cardiometabolic diseases and obesity are important risk factors for severity of childhood obesity (34).

Genetic Factors and Causes

Family and twin studies show that about 40 to 70% of variation in obesity can be explained by genetic factors (35). While environmental changes have increased obesity rates over the past 20 years, genetic factors still play a key role in the development of obesity (36). The low predictive power may be due to conditions where gene-gene, gene-environment, and epigenetic interactions are not fully identified using current methods based on population genetics (35).

The genetic causes of obesity can be generally classified as follows:

1) Monogenic causes resulting from a single gene mutation, mainly in the leptin-melanocortin pathway. Many genes, such as AgRP (agoti-related peptide), PYY (orexogenic), or MC4R (melanocortin-4 receptor) have been identified as monogenic contributors to obesity that disrupt appetite, weight, and hormonal signaling (ghrelin, leptin, and insulin) (37).

2) Syndromic obesity is caused by severe obesity due to neurodevelopmental abnormalities and other organ/system abnormalities. This may result from changes in a single gene or a larger chromosomal region that includes several genes (38).

3) Multigenic obesity is caused by the cumulative contribution of many genes.

In addition, some people develop obesity due to multiple genes (39). These genes affect their appetite (thus their calorie intake), hunger levels, overeating control, satiety, tendency to store body fat, and tendency to be inactive (40).

Epigenetic Modification

Although genes contributing to monogenic forms of obesity have been identified, the pace of change for the human genome is too slow for the genome to be a major player in the current obesity epidemic. However, epigenetics may provide a reasonable explanation for the increased prevalence of obesity in the past few decades without requiring a fundamental change in the genome (41). In multicellular organisms, the genetic code is homogeneous throughout the body, but the expression of the code can vary among cell types. Epigenetic studies have shown that heritable regulatory changes in genetic expression do not require changes in nucleotide sequences (42). Epigenetic modifications can be thought of as differential packaging of DNA that

enables or silences the expression of specific genes in tissues (29).

Obesity Treatments

Lifestyle Changes

Due to the lack of specific pharmacological interventions, "lifestyle modification" is the cornerstone of obesity management (16). Obese people are advised to lose at least 10% of their body weight through a combination of diet, physical activity, and behavioral therapy (or lifestyle modification) (43). Significant weight loss can be achieved in the short term by consuming controlled diets. Long-term weight control can be achieved through high levels of physical activity and consistent patient-physician contact. In many cases, lifestyle modification leads to a significant reduction in body weight, leading to a significant reduction in cardiovascular risk (44).

Anti-Obesity Drugs

Pharmacotherapy is recommended for those with a BMI ≥30 (or a BMI ≥27 with comorbidities) who cannot lose weight using lifestyle modification alone(45). The FDA has approved a number of pharmaceuticals for the short-term treatment of obesity, including Naltrexone-Bupropion (Contrave), Orlistat (Xenical, Alli), Liraglutide (Saxenda), and Phentermine-Topiramate (Qsymia) (46, 47). The FDA also approved the MC4R agonist-setmelanotide for use in people with severe obesity due to POMC, PCSK1, or LEPR (leptin receptor) deficiency in 2020. In addition, 11 compounds from 54 plant families have been identified as having anti-obesity potential. These families include Celastraceae, Zingiberaceae, Theaceae, Magnoliaceae and Solanaceae (48). Traditional Chinese medicine also offers unique solutions for the treatment of obesity, such as regulating fat metabolism, increasing hormone levels, and regulating intestinal microflora (49).

Surgery

For people with BMI > 40 or BMI > 35 with comorbidities who cannot lose weight with lifestyle modification or drug therapy, bariatric surgery or weight loss surgery is another option (50). Standard bariatric procedures, including BPD (biliopancreatic diversion), SG (sleeve gastrectomy), RYGB (Roux-en-Y gastric bypass), and AGB (adjustable gastric banding) can alter individuals' metabolic profiles (51). Studies report that the benefits of bariatric surgery go beyond weight loss. Bariatric surgery reduces the chronic inflammation involved in obesity and alters biomarkers, gut microbiota, and long-term T2DM remission (29).

Weight Loss and Energy Consumption

Many studies indicate that lifestyle improvement through following a correct diet and appropriate physical activity is the best and most appropriate way to lose weight. Although medical and surgical treatments have also been offered to treat obesity, there are potential side effects for a number of drugs used in the treatment of obesity (such as amphetamines, phenfluramine-phentermine, sibutramine). The possibility of abuse on the one hand, and weight gain after stopping these drugs on the other hand have raised concerns about this approach and have limited the use of medication for the treatment of obesity. In the case of surgical treatments, side effects such as electrolyte disorders, gallstones, stomach ulcers, arthritis and malabsorption, along with the potential complications of the surgery itself such as anesthesia complications, and laparotomy complications have limited their application to patients with a minimum BMI of 35 who suffer from the complications of obesity and have been unresponsive to other methods of weight loss for at least six months (52, 53).

Considering the above-mentioned cases, it seems that the first step in weight loss is behavioral changes and dietary pattern correction along with increasing energy consumption through increasing physical activity and exercise. The percentage of carbohydrates, protein, and fat in the diet has always been considered as one of the factors influencing weight loss. There is a difference of opinion among experts regarding the most useful prescription regimen. In a balanced diet, about 55% of energy is obtained from carbohydrates, 15% from protein and 30% from fat. While some experts recommend that the percentages remain unchanged in an energy-restricted diet, other combinations such as low-fat, high-protein diets also have their own supporters. The advantages and disadvantages of diets with different ratios are still being discussed (45, 54).

Weight loss diets fall into three general categories:

1. Low-calorie diets with a standard protein percentage

2. Low-calorie diets with an increased protein percentage
3. Very low-calorie diets with an increased protein percentage

Low-calorie diets with a high protein percentage stimulate GLP1, which affects the pancreas and leads to insulin secretion. Insulin secretion plays three important roles:

1. Insulin causes a 2% increases in metabolism, which leads to further increases in thermogenic energy after meals.
2. Insulin acts on fat cells, increases cell volume and leads to more leptin production. Leptin affects neurons and leads to faster and more complete induction of satiety.
3. Incretins prepare the intestine for the next meal and increase chyme production, for this reason, they have an inhibitory effect on the stomach and cause the production of better-quality chyme. Incretins also stimulate the intestine for digestion by directing the food that has already been digested to the anal canal. It seems that high-protein diets may be more accepted for weight loss compared to standard diets (46).

Very Low-Carbohydrate Diets (VLCD)

VLCDs were introduced more than two decades ago to induce rapid weight loss in obese individuals, comparable to starvation but without excessive body tissue loss (10). During their early development, it became apparent that the inclusion of even small amounts of protein in severely calorie-restricted diets resulted in a significant reduction in the utilization of body nitrogen or protein stores (11).

Therefore, to achieve rapid weight loss while preserving lean body mass, these diets are designed to initially provide 300-400 calories of high-quality protein as a regular meal with or without carbohydrates, supplemented with minerals and vitamins (10).

VLCD Composition and Nitrogen Balance

Protein and Carbohydrate Content

A major concern with VLCD therapy is that excessive negative nitrogen (protein) balance and loss of lean body mass may contribute significantly to the development of fatal cardiac arrhythmia. Experts believe that a high-protein, low-carb (or no-carb) diet is needed to maintain full lean body mass throughout the cycle. By restricting carbohydrate intake, hypoinsulinemia is induced, leading to increased lipolysis and ketosis, which in turn provide more fuel for the brain and other tissues while sparing protein stores (47, 55).

Protein Quality and Micronutrient Supplements

Due to concerns that low-quality protein intake or insufficient micronutrient supplementation may contribute to early mortality, VLCDs containing high-quality protein along with vitamins, minerals, trace elements, and essential fatty acids were introduced to treat obesity. Widespread use of these formulated VLCDs has repeatedly shown them to be safe and highly effective when used for a limited period of time under close medical supervision (11).

Low-Calorie Diet and Anthropometric Measurements

In a 1987 study, Barrows et al. examined the effects of a very low-calorie (420 kcal/day), high-protein (70 g/day) diet on body weight and body composition in 15 obese middle-aged women during 4–6 months. According to their results, the average weight loss was 20.5 kg (1.1 kg per week). Fat accounted for 83% and lean mass accounted for 17% of total body weight loss. In this study, the best predictor of body density in obese women before and after weight loss was trunk circumference (48).

In a 2003 study, Brehm et al. designed a randomized controlled trial to determine the effects of a VLCD on body composition and cardiovascular risk factors. Subjects were randomly assigned to either a VLCD or a calorie-restricted diet with a 70% calorie deficit for 6 months. The VLCD group lost more weight and body fat than the low-fat diet group. The mean levels of blood pressure, lipids, fasting glucose, and insulin were in the normal range in both groups at the beginning, but improved during the study with no differences between the two groups at 3 or 6 months. According the researchers, the VLCD was more effective than a low-fat diet for short-term weight loss and was not associated with adverse effects on cardiovascular risk factors in healthy women (49).

In a 2001 study, Djuri et al. examined the effect of low-fat and/or low-energy diets on anthropometric measures in participants in the Women's Diet Study. According to their results, low-fat, low-energy, and combined diets all led to similar and statistically significant reductions in

BMI, body fat percentage, and waist circumference during the 12-week intervention. However, the amount of weight loss varied by baseline weight, and the combination diet was the only intervention that resulted in significant weight loss for women who had been overweight at baseline. This suggests that although there may be an advantage to reducing dietary fat in women who are obese at baseline, any of these counseling strategies can be effective in improving the anthropometric predictors of health risks associated with overweight. In fact, flexibility in food choices may facilitate adherence to dietary recommendations in some individuals (49).

Liao et al. (2007) examined the effectiveness of a soy-based diet compared to a traditional low-calorie diet on weight loss and fat levels in overweight adults. In this study, 30 obese adults (average body mass index: 29-30 kg/m^2) were randomly divided into two groups. The soy-based low-calorie group consumed soy protein as the sole protein source, and the traditional low-calorie group consumed two-thirds animal protein and one-third plant protein on a 1,200 kcal/day diet for 8 weeks. Body weight, BMI, body fat percentage, and waist circumference decreased significantly in both groups. The decrease in body fat percentage was greater in the soy group than in the traditional group. Serum total cholesterol concentration, low-density lipoprotein cholesterol concentration, and liver function parameters decreased in the soy-based group and were significantly different from the measurements in the traditional group. No significant changes were observed in serum triglyceride levels, serum high-density lipoprotein cholesterol levels, and fasting glucose levels in the soy or traditional group. According to the researchers, soy-based low-calorie diets significantly reduced serum total cholesterol and low-density lipoprotein cholesterol concentrations and had a greater effect on reducing body fat percentage than traditional low-calorie diets. Therefore, soy-based diets have health benefits for reducing weight and blood lipids (56).

Low-Calorie Diets and Sleep

In a 1992 study, Suratt et al. investigated the effect of low-calorie diets combined with weight loss on OSA. The subjects consumed a VLCD diet of 420 kcal (67% protein, 4% fat, 29% carbohydrate) or 800 kcal (20% protein, 30% fat, 50% carbohydrate) with 100% of the recommended intake of minerals and vitamins. The results showed that VLCD and weight loss could improve OSA. However, people who lose a small amount of weight or those who are extremely obese before and after weight loss may not improve (57).

Kansanen et al. (2008) investigated the effect of weight loss through a low-calorie diet on the severity of OSA and autonomic nervous function in obese patients with obstructive sleep apnea syndrome (OSAS). Their results showed that weight loss through a VLCD is an effective treatment for OSAS. Also, weight loss significantly improved sleep apnea and had beneficial effects on blood pressure and baroreflex sensitivity (58).

A study conducted by Martin et al. in 2016 in the United States on 220 adults with an average age of 37 years showed that the participants lost 7.6 kg after 24 months of following a 25% energy-restricted diet. They lost weight and their sleep quality score improved. The study has some limitations however; the subjects were healthy and the number of white women was higher (59).

In 2016, Zhou et al. conducted a study in the US on two groups: 14 healthy individuals with an average age of 56 years (group 1), and 44 healthy individuals with an average age of 52 years (group 2). The first group were given a diet with a 750-kcal deficit and 10, 20, and 30% protein, and the second group were given a 3-week diet with 0.8 gr protein/kg of weight. This study showed that weight loss improves sleep quality regardless of its source. Also, the sleep indices in both groups included secondary measurements, which cannot be directly matched with the inclusion and exclusion criteria. Moreover, self-reported measures by the subjects such as the PSQI may have biased the outcomes (60).

Dobrosielski et al. (2016) conducted a study on 25 obese individuals older than 60 years old in the United States. Their results showed that after 12 weeks of following a restricted diet and following the lifestyle recommendations of the American Heart Association (90 minutes of exercise per week), there was a 9% reduction in weight, 5% in fat, and an 8% decrease in the apnea index among the participants compared to the control group (61).

Hudson et al. (2020) conducted a study in 51 healthy Americans with an average age of 41.5 years. The study was carried out during 12 weeks

using a diet with a 750-kcal deficit. According to their results, the BMI of all participants decreased. However, dietary intake did not affect any of the measured objective or subjective sleep quality outcomes. Over time, the objective measures of time spent in bed, time spent falling asleep, sleep onset, and wake time after sleep onset did not change. However, sleep efficiency improved in participants. The subjective measures of global sleep score (GSS) and daytime sleep score improved over time. Based on GSS, sleep classification changed from "poor" to "good". According to the results, losing weight may not improve objective sleep quality, but adults who are overweight or obese may sleep well while eating a healthy or high-fat diet. Among the limitations of this study was objective measurement of sleep quality, which is predictable for the participants beforehand (62).

Conclusion

Obesity is a serious public health problem, and the most common interventions are diet and exercise. Very low-calorie diets (VLCDs) are sometimes used for weight management. Although there are large amounts of evidence for the effect of sleep duration and quality on food choice and consumption in children and adults, less attention has been paid to the effect of food patterns and specific foods on sleep. Studies have shown that certain dietary patterns may improve both daytime alertness and nighttime sleep. The literature also reports that weight loss improves the quality of sleep and the related indices. Compared to a low-fat diet for short-term weight loss, VLCD is not associated with any adverse effects on cardiovascular risk factors. VLCD can improve OSA through weight loss. Furthermore, weight loss reduces sleep apnea and improves baroreflex sensitivity and blood pressure. Research has shown that weight loss diets with more protein, regardless of its source, promotes better sleep. Using a low-calorie diet and following the lifestyle recommendations of the American Heart Association can improve body weight and apnea index.

Declarations

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Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of Interest

There is no conflict of interest.

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