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Review Article

Dietary Fat Intake on Metabolic Health: An in-Depth Analysis of Epidemiological, Clinical, and Animal Studies

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Abstract

Background: The consumption of dietary fat plays a vital role in the maintenance of metabolic health as it exerts impact over several physiological processes, including lipid profiles, inflammation, and insulin sensitivity, among other factors. The aim of this comprehensive review seeks to assess the influence of dietary fat consumption on metabolic processes. *Methods:* An exhaustive and methodical exploration of pertinent databases, such as Web of Science, PubMed, and Scopus, was undertaken to identify animal studies, clinical trials, and epidemiological research. The search terms included "dietary fat," "metabolic health," "epidemiological studies," "clinical trials," and "animal studies". *Result:* Animal studies demonstrate that high intake of saturated fat impairs insulin sensitivity and glucose tolerance, while unsaturated fats such as monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs) have beneficial effects. Observational studies in humans reveal that higher intake of saturated fat is associated with an increased risk of metabolic syndrome and type 2 diabetes, whereas unsaturated fats lower the risk. *Conclusion:* Clinical trials have further supported the importance of replacing SFAs with healthier fats, such as MUFAs and PUFAs, particularly omega-3 and omega-6 fatty acids, in improving metabolic health markers in human subjects. Instead of advising against fats altogether, it is important to specify the preferred types of fats to be consumed as part of a healthy diet and lifestyle.

Keywords

Metabolic Health, Dietary Fat, Diabetes, Dyslipidemia, Hypertension

1. Introduction

In recent times, there has been a significant increase in the occurrence of metabolic diseases, including obesity, type 2 diabetes, dyslipidemia, and hypertension (HTN), on a global scale [1, 2]. Metabolic diseases are projected to impact around 30% of the populations residing in developing nations [3]. These disorders frequently exhibit a correlation with an unhealthy lifestyle that is characterized by suboptimal dietary decisions, such as the consumption of an excessive quantity of

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dietary fats [4]. Previous studies have indicated that dietary and lifestyle adjustments may have more efficacy in preventing the onset of metabolic diseases compared to pharmaceutical interventions [5]. Historically, low-fat diets have been proposed to improve metabolic health [6]. Nevertheless, emerging evidence have challenged this perspective and emphasized the need of distinguishing between the types of dietary fats and their effect on metabolic well-being. Studies have demonstrated a significant correlation between the excessive intake of trans fats, which are frequently included in processed food products, and adverse impacts on metabolic well-being [7, 8].

The findings of a meta-analysis indicate that there is no significant correlation between a higher score on the pro-inflammatory dietary index (DII) and an elevated susceptibility to metabolic diseases. It was strongly associated with a 35% higher likelihood of developing cardiovascular disease (CVD) [9]. Over the last several decades, the "diet-heart hypothesis" has gained popularity. It suggests that consuming more total dietary fat and saturated fatty acids (SFA) leads to higher levels of low-density lipoprotein cholesterol (LDL-c) and total cholesterol (TC) in the blood [10, 11]. However, a meta-analysis of epidemiological studies resulted in inadequate data to support a connection between the consumption of dietary saturated fatty acids (SFAs) and an increased risk of coronary heart disease (CHD) [12]. Previous studies have indicated that the adoption of a high-fat diet rich in unsaturated fatty acids (UFA), such as the Mediterranean diet, might potentially contribute to a reduction in the prevalence of type 2 diabetes mellitus (T2DM) and other metabolic diseases through the modulation of blood pressure and heart disease [13, 14].

In the 2015-2020 Dietary Guidelines for Americans, the recommendation to limit saturated fat (SFA) to fewer than 10% of daily calories and replace it with unsaturated fats (UFA) was eliminated; however, the total fat limit was retained. It is recommended that individuals augment their consumption of nuts, plant oils, and fatty fish, while concurrently reducing their diet of red meat and processed foods [15]. Presently, developing countries are confronted with a nutritional transition characterized by an increasing prevalence of obesity, metabolic syndrome, and type 2 diabetes [16]. The function of dietary fat consumption in metabolic health and disease has been the subject of much research. This review presents empirical information derived from animal research, human observational studies, and clinical trials regarding the resultant effect of total fat intake and different types of fat on metabolic syndrome, obesity, insulin resistance, and type 2 diabetes. This study investigates the interplay between dietary fat and carbohydrates, aiming to elucidate the probable pathways that connect fat consumption with metabolic dysfunction.

2. Methods

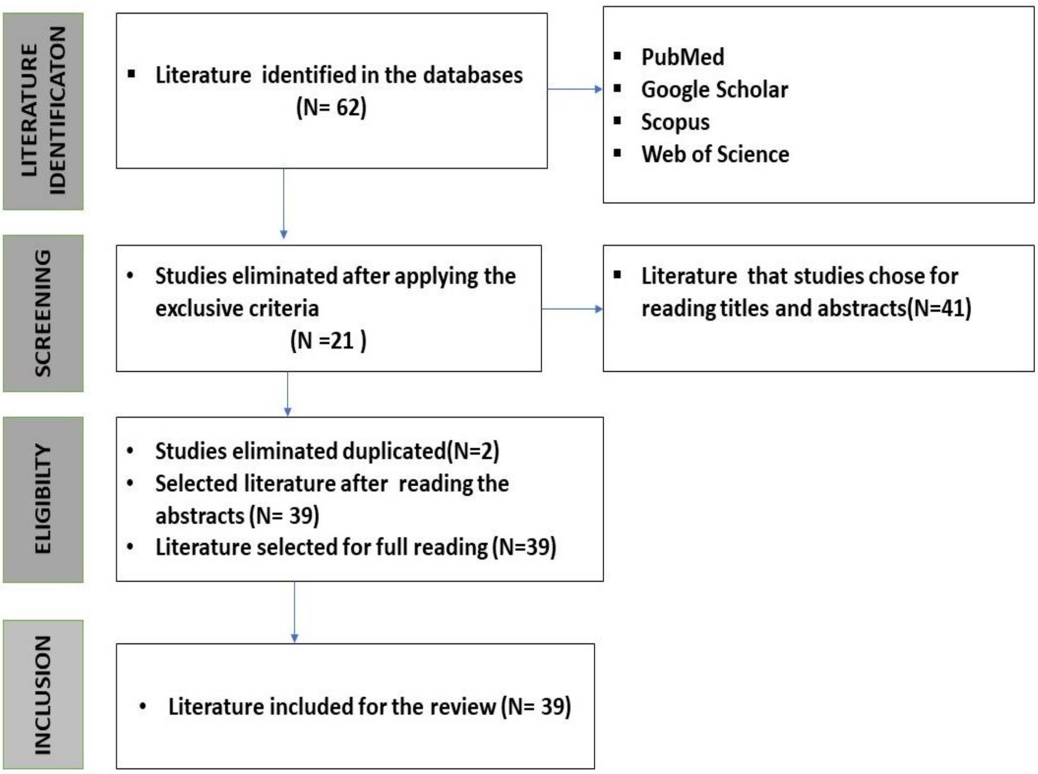

Figure 1. *Show the eligibility for inclusion and exclusion criteria.*

A systematic search of relevant databases, including PubMed, Google scholar, Scopus, and Web of Science, was conducted to identify animal studies, clinical trials, and epidemiological studies investigating the association between dietary fat intake and metabolic health outcomes. Key search terms included "dietary fat," "metabolic health," "animal studies," "clinical trials," and "epidemiological studies." Studies published within the last decade were prioritized, along with seminal studies from earlier periods. The process of data extraction was carried out independently by three reviewers, who systematically examined the titles and abstracts of publications with the intent to detect and remove any occurrences of redundant data. The preliminary review of the literature resulted in a cumulative count of 62 relevant articles. Following that, a total of 21 publications were excluded from consideration since they did not align with the terms employed in the search criteria. Two duplicate papers were eliminated. Consequently, a total of 39 papers were selected for further evaluation and data extraction, forming the basis of this review paper. The inclusion and exclusion criteria are depicted graphically in figure 1.

2.1. Epidemiological Studies

Certain types of dietary fat have been associated with an increased risk of metabolic diseases as reported in several in several observational studies. Increased intake of saturated fat has been linked to increased risk of metabolic syndrome, type 2 diabetes, and cardiovascular disease [17]. Swopping saturated fats for unsaturated fats decrease the danger of developing metabolic syndrome and type 2 diabetes [18]. Reduced risk of metabolic syndrome is linked to higher PUFA consumption, particularly omega-3s from fish [19]. Unsaturated fats reduce risk, but saturated and trans fats are linked to an increased risk of metabolic illness, according to human observational evidence [18, 20].

The study conducted by Cicero et al. assessed the effects of PUFA supplementation on patients diagnosed with metabolic syndrome and hypertension. The observed significant decline in plasma lipid levels, specifically Total Cholesterol (TC) and Triglycerides (TG), is a positive development, as elevated lipid levels have been linked to a higher risk of cardiovascular diseases. An upsurge in High-Density Lipoprotein cholesterol (HDL-c) is significant because HDL-c is regarded as beneficial cholesterol that aids in the elimination of surplus cholesterol from the bloodstream [18].

Observed reduction in blood pressure indices, namely Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), and Pulse Pressure (PP), suggest the administration of PUFA supplementation might potentially produce beneficial effects in the regulation of blood pressure [19]. It is imperative to decrease blood pressure in order to mitigate the likelihood of cardiovascular incidents, such as myocardial infarctions and cerebrovascular accidents [20]. The negative correlation between age and the reduction in diastolic blood pressure (DBP) suggests that older patients may derive more significant advantages in terms of blood pressure lowering from the addition of polyunsaturated fatty acids (PUFA) [19]. The association between dietary macronutrients and metabolic syndrome was investigated by Ahola et al. The results of the study revealed that there was no direct correlation between the proportions of macronutrients or fatty acid intake and the occurrence of metabolic syndrome [21]. This indicates that the exclusive determinant for the development of metabolic syndrome may not be the total distribution of carbohydrates, lipids, and proteins in the diet. Nevertheless, the study found associations between dietary preferences and specific metabolic markers. Opting for carbohydrates (CH) instead of fats had been associated to a reduced risk of increase in waist circumference (WC) [21]. The findings of this study suggest that the specific macronutrient consumed, rather than its overall distribution, may have an influence on abdominal obesity, a significant factor in the development of metabolic syndrome. In addition, opting for carbohydrates (CH) or fats over proteins have been associated to a decreased probability of high blood pressure (BP) [4].

This indicates that the choice of macronutrients in one's dietary intake may have an impact on the regulation of blood pressure. It is imperative to note that these associations have been reported within the context of the study, and further study is needed to corroborate a cause-and-effect relationship. The study was conducted to explore the correlation between dietary patterns and metabolic parameters. Two unique dietary patterns (F1 and F2) were observed in the study. The presence of the F1 pattern was found to be correlated with decreased levels of fasting serum glucose, even after adjusting for body mass index (BMI). These findings suggest that specific dietary patterns could potentially have a role in the development of central obesity, which is a significant risk factor for metabolic syndrome [21, 4]. The findings indicate a negative correlation between the F2 pattern and saturated fat (SFA) consumption, implying that a decrease in the intake of saturated fats could potentially have positive effects on metabolic well-being.

In the study by Ebbesson et al., the study participants showed a slight overweight condition at the outset, accompanied by relatively low levels of blood pressure and triglycerides. In addition, they had elevated levels of high-density lipoprotein cholesterol (HDL-C), an assortment of cholesterol that is commonly regarded as beneficial [22]. The research revealed a positive correlation between the consumption of saturated fatty acids (SFA) and heightened triglyceride levels as well as elevated blood pressure. Consumption of trans fatty acids has been found to be associated with elevated blood pressure [22]. In contrast, omega-3 fatty acids (n-3 FA), encompassing distinct variants such as EPA, DHA, and DPA, have demonstrated favorable correlations with enhanced metabolic well-being. Research has indicated a positive correlation between omega-3 fatty acids and elevated levels of high-density lipoprotein cholesterol (HDL-C), as well as enhanced insulin resistance. Hekmatdoost et al. conducted a study which revealed a positive correlation between increased consumption of saturated fatty acids and overall fat intake, and elevated systolic blood pressure (SBP) and triglyceride levels, along with decreased HDL-C levels [23]. Omega-3 fatty acids have been associated with increased levels of HDL-C (high-density lipoprotein cholesterol) and improved insulin resistance. Nevertheless, there is currently no validated correlation between linoleic acid (LA), oleic acid, and the constituents of metabolic syndrome (MetS) [24].

Research has established a correlation between the intake of saturated fat (SFA) and increased levels of triglycerides, as well as decreased levels of high-density lipoprotein cholesterol (HDL-C) [25, 26, 24]. Conversely, the consumption of monounsaturated fat (MUFA) had a positive correlation with elevated levels of high-density lipoprotein cholesterol (HDL-C), but polyunsaturated fat (PUFA) demonstrated a negative association with HDL-C levels. There was a favorable correlation between the ratio of polyunsaturated fat to saturated fat (P/S ratio) and HDL-C levels. Several studies have revealed that a higher P/S ratio is indicative of a comparatively greater consumption of polyunsaturated fats in relation to saturated fats [27, 28]. These studies emphasize the significance of the content of dietary fat in connection to metabolic health. The authors present empirical support for the notion that increased consumption of saturated fatty acids (SFA) may exert detrimental impacts on metabolic indicators, conversely, omega-3 fatty acids (n-3 FA) and monounsaturated fats (MUFA) have been linked to enhanced metabolic health outcomes [19, 23]. It's important to note that these findings are based on observational studies, and further research is needed to establish causality and determine optimal dietary recommendations for metabolic health maintenance and disease prevention.

Table 1. *Epidemiological studies of findings.*

Reference	Sample size	Methods	Key findings
Derosa et al., (2013) [29]	91 participants	Participants were prescribed a 3 g/day omega-3 PUFAs (polyunsaturated fatty acids) supplementation for a period of 24 months.	Omega-3 PUFAs supplementation for 24 months resulted in improved cholesterol levels and reduced blood pressure, including a decrease in systolic blood pressure by 2.6 mmHg and diastolic blood pressure by 1.4 mmHg. Additionally, there was a decrease in basal heart rate by 4.1 bpm, and the extent of blood pressure improvement was influenced by baseline blood pressure levels and patient age.
Ahola et al., (2017) [21]	791 Participant	-Self-administered dietary questionnaire -3-day exercise and diet record. -Another 3-day exercise and control.	The proportions of dietary macronutrients or fatty acids were not associated with Metabolic Syndrome (MetS), and there were no differences in macronutrient distribution between individuals with and without MetS. However, choosing carbohydrates over fats was linked to a lower likelihood of increased waist circumference, and opting for carbohydrates or fats instead of proteins was associated with a reduced probability of elevated blood pressure.
Cicero et al., (2010) [19]	111 Participant	Patients with normal to high blood pressure and MetS received daily 2 grams of 85% EPA and DHA-rich esterified PUFAs for 12 months.	After a 3-month treatment, there were notable reductions in plasma lipid levels, specifically Total Cholesterol (TC) and Triglycerides (TG), along with an increase in High-Density Lipoprotein cholesterol (HDL-C). During a 12-month treatment period, PUFA supplementation resulted in a significant decrease in Systolic Blood Pressure (SBP) by an average of 2.7 mmHg, Diastolic Blood Pressure (DBP) by 1.3 mmHg, and Pulse Pressure (PP) by 1.4 mmHg, as well as a decrease in basal heart rate by an average of 4.0 beats per minute (bpm). The decrease in DBP was influenced by patient age and remained consistent across different patient sexes.
Ebbesson et al., (2007) [22]	691 (325 men and 366 women)	Dietary intake was assessed using a FFQ	The beginning of the study, the participants were slightly overweight with low blood pressure (BP) and triglyceride (TG) levels, and high levels of high-density lipoprotein cholesterol (HDL-C). Consuming saturated fatty acids (SFA) was associated with elevated TG levels and increased BP, while trans fatty acids were linked to higher BP. Omega-3 fatty acids (n-3 FA), including EPA, DHA, and DPA, were associated with improved metabolic health, such as lower BP, TG levels, fasting blood glucose (FBG), and insulin resistance. However, alpha-linolenic acid (ALA) consumption did not show significant associations with the components of Metabolic Syndrome (MetS).

Reference	Sample size	Methods	Key findings
Hekmatdoost et al., (2011b) [24]	822 (354 men and 468 women	Assessment of FFQ, Height, BMI, WC, BP, age, physical activity, smoking habits, blood samples	There is a significant association between dietary consumption of saturated fatty acids (SFA) and Metabolic Syndrome (MetS), with higher SFA intake and overall fat intake linked to elevated systolic blood pressure (SBP) and triglyceride (TG) levels, as well as lower high-density lipoprotein cholesterol (HDL-C) levels. Individuals with low SFA intake tend to consume more grains, dairy, fruits, and vegetables and less meat compared to those with high SFA intake, and there is no established connection between linoleic acid (LA), oleic acid, and MetS components, while age was not found to be associated with saturated fatty acid intake.
Shab−Bidar et al., (2014) [25]	2750 (44% men and 56% women	Dietary intake was evaluated through the utilization of a Food Frequency Questionnaire (FFQ).	Consumption of saturated fats was linked to higher triglyceride levels and lower HDL-C levels, while monounsaturated fats were associated with higher HDL-C levels. The ratio of polyunsaturated to saturated fats was positively related to HDL-C levels and negatively associated with the LDL: HDL-C ratio, and these dietary fat factors were significantly associated with the risk of Metabolic Syndrome, except for total PUFA intake.
Tierney et al., (2011a) [30]	477 participants	The researchers used a validated food frequency questionnaire to assess dietary intake.	Individuals with metabolic syndrome (MetS) had distinct dietary habits, characterized by higher total fat and MUFA intake, lower carbohydrate and fiber consumption, and lower physical activity levels compared to those without MetS. Furthermore, men and women with MetS were more likely to deviate from recommended macronutrient distribution ranges, particularly for carbohydrates, total fat, MUFAs, and α-linolenic acid, and were less likely to meet established dietary recommendations.

2.2. Clinical Trials

The outcomes of these clinical trial findings pertain to the comprehension of the correlation between nutrition and metabolic health. The study conducted by Poppitt et al. found that the low-fat complex carbohydrate (LF-CC) diet resulted in the significant weight loss when compared to both the control diet and the low-fat simple carbohydrate (LF-SC) diet [29]. This suggests that the composition of carbohydrates in the diet may play a role in weight management [31, 32, 33]. Additionally, all three dietary groups showed a decrease in total cholesterol levels, indicating that dietary modifications can have positive effects on lipid profiles [33]. Álvarez Hernández et al.'s studied the effects of palm oil (PO) on hepatic metabolism. The findings revealed that PO administration decreased insulin sensitivity in various tissues, including whole-body, hepatic, and adipose tissue. This suggests that palm oil consumption contribute to insulin resistance [34], which is a key factor in the development of metabolic disorders such as type 2 diabetes [35]. Furthermore, the increase in hepatic triglyceride and ATP content after PO administration indicates an adverse impact on liver health [33].

In a study conducted by Louise M. Brady, the association between dietary polyunsaturated fatty acids (PUFA) and metabolic syndrome in Indian Asians residing in the United Kingdom was investigated. The study found that the prevalence of metabolic syndrome in Indian Asians is higher than in indigenous Caucasian populations. The metabolic abnormalities in this group are associated with an imbalance in dietary PUFA intake, particularly with higher intake of n-6 PUFA and lower intake of long-chain n-3 PUFA [36]. This highlights the importance of considering the quality and balance of dietary fats in relation to metabolic health. Lee et al conducted a study to investigate the effects of dietary supplementation with corn oil (CO), a mixture of botanical oil (BO) (borage/echium oil), and fish oil (FO). The results indicated that the cohort administered with the BO combination exhibited substantial reductions in both total cholesterol and LDL cholesterol concentrations [37]. This suggests that the BO combination have beneficial effects on lipid profiles, potentially reducing the risk of cardiovascular diseases associated with metabolic syndrome which is accordance with other studies [38, 39]. In contrast, the group that received carbon monoxide (CO) did not exhibit any significant changes in the assessed biomarkers, suggesting that the administration of CO may not exert a substantial influence on the evaluated parameters.

The results suggested that insulin-resistant subjects with the highest HOMA-IR showed improvements in insulin resistance and reduced insulin and HOMA-IR concentrations after ingesting the HMUFA and LFHCC n-3 diets [40]. This implies that altering the composition of fat diet, particularly by substituting saturated fatty acids with monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA), has positive effects on the ability of the body to respond to insulin and the metabolism of glucose in individuals who have insulin resistance. Furthermore, Yubero-Serrano's study revealed that subjects with reduced Homeostatic Model Assessment of Insulin Resistance

(HOMA-IR) demonstrated decreases in body mass index (BMI) and waist circumference subsequent to the consumption of both the LFHCC control and LFHCC n-3 diets [40]. This indicates that dietary interventions focusing on low-fat, high-complex carbohydrate diets supplemented with long-chain n-3 PUFAs may be effective in reducing adiposity and central obesity in individuals with lower levels of insulin resistance [31, 41]. Furthermore, the Yubero-Serrano study demonstrated that subjects with a low to medium HOMA-IR exhibited improvements in blood pressure, triglyceride, and LDL cholesterol levels after consuming the LFHCC n-3 diet. This suggests that incorporating long-chain n-3 PUFAs into the diet may have positive effects on cardiovascular risk factors in individuals with moderate levels of insulin resistance [40].

These research findings emphasize the potential advantages of dietary treatments in enhancing biomarkers associated with metabolic syndrome and insulin resistance. According to the findings, the inclusion of oils, such as the combination of BO containing alpha-linolenic acid, gamma-linolenic acid, and stearidonic acid, or the consumption of diets abundant in MUFA and n-3 PUFAs, could potentially result in beneficial alterations in lipid profiles, insulin sensitivity, body composition, and cardiovascular risk factors. It is imperative to point out that the findings are limited in scope to the populations under investigation and should be approached with prudence when considering broader implications. Additional investigation is required to delve into the enduring consequences and underlying mechanisms that contribute to the observed results. However, the present evidence enhances the current understanding of dietary interventions for the management of metabolic syndrome and offers valuable insights for future interventions and clinical practice.

Table 2. *Clinical Trials of some findings.*

Reference	Sample size	Methods	Key finding
Lee et al., (2014) [37]	59 participants	The participants were divided into three groups: one group received corn oil (CO), another group received a botanical oil (BO) combination (borage/echium oil), and the third group received fish oil (FO).	The study found that the groups receiving the BO and FO dietary supplements showed significant improvements in lipid profiles, with BO reducing total and LDL cholesterol, and FO reducing triglycerides and hemoglobin A1c while increasing HDL cholesterol, whereas the CO group did not show any significant changes.
Hernández et al., (2017) [34]	14 Participants	Healthy individuals randomly received either palm oil (PO) or vehicle (VCL). Hepatic metabolism was analyzed using in vivo 13C/31P/1H and ex vivo 2H magnetic resonance spectroscopy.	Administration of palm oil decreased insulin sensitivity, increased hepatic triglyceride and ATP content, and altered glucose metabolism, while also differentially regulating various gene pathways, ultimately leading to rapid increases in hepatic lipid storage, energy metabolism, and insulin resistance.
Tardivo et al., (2015) [9]	87 Participants	The participants were randomly assigned to one of two groups: a control group (n=43) that followed a diet alone and an intervention group (n=44) that followed a diet along with omega-3 supplementation (900mg/day orally).	A dietary intervention combined with omega-3 supplementation in postmenopausal women with metabolic syndrome led to significant reductions in BMI, waist circumference, blood pressure, triglycerides, insulin resistance, and inflammatory markers, beyond the benefits seen with diet alone.
Poppitt et al., (2002b) [33]	46 Participants	The subjects were randomly assigned to one of three dietary groups: control diet, low-fat complex carbohydrate diet (LF-CC), or low-fat simple carbohydrate diet (LF-SC). The intervention lasted for 6 months.	The LF-CC diet had a significant impact on body weight and BMI, leading to the greatest weight loss compared to the control diet and LF-SC diet. Additionally, the LF-CC diet resulted in the largest decrease in total cholesterol levels, while LDL cholesterol levels remained unchanged across all groups. HDL cholesterol levels decreased over time in all three groups, and triacylglycerol concentrations were highest in the LF-SC group.
Venturini et al., (2015) [42]	The study included 102 patients (81 women and 21 men).	The participants were randomly assigned to one of four groups: the control group (CG) maintained their usual diet, the fish oil group (FO) received 3 g/d of fish oil u-3 fatty acids, the extra virgin olive oil group (OO) received 10 mL/d of extra	The combination of fish oil and extra virgin olive oil supplementation led to significant reductions in total cholesterol and LDL-C, as well as improvements in lipid and oxidative stress markers, in patients with metabolic syndrome, suggesting a beneficial synergistic effect on lipid metabolism

Reference	Sample size	Methods	Key finding
		virgin olive oil, and the fish oil and extra virgin olive oil group (FOO) received 3 g/d of fish oil u-3 fatty acids and 10 mL/d of extra virgin olive oil.	and oxidative stress.
Yubero-Serrano et al., (2015b) [40]	472 Participants with metabolic syndrome from 8 European countries	The study involved randomly assigning subjects to one of four diets: a high-saturated fatty acid diet, a high-monounsaturated fatty acid diet, a low-fat high-complex carbohydrate diet with n-3 PUFA supplementation, or a low-fat high-complex carbohydrate diet with a placebo.	Consuming specific diets, including HMUFA and LFHCC n-3, improved insulin resistance, reduced body mass index and waist circumference, and favorably altered lipid profiles and blood pressure in subjects with varying degrees of insulin resistance.

2.3. Animal Studies

A number of studies have used a variety of high-fat diets that vary from twenty percent to sixty percent of total energy. Both plant-based oils, such as corn, safflower, or olive oil, and animal-based fats, such as beef tallow and lard, are utilised in the process. The utilisation of plant-based oils is more common [43]. MetS in experimental animals has been widely induced by high-fat diets. More precisely, it has long been known that high-fat diets can cause animals to become obese [44, 45]. In addition, studies have found that consuming a diet that is high in fat can effectively induce insulin resistance, dyslipidemia, hyperglycemia, and raised levels of free fatty acids in the blood, either on their own or in combination with other related conditions [23]. Mice and rats given high-fat diets, especially saturated fat are more probable to be overweight, develop insulin resistance, have impaired glucose tolerance, and have fatty livers compared to those given low-fat diets [46]. Replacing saturated fats with unsaturated fats like olive oil and fish oil prevents high-fat diet induced metabolic dysfunction in rodents [47, 48]. Omega-3 polyunsaturated fatty acids (PUFAs) enhance insulin sensitivity, boost energy expenditure, and mitigate the obesogenic and diabetogenic consequences of saturated fats [49, 50]. Trans fats markedly increase visceral fat deposition, insulin resistance, and inflammation in non-human primates [51]. Diets high in saturated fat alter hypothalamic appetite regulation by decreasing orexigenic neuropeptide Y and agouti-related protein and reducing serotonin receptor binding [52].

The long-term effects of various dietary fats (with fat contents of 10%, 32%, and 45%) on body fat and metabolism in rats were investigated in thorough research by Ghibaudi et al., 2002. The findings demonstrated that calorie intake, weight gain, fat mass, plasma glucose, cholesterol, triglycerides, free fatty acids, leptin, and insulin levels all increase in proportion to the amount of fat in the diet [53]. Similar increases in body mass, total fat pads, plasma triglyceride levels, and levels of high-density lipoproteins (HDL) and low-density lipoproteins (LDL) were seen in mice given a high-fat meal that included 60% fat [30]. Another animal model fed a high-fat diet also showed elevated levels of total cholesterol, LDL cholesterol, and unesterified cholesterol [45]. Moreover, a subsequent study revealed that male C57BL/6 J mice consuming a high-fat diet experienced elevated body weight, total cholesterol, and leptin levels [54]. Additionally, mice fed a high-fat diet demonstrated increased body weight, plasma lipids, plasma insulin levels, and insulin resistance compared to those fed a standard chow diet [52]. In summary, excessive consumption of a high-fat diet leads to an increased production of very-low-density lipoproteins (VLDL) in the liver, which distributes the synthesized triglycerides. This can result in obesity, dyslipidemia, cholesterol accumulation in arteries, and insulin resistance caused by the accumulation of triglycerides in the liver. Also, saturated, and trans fats impair metabolic health, while unsaturated fats like MUFAs and PUFAs have protective effects. Omega-3 PUFAs counteract the deleterious metabolic impact of saturated fat.

3. Conclusion

Epidemiological, clinical, and animal studies have all pointed to a direct correlation between fatty acid consumption and the risk for metabolic disease. Saturated fatty acids' (SFAs) effect on metabolic diseases is context dependent according to other nutrients. Dietary fat consumption substantially affects metabolic health outcomes, according to results from animal research, clinical trials, and epidemiological investigations. The consumption of saturated fatty acids (SFAs) has been associated to negative metabolic effects, whereas increased intake of monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs), such as omega-3 and omega-6 fatty acids, are associated with improved metabolic profiles. When formulating dietary guidelines, it is important to emphasize the examination of different types of fats consumed, rather than solely concentrating on the reduction of overall fat consumption, in order to attain desirable health outcomes among individuals. Instead of advising against fats altogether, it is important to specify the preferred types of fats to be consumed as part of a healthy diet and lifestyle. The results of the study also highlight the significance of taking into consideration the quality and content of dietary fats when developing dietary guidelines for the improvement of metabolic health. Additional investigation is required to probe into the fundamental lasting effects of different dietary fats on metabolic health outcomes, ultimately providing essential knowledge for the development of evidence-based dietary recommendations aimed at promoting optimal metabolic health.

Abbreviations

SFA	Saturated Fatty Acids
MUFA	Monounsaturated Fatty Acids
PUFA	Polyunsaturated Fatty Acids
LDL-c	Low-Density Lipoprotein Cholesterol
TC	Total Cholesterol
CVD	Cardiovascular Disease
CHD	Coronary Heart Disease
T2DM	Type 2 Diabetes Mellitus
HTN	Hypertension
DII	Dietary Inflammatory Index
HDL-c	High-Density Lipoprotein Cholesterol
TG	Triglycerides

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Conflicts of Interest

The authors declare no conflicts of interest.

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