Effects of diets rich in monounsaturated fatty acids on the management and prevention of insulin resistance: A systematic review

⊕E.L.L. Ramos[a], ⊕M.F.C. Lima[a], ⊕A.C.S.F. Azevedo[a], ⊕M.G.F. Lopes[a], ⊕A.P.B. Moreira[b] and ⊕C.T. Souza[a, ✉]

[a] Research Centre in Nutrients and Physical Exercise Applied to Metabolic Syndrome, Medicine School, Universidade Federal de Juiz de Fora, Juiz de Fora, Brazil.

[b] Department of Nutrition, Biological Sciences Institute, Universidade Federal de Juiz de Fora, Juiz de Fora, Brazil.
✉ Corresponding author: claudio.teodoro@ufjf.edu.br.

SUMMARY: Insulin resistance (IR), which is linked to obesity, is a mechanism associated with metabolic diseases, mainly type 2 diabetes mellitus. Studies have shown that monounsaturated fatty acids (MUFAs) have anti-inflammatory and anti-oxidative properties which positively affect IR. This systematic review examined the effects of MUFAs from different sources on IR in obese or overweight patients with or without metabolic syndrome. A search was carried out in the PubMed/Medline and Bireme/VHL databases, and data from 16 studies were analysed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. The intervention time ranged from 1 day to 5.2 years. All participants were overweight or obese; some had central obesity, a moderate risk of cardiovascular disease, low high-density lipoprotein levels, altered fasting glucose levels, prediabetes or type 2 diabetes mellitus. This systematic review provides evidence that MUFA-rich diets can improve IR.

KEYWORDS: *Metabolic syndrome; Monounsaturated fatty acids; Obesity; Systematic review.*

RESUMEN: ***Efectos de dietas ricas en ácidos grasos monoinsaturados en la gestión y prevención de la resistencia a la insulina: Una revisión sistemática.*** La resistencia a la insulina (RI), que está ligada a la obesidad, es un mecanismo asociado a enfermedades metabólicas, principalmente a la diabetes mellitus tipo 2. Los estudios han demostrado que los ácidos grasos monoinsaturados (AGMI) tienen propiedades antiinflamatorias y antioxidantes, que afectan positivamente a la RI. Esta revisión sistemática examinó los efectos de los AGMI de diferentes fuentes sobre la RI en pacientes obesos o con sobrepeso con o sin síndrome metabólico. Se realizó una búsqueda en las bases de datos PubMed/Medline y Bireme/VHL, y se analizaron los datos de 16 estudios de acuerdo con las pautas Preferred Reporting Items for Systematic Reviews and Meta-Analyses. El tiempo de intervención osciló entre 1 día y 5,2 años. Todos los participantes tenían sobrepeso u obesidad; algunos tenían obesidad central, riesgo moderado de enfermedad cardiovascular, niveles bajos de lipoproteínas de alta densidad, niveles alterados de glucosa en ayunas, prediabetes o diabetes mellitus tipo 2. Esta revisión sistemática proporciona evidencia de que las dietas ricas en MUFA pueden mejorar la RI.

PALABRAS CLAVE: *Ácidos grasos monoinsaturados; Obesidad; Revisión sistemática; **S**índrome metabólico.*

1. INTRODUCTION

Obesity is highly prevalent among adults and increases costs for public health systems worldwide (Bovolini *et al*., 2021). Obesity usually occurs when energy intake exceeds energy expenditure from metabolic and physical activities, leading to fat accumulation, mainly in visceral depots (Crudele *et al*., 2021). Excessive fat accumulation is a risk factor for many chronic diseases, including type 2 diabetes mellitus (T2DM). Although the exact aetiology of obesity is unknown, insulin resistance (IR) is a common factor that links obesity to T2DM and other metabolic disorders (Cho *et al*., 2017). IR is defined as a subnormal response to insulin-stimulated glucose uptake in skeletal muscles and adipose tissue and/or the suppression of hepatic gluconeogenesis. The development of IR is mainly associated with low-grade chronic inflammation induced by pro-inflammatory cytokines (e.g. interleukin-1 beta, interleukin-6, and tumour necrosis factor-alpha) and increased macrophage infiltration into peripheral tissues (Rehman and Akash, 2016). Oxidative stress may also be involved in the development of IR (Furukawa e*t al*., 2004; Hurrle and Hsu, 2017).

Dietary patterns may play a dual role in determining the positive and negative effects of the onset and management of metabolic diseases. A systematic review and meta-analysis showed that altered nutritional habits play an essential role in the risk of IR development (Clifton, 2019). While Western dietary patterns, which are characterized by excessive consumption of ultra-processed foods, soft drinks, carbohydrates, and saturated fatty acids, and low or no physical exercise can lead to the onset of obesity, IR, and T2DM. A balanced diet which is low in sugar, simple carbohydrates, and saturated fatty acids and high in vegetables fiber, monosaturated fatty acids (MUFAs), and polyunsaturated fatty acids (PUFAs) has positive effects on metabolic risk factors (Clifton, 2019).

The beneficial properties of fatty acids are undervalued. Recent studies indicate that fatty acids, especially MUFAs, are essential for human health. Studies have shown that MUFAs play a pivotal role in health owing to their anti-inflammatory and anti-oxidative properties, which positively affect IR (Clifton, 2019; Ravaut e*t al*., 2021). Interestingly, diet supplementation with olive oil (a component of the MUFA-rich Mediterranean diet) correlates with a low incidence of obesity and metabolic diseases and, therefore, low rates of chronic inflammation and mortality (Ravaut *et al*., 2021). This study aimed to systematically review and summarize the existing evidence on the effect of a MUFA-rich diet on IR in overweight or obese individuals with or without metabolic syndrome (MetS).

2. MATERIALS AND METHODS

2.1. Study design

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.

2.2. Eligibility criteria

We included randomized, controlled studies involving men and women aged 20–65 years who were overweight or obese (body mass index ≥ 25 kg/m^2) and either did or did not have MetS. Studies using MUFA-rich diets (e.g. the Mediterranean diet) or MUFA supplements (e.g. nuts or vegetable oils with emphasis on olive oil [discussion item 4.3]) as the mode of intervention were included. We adopted IR-related biochemical parameters (e.g. blood glucose, insulin, homeostatic model assessment of insulin resistance [HOMA-IR], C-peptide, glucagon-like peptide 1 [GLP-1], and glycosylated haemoglobin levels) as the main outcome measures.

2.3. Exclusion criteria

We excluded intervention studies involving healthy individuals or pregnant women and experimental studies. Articles published more than 10 years ago were also excluded.

2.4. Research methods

PubMed and Bireme/VHL (Virtual Health Library) were searched for articles published between 2010 and 2020. No publication language restrictions were imposed. In both databases, the search was performed by combining keywords related to MUFA ("monounsaturated fatty acids" OR "MUFA"; "extra virgin olive oil" OR "olive oil"; "nuts" OR "nut"; "Mediterranean diet") and the expected results related to IR assessment ("Insulin Resistance" OR "Insulin Sensitivity" OR "Insulin" OR "HOMA"). Only randomized clinical trials were included (Figure 1).

2.5. Data extraction and management

Three researchers independently selected the articles. Discrepancies were discussed with two other review researchers until a consensus was reached. The following data were extracted from each study: author; publication year; number and characteristics of participants; age group; MUFA intervention duration, quantity, and type; control type; and main results with research outcomes (Table 1).

3. RESULTS

3.1. Literature search

The search identified 124 articles in Pubmed and 21 articles in Bireme: 30 using "monounsaturated fatty acids" OR "MUFA," 30 using "extra virgin olive oil" OR "olive oil," 36 using "nuts" OR "nut," and 49 using "Mediterranean diet." After excluding duplicate, reviews, and irrelevant articles, 67 were subjected to full-text review, and 16 of them were finally included (Figure 1).

3.2. Study characteristics

Sixteen studies were included in this systematic review. The intervention time ranged from 1 day to 5.2 years. The analysed studies included 1341 participants from countries on all continents except Africa. Nine studies were randomized crossover studies, five were randomized clinical trials, one was a randomized, parallel-arm controlled trial, and one was a nonrandomized clinical trial. Table 1 summarizes the information extracted from the included studies. All participants were overweight or obese. Some had MetS, central obesity, a moderate risk of cardiovascular disease, a low high-density lipoprotein (HDL) level, an altered fasting glucose level, prediabetes, or T2DM.

3.3. Intervention with MUFAs

The interventions proposed by the analysed studies are detailed in Table 1. The main interventions were supplementation with extra virgin olive oil or nuts, MUFA-rich diets including different sources of vegetable oils, and/or a Mediterranean diet.

4. DISCUSSION

This systematic review explores the effects of MUFA-rich diets on IR in adults and older individuals. In most of the included studies, improvements were observed in IR-related parameters (i.e. reduction in blood glucose, insulin, and HOMA-IR levels) after short- or long-term consumption of MUFA-rich diets; whereas the other studies did not report negative results, reinforcing the safety and importance of dietary MUFAs.

4.1. MUFA-rich diets from the consumption of extra-virgin olive oil

One study revealed that short-term extra virgin olive oil consumption, compared with a diet without olive oil consumption, resulted in a 20% decrease in postprandial serum glucose levels and a 40% increase in insulin levels among patients with impaired fasting glucose (Carnevale et al., 2017). The authors suggested that the inhibition of DPP-4 activity is a potential mechanism for GLP-1 and insulin upregulation. A study by D'Amore et al. (2016) showed improved blood glucose and insulin sensitivity after short-term consumption of high-polyphenol extra virgin olive oil versus low-polyphenol extra virgin olive oil in individuals without MetS. Polyphenol-rich oil also promoted the transcription of genes and miRNAs involved in anti-inflammatory responses and energy homeostasis. Interestingly, these effects were partially lost in patients with MetS and those consuming low-polyphenol extra virgin olive oil, highlighting the importance of the phenolic fraction and the individual's health status. In another two studies involving olive oil supplementation, Valente et al. (2018) did not observe any effects of short-term consumption of extra virgin olive oil versus coconut oil in overweight women and Galang et al. (2020), in a randomized controlled crossover trial, identified significantly increased postprandial glucose levels in patients with type 2 diabetes mellitus, after adding a tablespoon of extra-virgin olive oil.

4.2. MUFA-rich diets from the consumption of nuts

Three studies which examined the effects of nut consumption were included in this review. Hernández-Alonso et al. (2017) observed that a 4-month pistachio-enriched diet positively modulated the expression of some insulin sensitivity-related miRNAs in pre-diabetic individuals. In contrast, Liu et al. (2017) did not observe any effects of short-term peanut consumption on glycaemic and insulin responses

TABLE 1. Characteristics of studies included in the systematic review

Studies	Country	Design	Population	Duration of intervention	Intervention with MUFA	Secondary intervention/control	Results with MUFA related to insulin resistance
Carnevale et al. (2017)	Italy	RCTC	30 women and men	1 day per intervention	Meal with 10g of EVOO	Control meal without EVOO	↓ of postprandial glucose and DPP-4 activity and ↑ insulin and GLP-1
D'Amore et al. (2016)	Italy	CT	24 women and men	1 day per intervention	50ml of high-polyphenols EVOO	50ml of low-polyphenols EVOO	Low-polyphenols EVOO: ↑ glucose and insulin sensitivity; transcription of genes and miRNAs involved in anti-inflammatory responses and energy homeostasis
Valente et al. (2018)	Brazil	Single-blind RCTC	15 women	1 day per intervention	Breakfasts with 25mL of EVOO	Breakfasts with 25mL of virgin coconut oil	No significant effect between the diets
Galang et al. (2020)	Philippines	RCTC	13 women and men	1 day per intervention	Standard breakfast with one tablespoon of EVOO	Standard breakfast without EVOO	↑ postprandial glucose levels
Hernández-Alonso et al. (2017)	Spain	RCTC	49 women and men	4 months per intervention	Pistachio-supplemented diet (57 g/day of pistachios)	Isocaloric control diet	↓ circulating miR-192 and miR-375 were positively correlated with glucose, insulin and HOMA-IR
Liu et al. (2017)	Australia	RCTC	15 men	1 day per intervention	Peanut meal (shake) with 85 g of ground peanuts	Control meal (shake) matched for energy and macronutrient content	No significant effect between the diets
Abbaspour et al. (2019)	USA	RPACT	48 women and men	8 weeks	42.5 g of mixed nuts	69 g of pretzels without salt	↓ glucose ↓ insulin ↓ weight
Montserrat-de la Paz et al. (2018)	Spain	RCTC	16 men	1 day per intervention	Fatty meal with MUFA (refined olive oil) + Niacin; Fatty meal with MUFA + n-3 PUFA (refined olive oil + fish oil with EPA and DHA) + Niacin	Fatty meal with SFA (milk cream) + Niacina; No fat meal + Niacina	↑ insulin secretion (HOMA-β) ↓ HOMA-IR Smaller postprandial C-peptide
Luis et al. (2017)	Spain	RCT	361 women and men	3 months	High MUFA hypocaloric diet (46.0% CHO, 34.4% FA, 19.6% PTN), including virgin olive oil	High PUFA hypocaloric diet (45.9% CHO, 34.3% FAT, 19.8% PTN), including sunflower oil	↓ Insulin and HOMA-IR in the AA group (wild-type group)
Lago et al. (2016)	Brazil	RCT	18 women	45 days	Rich MUFA-diet (15% of MUFA and 10% of PUFA)	Rich PUFA-diet (15% of PUFA and 10% of MUFA)	↓ fasting glucose; insulin and HOMA-IR in the MUFA-diet group
Chang et al. (2018)	Malaysia	Double-blind RCTC	30 women and men	1 day per intervention	High-fat meal with 50.9 g of high oleic sunflower oil (MUFA)	Meal 1: high-fat meal with 50.9g of palm oil (SFA); Meal 2: high-fat meal with 50.9g of sunflower oil (PUFA); Meal 3: Low-fat/high-sucrose	Low-fat/high-sucrose meal induced a greater response for GLP-1, C-peptide, insulin and glucose
Chang et al. (2016)	Malaysia	RCTC	47 women and men	6 weeks per intervention	High-fat diet rich in MUFA (49g sunflower oil with 20% MUFA) + Test meal with 51 g fat	High-fat diet rich in SFA + Trial meal containing 51 g of fat; Control diet rich in CHO + Test meal with 21 g of fat	Lower curve and peak of C-peptide, insulin and glucose with MUFA-rich meal compared to the control diet
Vafeiadou et al. (2015)	United Kingdom	Single-blind RCT	195 women and men	16 weeks	High MUFA diet (refined olive oil and olive oil/rapeseed oil blended spread)	High SFA diet (butter); High n-6 PUFA diet (safflower oil and spread)	No significant effect among the diets
Brassard et al. (2017)	Canada	RCTC	64 women and men	4 weeks per intervention	High MUFA diet (refined olive oil)	High SFA diet (cheese); High SFA diet (butter); High PUFA diet (corn oil); Low-fat/high-CHO	No significant effect among the diets
Maiorino et al. (2016)	Italy	RCT	215 women and men	1 year	Mediterranean diet (<50% CHO and > 30% FAT), with 30–50 g of olive oil	Low-fat diet with < 30% FAT and < 10% SFA	↓ HOMA-IR
Maiorino et al. (2017)	Italy	RCT	201 women and men	5.2 years	Mediterranean diet (<50% CHO and > 30% FAT), with 30–50 g of olive oil	Low-fat diet with < 30% FAT and < 10% SFA	↓HbA1c ↓HOMA-IR

↓: reduction; ↑: increase; DPP-4: dipeptidyl-peptidase-4; EVOO: extra virgin olive oil; GLP-1: glucagon-like peptide-4; RCT: Randomized Clinical Trial; RCTC: Randomized Clinical Trial Crossover; RPACT: Randomized, Parallel-arm Controlled Trial; CT: Fatty Acids; FA: Fatty Acids; MUFA: Monounsaturated Fatty Acids; PUFA: Polyunsaturated Fatty Acids; SFA: Saturated Fatty Acids; CHO: Carbohydrate; PTN: Protein.
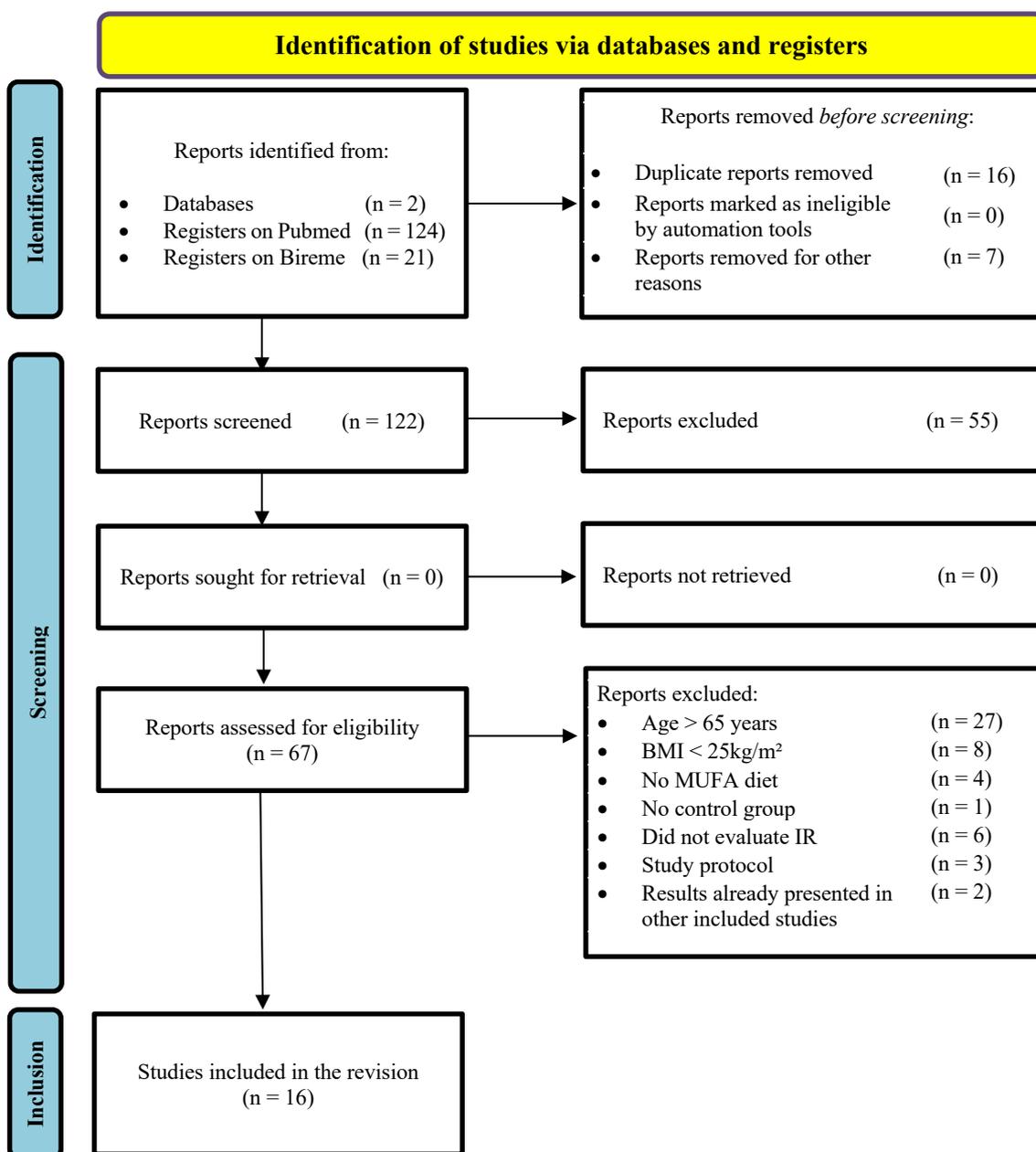
FIGURE 1. PRISMA Flow Diagram detailing the database searches, the number of abstracts screened and the full texts retrieved. BMI: Body Mass Index; MUFA: Monounsaturated Fatty Acids; IR: Insulin Resistance

in overweight individuals. Unlike previous studies, Abbaspour *et al.* (2019) reported blood glucose and insulin level reductions in overweight individuals after an 8-week diet with mixed-nut supplementation. This beneficial effect on glycaemic control can be attributed, in part, to the replacement of carbohydrates by MUFAs. Notably, the proteins and fibers contained in nuts can also contribute to this hypoglycaemic effect (Azzout-Marniche *et al.*, 2014; Weickert and Pfeiffer, 2008). Another finding of this study was

body weight reduction in the nut consumption group (Abbaspour *et al.*, 2019). According to Qian *et al.* (2016), the effects of a MUFA-rich diet on metabolic risk factors may be partially mediated by changes in body weight. The introduction of a variety of nuts to the diet is interesting, as it can prevent food monotony and maintain consumption. In addition, nuts differ in their nutrient and bioactive compound contents; thus, a combination of nuts provides a greater range of health benefits (Abbaspour *et al.*, 2019).

4.3. MUFA-rich diets including different sources of vegetable oils

Seven studies on MUFA-rich diets using different vegetable oil sources were included in this systematic review. Montserrat-de la Paz *et al.* (2018) evaluated the effects of a short-term diet with the three meals containing different sources of fat (saturated fatty acids [milk cream], MUFAs [refined olive oil], MUFAs plus n-3 PUFAs [refined olive oil plus fish oil with EPA and DHA], and no-fat meals) among individuals with MetS. All meals were supplemented with 2 g of niacin. Compared to meals containing saturated fatty acids, meals containing MUFAs improved glycaemia and postprandial insulinaemia and increased C-peptide levels, and showed greater insulin production. The same group of researchers previously demonstrated that the nature of dietary fats in meals influences postprandial triglyceride levels and the control of insulin secretion and sensitivity among individuals with normal or elevated fasting triglyceride levels (López *et al.*, 2008; Lopez *et al.*, 2011). The results of these studies showed improved postprandial beta-cell function and lower IR when the proportion of MUFAs versus that of saturated fatty acids in the diet was increased (Lopez *et al.*, 2011; López *et al.*, 2008).

In a study by Luis *et al.* (2017), obese participants consumed a high-MUFA hypocaloric diet (including virgin olive oil) or a high-PUFA hypocaloric diet for 3 months. In the high-MUFA hypocaloric diet group, individuals with the AA genotype (wild type) showed a reduction in insulin and HOMA-IR levels. This result shows that a single nucleotide polymorphism (SNP) in the brain-derived neurotrophic factor gene (rs10767664 variant) modifies IR after weight loss following a high-MUFA hypocaloric diet. However, the effect of dietary fat composition on the metabolic parameters related to this SNP remains unclear.

Another study which compared the effects of a MUFA-rich diet *versus* a PUFA-rich diet for 45 days in obese women (BMI > 35kg/m²) was conducted by Lago *et al.* (2016). Although the authors did not identify the MUFA and PUFA sources used, they emphasized that the diet was individualized and had a caloric restriction of about 500 to 1000 kcal per day. At the end of the study, no statistical differences were observed when comparing the PUFA-rich diet and the MUFA-rich diet, but the intragroup evalua-

tion showed a drop in the level of fasting glucose, insulin levels and HOMA-IR, in the MUFA-rich group. These results suggest that the MUFA-rich diet was more efficient in reducing insulin resistance in the studied population.

Two studies did not show the potential benefit of MUFAs versus other fatty acids on IR; however, a high-carbohydrate diet produced interesting results. Chang *et al.* (2018) compared the effects of replacing 7% of one's dietary energy with carbohydrates (simple sugar supplied as sweetened drinks), MUFAs (high-oleic sunflower oil blend), or saturated fatty acids (palm oil) for 6 weeks in individuals with abdominal obesity. The use of MUFAs or saturated fatty acids had no differential impact on glucose and insulin homeostasis and gastrointestinal peptides (GLP-1, GIP, ghrelin, PYY, and CCK) in the fasting or postprandial periods. The diet with refined carbohydrates had greater adverse effects on insulin secretion. In another study, Chang *et al.* (2016) evaluated individuals with MetS who consumed high-fat meals (enriched with saturated fatty acids, MUFAs [high-oleic sunflower oil], or n-6 PUFAs) or low-fat/high-sucrose meals. The short-term consumption of fatty acids (saturated fatty acids, MUFAs, and n-6 PUFAs) resulted in similar insulin, glucose, and C-peptide responses over time (Chang *et al.*, 2016). Compared to high-fat meals (regardless of the fatty acid type), the low-fat/high-sucrose meal induced a greater response for C-peptide (45%), insulin (45%), and glucose (49%).

Two other studies also showed no benefit of MUFAs versus other fatty acids on IR, but positive results were observed for MetS-related parameters. Vafeiadou *et al.* (2015) evaluated the effects of the consumption of three isoenergetic diets rich in saturated fatty acids (butter), MUFAs (refined olive oil and olive oil/rapeseed oil blended spread), or n-6 PUFAs (safflower oil and spread) for 16 weeks in individuals with a moderate cardiovascular disease risk. Replacing saturated fatty acids with MUFAs attenuated nocturnal systolic blood pressure. Regarding the patients' fasting lipid profiles, replacing saturated fatty acids with MUFAs or n-6 PUFAs reduced the total (28.4% and 29.2%, respectively) and low-density lipoprotein (LDL) (211.3% and 213.6%, respectively) cholesterol levels, and the total cholesterol to HDL cholesterol ratio (25.6% and 28.5%, respectively), without significant differenc-

es between MUFAs and n-6 PUFAs. Brassard *et al.* (2017) evaluated individuals with abdominal obesity and low HDL cholesterol levels who consumed five isoenergetic diets, each for 4 weeks: 1) rich in saturated fatty acids (cheese), 2) rich in saturated fatty acids (butter), 3) rich in MUFAs, 4) rich in PUFAs, and 5) low-fat, high-carbohydrate. Compared to the diets rich in saturated fatty acids (cheese or butter), the diet rich in MUFAs reduced LDL and the total cholesterol to HDL cholesterol ratio.

4.4. Mediterranean diet

Two studies included in the review evaluated the effects of a Mediterranean diet in patients with T2DM, and long-term follow-ups showed benefits in terms of IR. The Mediterranean diet is one of the most widely described and evaluated diets in scientific literature. It is characterized by a high intake of nuts, vegetables, legumes, fruits, grains, fish, seafood, and extra virgin olive oil and a moderate intake of red wine (Schwingshackl *et al.*, 2020). A large body of observational and experimental evidence suggests that greater adherence to the Mediterranean diet is related to glucose homeostasis, with an emphasis on reduced IR (Roldan *et al.*, 2019; Vitale *et al.*, 2018; Park *et al.*, 2017; Zhong *et al.*, 2016). This beneficial effect is probably related to its contents of MUFAs; PUFAs; fiber; and bioactive compounds such as polyphenols, vitamins, and minerals which result in anti-inflammatory and anti-oxidant actions, GLP agonists, and changes in the intestinal microbiota (Schwingshackl *et al.*, 2020; Martín-Peláez *et al.*, 2020). The PREDIMED study showed that adherence to a Mediterranean diet enriched with either an average of 50 mL/day of virgin olive oil or 30 g/day of nuts for 5 years, compared with a low-fat diet, in participants with MetS decreased xanthine oxidase activity and increased plasma superoxide dismutase and catalase activities (Sureda *et al.*, 2016). Notably, the unique actions of different nutrients or compounds and their derived metabolites can be enhanced by interactions and synergies, making the Mediterranean diet an invaluable tool for the prevention and control of metabolic diseases (Tosatti *et al.*, 2021; Martín-Peláez *et al.*, 2020).

4.5. Limitations

Although this systematic review supports the beneficial role of MUFAs in IR, whether these effects are a primary or secondary outcome of the improvement in obesity-associated chronic inflammation and oxidative stress remain unclear. Another limitation is the diversity of the included publications. Heterogeneity in study characteristics is common in nutritional intervention studies. Therefore, unsurprisingly, the studies selected for the present analysis varied with regard to the type of diets, definition of MUFA-rich diets, study population, intervention duration, and long-term follow-up protocols.

Another consideration is the variation in MUFA levels in the articles reviewed. Use of different MUFA doses is a relevant factor that may have influenced the results. Most dietary guidelines for MUFA consumption are based on the subtraction of recommended saturated and polyunsaturated fat intakes from the total fat intake rather than on evidence for the optimal level of MUFA intake (Liu *et al.*, 2017). A few guidelines have specified quantitative recommendations for MUFA intake, ranging from 10 to 25% of the total caloric value of the diet (Schwingshackl *et al.*, 2021; Sociedade Brasileira de Cardiologia, 2017). Thus, when considering an average requirement of 2000 kcal/day, the minimum recommendation of 10% is equivalent to 22 g of MUFAs. On a daily basis, this MUFA content can be achieved by consuming approximately 27 mL of extra virgin olive oil (Jimenez-Lopez *et al.*, 2020), 67 g of almonds (NEPA, 2011), or 37 g of macadamia nuts (Kris-Etherton, 1999), regardless of food sources.

5. CONCLUSIONS

Our systematic review showed that some improvement in IR-related parameters was observed in most of the evaluated studies, despite the diversity of MUFA interventions, doses, and outcomes. Therefore, individuals with IR may benefit from the consumption of extra virgin olive oil, nuts, a MUFA-rich diet including different sources of vegetable oils, or a Mediterranean diet. However, further studies are necessary to establish dose recommendations.

DISCLOSURE

All authors declare no conflicts of interest regarding the contents of this article.

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