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REVIEW ARTICLE



Efficacy of the Mediterranean Diet for Visceral Fat Reduction and Metabolic Health: A Systematic Review

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Abstract

This systematic review examines the impact of the Mediterranean diet (MD) on weight management and metabolic health, drawing from a comprehensive analysis of relevant literature. The review encompasses diverse studies, including variations like the Green-Mediterranean diet, to provide a nuanced understanding of the MD's versatility and effectiveness across different populations and contexts. Findings reveal consistent reductions in abdominal fat, improvements in cardiovascular risk factors, and a lower risk of diabetes among individuals adhering to the MD. Additionally, the MD demonstrates cardiometabolic benefits, highlighting its role in cardiovascular disease prevention and mitigating diabetes risk. Distinct metabolic profiles observed between metabolically healthy and unhealthy obese individuals underscore the importance of dietary patterns, particularly the MD, in modulating metabolic health outcomes. The emergence of the Green-Mediterranean diet as a promising intervention for reducing intrahepatic fat and mitigating non-alcoholic fatty liver disease prevalence aligns with broader health and ecological objectives. Furthermore, the MD improves diet quality and adipose tissue distribution, indicating its comprehensive impact on health. While the review acknowledges limitations such as study heterogeneity and limited long-term data, it underscores the MD as a viable and holistic strategy for sustainable weight management and improved metabolic health. Future research should aim for standardized protocols and longer follow-up durations to enhance understanding of the MD's long-term benefits.

Key words: Metabolic Health, Mediterranean, cardiovascular, abdominal, emergence

1 | INTRODUCTION

The detrimental implications of abdominal fat, particularly visceral fat tissue (VAT), on health outcomes such as obesity, cardiovascular diseases (CVD), hypertension (HTN), type 2 diabetes (T2D), and other metabolic disorders, underscore the need for effective interventions. An approach to fat loss involves a low-fat diet, which did not demonstrate any cardiovascular advantages (Temporelli P. L. 2023; Salas-Salvadó et al. 2019; Dinu, M., et al. 2021) approach to weight loss is limiting carbohydrate intake. However, low-carbohydrate diets typically contain high levels of saturated fat, lack fiber and essential minerals, and

are linked to elevated LDL cholesterol. According to a recent study, elevated levels of LDL cholesterol (LDL-C) at or above 130 mg/dL are significantly associated with increased risks of all-cause mortality and cardiovascular disease (CVD) (Peng, K. et al. 2022; Salas-Salvadó et al. 2019; Mathieu, S., et al. 2023). Additionally, their effectiveness in reducing weight tends to diminish after 12 months. Another nutrition strategy is the Mediterranean Diet (MD) which serves as a viable alternative to both low-fat and low-carbohydrate diets for weight loss. In this paradigm, the emphasis lies not only on the quantity but more on the quality of fats and carbohydrates (Salas-Salvadó et al. 2019; Agnoli, C, et al. 2018; Best, N., & Flannery, O. 2023; Jaacks, L.

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M., et al. 2018; Mathieu, S., et al. 2023).CVD and various other metabolic disorders. This process is influenced by various mechanisms, including lowering mild inflammation, enhancing endothelial function, and reducing oxidative stress (Castro-Barquero et al. 2018; Sofi, F. et al. 2018; García-Montero, C., et al. 2021;Nani, A., et al 2021; Mathieu, S., et al. 2023). In addition, the MD is a valuable source of vitamins, minerals, antioxidants, mono- and polyunsaturated fatty acids, and fiber, offering a diverse array of health advantages (Vitale, M. 2018; Nani, A., et al 2021;Galmes-Panades et al. 2019; Castro-Barquero et al. 2018; Papadaki, A. 2020; Carlos, S. 2018; Nani, A., et al 2021; Dinu, M., et al. 2021).

The specific focus of this study was to investigate how the Mediterranean diet impacts fat reduction in adults, with an emphasis on its effects on abdominal fat. Abdominal fat, including visceral fat, is known to elevate the risk of numerous health complications, including insulin resistance, CVD, obesity, hypertension, and type 2 diabetes (Rees, K., Takeda et al. 2019; Sofi, F. et al. 2018; Mirabelli, M. 2020; Papadaki, A. 2020; Agnoli, C, et al. 2018; Dinu, M., et al. 2021). Assessing the efficacy of the Mediterranean diet in decreasing abdominal fat holds significant implications for healthcare practitioners and individuals pursuing weight management through dietary interventions.

While individual studies displayed a positive association between adopting the Mediterranean diet and reducing body fat, a comprehensive evaluation through a systematic review is necessary. This study aimed to fill in gaps in existing knowledge by combining evidence and offering insights into how the Mediterranean diet affects the reduction of fat in adults and improving metabolic health. Top of Form

2 | METHODS

This systematic review used the framework of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) to evaluate qualitative data concerning the effects of a Mediterranean diet on visceral fat and metabolic factors. (Page MJ, et al. 2021). This protocol served as a blueprint, encompassing the study design, methodology, pre-defined outcome measures, and a statistical analysis plan.

2a. Protocol and Registration

A detailed study protocol was developed and registered with The International Prospective Register of Systematic Reviews (PROSPERO-CRD42023443886.

The registration ensured methodological transparency, minimized reporting biases, and upheld the scientific rigor of the systematic review.

2b. Search Strategy

A rigorous search strategy was deployed to identify studies exploring the effects of the Mediterranean diet on abdominal fat reduction. Key databases, including PubMed and Google Scholar, were utilized six years (2018-2024). The search strategy encompassed chosen keywords such as "Mediterranean diet," "abdominal fat," "visceral fat," and related terms; see Table 1 for the complete list. Additionally, manual searches of reference lists from retrieved articles and relevant systematic reviews were conducted to find potential additional studies of significance.

Table 1 Key Terms Describing the Topic Elements

Key Words MeSH Terms to describe the population	Key Words MeSH Terms to describe the intervention	Key Words MeSH Terms to describe the outcome
Adults	Mediterranean Diet	Fat loss
Middle-aged individual	Mediterranean	Abdominal fat
Elderly		Visceral fat
		Visceral fat reduction

2c. Eligibility Criteria

Eligibility criteria are outlined in Table 2. This systematic review considered studies involving adults aged 18 years and older who exhibited abdominal fat or abdominal obesity. The primary focus of the review was on interventions related to the Mediterranean diet and their impact on reducing abdominal fat. Consequently, studies assessing the effects of the Mediterranean diet specifically for abdominal fat reduction were included. The desired outcome for inclusion was studies that reported data on changes in abdominal fat or visceral fat. The review encompassed all types of study designs to comprehensively explore the existing evidence.

The systematic review excluded studies involving children, adolescents, men, and women who did not exhibit abdominal fat or abdominal obesity. Studies that evaluated dietary interventions other than the Mediterranean diet or interventions unrelated to abdominal fat were also excluded. Additionally, studies lacking relevant outcome data related to abdominal fat were not considered for inclusion. The inclusion criteria specified that only studies published in the English language were incorporated, ensuring a consistent and manageable scope for analysis.

Table 2: Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Age	Adults (18 years and older)	Children and adolescents
Gender	Men and women	None
Setting / Country	No specific restrictions	None
Health Status / Problem / Condition	Individuals with belly fat or abdominal obesity	None
Intervention / Exposure	Studies evaluating the Mediterranean diet as an intervention for belly fat loss	Other dietary interventions or unrelated interventions
Outcome	Studies evaluating the Mediterranean diet as an intervention for belly fat loss	No relevant outcome reported
Study Design Preferences	All study designs	None
Size of Study Groups:	Typically, at least 30 participants in	Studies with very small sample

Typically, at least 10 in each study group.	each study group	sizes (less than 30 participants per group)
Language Indicate if limited to articles in English	English	Studies in languages other than English
Publication Year Range Limit to past 5 years (if longer – provide rationale)	(Last 6 years (2018-2024	Studies published before 2018
OTHER (if applicable) specify	None	Specify any additional criteria if necessary

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2d. Data Extraction and Quality Assessment

Utilizing a standardized data extraction form

The systematic review employed an established tool for quality and risk of bias assessment, including the Cochrane Collaboration's Risk of Bias Tool for randomized controlled trials (RCTs) (Higgins, J. P. T. 2011). Rigorous evaluation using the Academy of Nutrition and Dietetics Evidence Analysis Library aimed to ensure the methodological soundness and internal validity of the studies included in the systematic review (ANDEAL, 2022).

3 | RESULTS

The systematic review emphasizes the beneficial impact of the Mediterranean diet on weight management and metabolic health. A comprehensive analysis of diverse studies showcases reductions in abdominal fat, improvements in cardiovascular risk factors, and enhanced metabolic parameters. The findings underscore the Mediterranean diet's potential as a holistic approach to promot-

Impact of Mediterranean Diet on Health Parameters:

The intervention group, which followed the Mediterranean Diet (MD), showed significant improvements compared to the control group in various health parameters (Salas-Salvadó, et al. 2019; Sofi, F, et al 2018; Vitale, M, et al. 2018; Poráčová, J, et al 2022; Benítez-Arciniega, A., et al. 2014; Mathieu, S., et al. 2023). After six months, the intervention group demonstrated a substantial reduction in waist circumference (-2.1 cm, $p < 0.001$) and fasting glucose levels (-0.21 mmol/L, $p = 0.02$). At the 12-month mark, the intervention group continued to exhibit favorable outcomes, with significant reductions in waist circumference (-2.5 cm, $p < 0.001$), fasting glucose levels (-0.35 mmol/L, $p = 0.01$), insulin levels (-18.8 pmolp = 0.002), HOMA-IR index (-1.09, $p < 0.001$), total cholesterol/HDL cholesterol ratio (-0.19, $p = 0.001$), and triglyceride/HDL cholesterol ratio (-0.19, $p = 0.001$). led to significant reductions in various key health indicators among participants: Bpg/mL, $p < 0.05$).pgpgp<0.05)(Salas-SalvadóMeslier, V. et

ing health and preventing chronic diseases. Comparisons with alternative dietary interventions provide valuable insights into its distinct advantages for sustainable weight management and metabolic health improvements. Figure 1 shows the PRISMA flowchart. The PRISMA flowchart outlines the systematic process employed for the identification and inclusion of relevant studies in a review (Page MJ, et al. 2021) PubMed and Google Scholar. Following the removal of duplicate records, 290 unique records remained for screening. Subsequently, 112 records were excluded during the screening process, leaving 178 records for further evaluation. Among these, 128 reports were identified for retrieval, indicating potential relevance to the study's objectives. Upon assessing the eligibility of these reports, 40 were deemed ineligible based on predefined criteria. Ultimately, 45 studies were included in the review after meeting the criteria for relevance and suitability. Each of these included studies underwent thorough analysis, resulting in the generation of reports for each of them.

Figure 1: PRISMA Flow Chart

al. 2020; Richard, C, et al. 2012; Agnoli, C, et al. 2018 Shatwan, I. M., et al. 2021; Benítez-Arciniega, A., et al. 2014; Jaacks, L. M., et al. 2018; Mathieu, S., et al. 2023). The MD demonstrated significant improvements in various health parameters, including reductions in waist circumference, fasting glucose levels, HbA1c levels, insulin levels, lipid ratios, body weight, BMI, fat mass, LDL cholesterol, and oxidative stress. Additionally, it showed favorable effects on interleukin-17 levels. Overall, these findings suggested that adherence to the MD can lead to notable improvements in metabolic health and inflammation markers, highlighting its potential as a beneficial dietary approach.

Cardiometabolic Effects of Mediterranean Diet Intervention:

Following a two-month intervention period, individuals adhering to the MD demonstrated significant enhancements in endothelial function, as evidenced by a notable increase in flow-mediated dilatation (FMD). The findings, along with favorable changes in dietary intake and blood pressure levels, highlight the potential cardiovascular benefits associated with

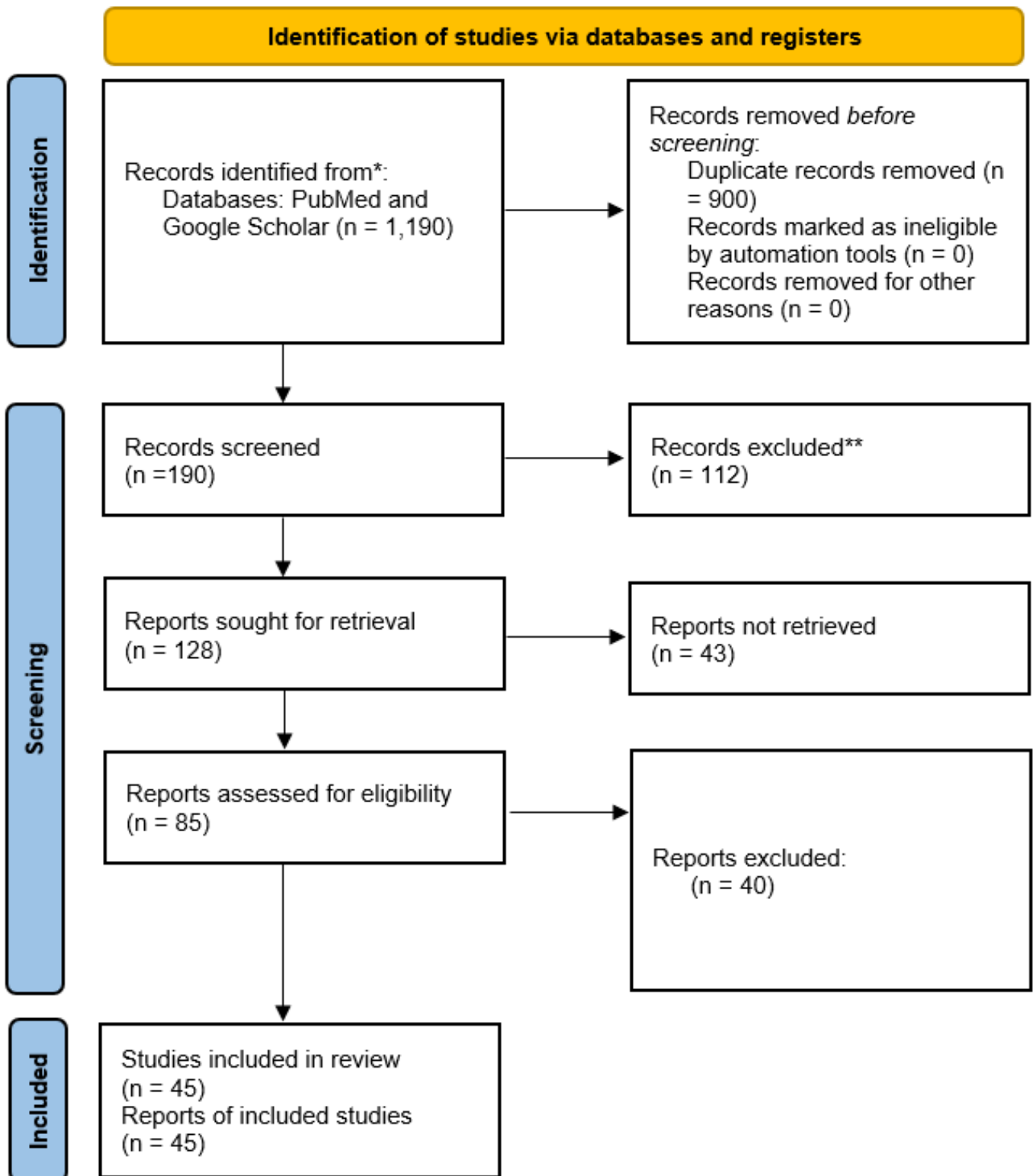


Fig. 1:

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this dietary pattern. associated with this dietary pattern (Papadaki, A. 2020; Carlos, S, et al. 2018; Bajerska, J. 2018; Rees, K., et al. 2019; Lăcătușu, C. M., et al 2019; Mathieu, S., et al. 2023). After two months, significant (p) increased intake of total fat, monounsaturated fatty acids, dietary fiber, and vitamin C compared to the control group. Changes in lipids and C-reactive protein (CRP) concentrations differed significantly (p) in the intervention group (-6.44 mm Hg; 95% CI: -8.57, -4.31 mm Hg) compared to the control group (-0.76 mm Hg; 95% CI: -2.83, 1.31 mm Hg) (Rallidis, L. S, et al. 2018). There was also a trend for a significant (reduction in insulin resistance, as measured by the homeostasis model assessment (HOMA-IR), in the intervention group compared to the control group (Bajerska, J. 2018; Rees, K., et al. 2019). In summary, adherence to the Mediterranean Diet for two months resulted in significant improvements in endothelial function, dietary intake, blood pressure levels, lipid profiles, and inflammation markers, underscoring its potential for cardiovascular health promotion.

Mediterranean Diet and Diabetes Risk:

The MD emerges as a powerful protective factor against new-onset diabetes, with higher adherence levels significantly associated with a lower risk of developing the condition, highlighting its preventive potential, and underscoring the importance of dietary patterns in diabetes risk mitigation (Buchanan, A., & Villani, A. 2021 Vitale, M, et al. 2018 Poulimeneas D, et al. 2020). Individuals with higher adherence to the MD displayed a significantly (p<0.0001) lower risk of new-onset diabetes, with a 16% reduction compared to those with the lowest adherence (Vitale, M, et al. 2018). Additionally, adherence to the showed an inverse association with the risk of new-onset diabetes. Notably, a significant 2-diabetes (p=0.038), emphasizing the preventive potential of this dietary pattern in mitigating diabetes risk (Vitale, M, et al. 2018 Poulimeneas, D, et al. 2020). The Mediterranean Diet emerged as a potent protective factor against new-onset diabetes, with higher adherence levels significantly reducing the risk of developing the condition, thus emphasizing its preventive potential and the crucial role of dietary patterns in mitigating diabetes risk.

Metabolically Healthy Obese (MHO) vs. Metabolically Unhealthy Obese (MUO):

The prevalence of metabolically healthy obese (MHO) individuals and their distinct metabolic profiles revealed significant associations with age, BMI, visceral adipose tissue (VAT), and adherence to the Mediterranean diet, shedding light on the potential role of dietary patterns in mitigating metabolic health risks among obese populations (Leone, A, et al. 2022; Panizza, C. E. et al. 2019; Sánchez, M, et al. 2019; Galmes-Panades 2019 Shatwan, I. M., 2021; Tussing-Humphreys, L., et al. 2022; Mathieu, S., et al. 2023)

In this study, 21.2% of women were classified as metabolically healthy obese (MHO) metabolically unhealthy obese (MUO) (p<0.001) (Sánchez, M, et al. 2019; Galmes-Panades 2019 Shatwan, I. M., 2021). MHO women exhibited lower ultrasound-estimated visceral adipose tissue (VAT) of 145.7 cm³ (MHO) versus 198.4 cm³ (MUO), higher fat-free mass (FFM) of 54.8 kg (MHO) compared to 50.3 kg (MUO), and higher ultrasound-estimated subcutaneous adipose tissue (SAT) of 243.1 cm³ (MHO) versus 212.5 cm³ (MUO) (Leone, A, et al. 2022 Panizza, C. E. et al. 2019). Adherence to the Mediterranean diet was not significantly (p=0.068) different between the two groups, and overall adherence was observed in only 11.6% of the women. Postmenopausal women adhering to the Mediterranean diet had a 45% lower risk of MUO (Odds Ratio [OR] = 0.55, 95% Confidence Interval [CI]: 0.31; 0.96), while no significant (p=0.2022; Panizza, C. E. et al. 2019; Tussing-Humphreys, L., et al. 2022). The study findings highlighted the distinct metabolic profiles of metabolically healthy obese (MHO) individuals compared to metabolically unhealthy obese (MUO) individuals, with age, BMI, visceral adipose tissue (VAT), and adherence to the Mediterranean diet playing significant roles. Additionally, postmenopausal women adhering to the Mediterranean diet showed a substantially lower risk of MUO, underlining the potential of dietary patterns in influencing metabolic health among obese populations, particularly in specific demographic groups.

Green-MED Diet Impact on IHF% Loss and NAFLD:

The Green-Mediterranean (Green-MD) diet emerged as a potent intervention for reducing intrahepatic fat (IHF%) and mitigating the prevalence of non-alcoholic fatty liver disease (NAFLD), as evidenced

by its superior outcomes compared to the Mediterranean (MD) and High Dietary Guidance (HDG) groups, underscored by significant IHF loss and distinct changes in biomarkers and microbiome composition (Yaskolka Meir, et al. 2021; Zelicha, H, et al. 2021). The Green-Mediterranean (Green-MD) diet places a strong emphasis on consuming plant-based foods like fruits, vegetables, whole grains, nuts, seeds, legumes, and olive oil, while decreasing the intake of animal products (Yaskolka Meir, et al. 2021; Zelicha, H, et al. 2021; Muscogiuri, G, et al. 2022; Castro-Barquero, S, et al. 2018). Considering the environmental consequences of food production and consumption, the Green-MD diet achieved a 4.8% IHF loss (Green-MD; $p < 0.05$) compared to 2.6% (MD) and 2.4% (HDG). NAFLD decreased to 31.5% in the Green-MD group, contrasting with 47.9% in the MD group and 54.8% in the HDG group. The Green-MD group also showed higher total plasma polyphenol levels and specific changes in biomarkers and microbiome composition associated with IHF loss (Yaskolka Meir, et al. 2021; Zelicha, H, et al. 2021; 2018). Therefore, the Green-Mediterranean (Green-MD) diet demonstrated significant efficacy in reducing intrahepatic fat (IHF%) and lowering the prevalence of NAFLD, suggesting its potential as a promising dietary intervention for improving liver health and overall metabolism.

Mediterranean Diet and Diet Quality Improvements:

The Mediterranean-style diet score (MDS) emerged as a crucial determinant of adipose tissue distribution, with improvements in diet quality correlating significantly with reduced fat accumulation in visceral adipose tissue (VAT), subcutaneous adipose tissue (SAT), and pericardial adipose tissue (PAT), highlighting the potential of dietary interventions to modulate adiposity and cardiovascular risk (Galmes-Panades, A. M. 2019; Panizza, C, et al. 2019; Leone, A, et al. 2022; Hennein, R, et al. 2019; Poráčová, J, et al. 2022; Galilea-Zabalza, I, et al. 2018). Each standard deviation increase in MDS was linked to reductions of 50 cm³ in VAT, 52 cm³ in SAT, and 1.3 cm³ in PAT. No significant association ($p = 0.38$) was observed between genetic risk scores (GRSs) and changes in VAT or SAT. However, an increase in the PAT GRS was associated with a 1.2 cm³ increase in Δ PAT. Additionally, participants with a higher

PAT GRS and improved MDS had a more favorable change in PAT compared to those with no improvements in MDS (Leone, A; Hennein; Poráčová, J. et al. 2022). In summary, adherence to the Mediterranean-style diet score (MDS) was significantly associated with improved adipose tissue distribution, highlighting the potential of dietary interventions to positively influence adiposity and cardiovascular risk, independent of genetic predisposition.

Diverse Effects of Different Diets:

A comparative analysis of diverse dietary interventions elucidated their differential effects on weight loss and metabolic health parameters, revealing notable distinctions such as greater reductions in visceral adipose tissue (VAT), total fat mass, and alanine aminotransferase (ALT) levels in the Intermittent Energy Restriction Diet (a dietary approach that involves alternating periods of marked energy restriction with periods of normal or ad libitum energy intake) combined with Mediterranean Diet (IER+MD) group compared to the DASH group (Agnoli, C, et al. 2018; Panizza, C. E, et al. 2019; Gepner, Y, et al. 2021; Tussing-Humphreys, L., et al. 2022). The Mediterranean Diet, when combined with a Low-Carbohydrate (MD/LC) component, exhibited superiority in reducing hepatic fat content (HFC) compared to the Low-Fat (LF) diet, highlighting the nuanced impact of dietary composition on metabolic outcomes (Panizza, C. E, et al. 2019; Gepner, Y, et al. 2021).

The IER+MD significant ($p = 0.02$) reduction in Dietary Approaches to Stop Hypertension (DASH) diet. The Dietary Approaches to Stop Hypertension (DASH) diet is characterized by reduced amounts of saturated fat, total fat, and cholesterol, along with high amounts of fiber, protein, and some electrolytes (potassium, magnesium, and calcium) from fruits and vegetables. This dietary pattern emphasizes the consumption of fruits, vegetables, nuts, legumes, whole grains, and seafood, while limiting intake of red/processed meat and saturated fat (Wang, J. S., et al. 2022; Panizza, C. E, et al. 2019). The time-restriction (CD) diet groups. However, the CD group exhibited a significantly longer time below the glucose range of 3.9 mmol/L, indicating a higher risk of hypoglycemia than MD and TJD groups (Luo, Y, et al. 2022). The diet led to a significantly ($p = 0.036$) (Ditano-Vázquez, et

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al. 2019;Gepner, Y, et al. 2021).The comparative analysis of diverse dietary interventions highlights their varying impacts on weight loss and metabolic health parameters. Notably, the Intermittent Energy Restriction Diet combined with Mediterranean Diet (IER+MD) showed superior reductions in visceral adipose tissue (VAT), total fat mass, and alanine aminotransferase (ALT) levels compared to the Dietary Approaches to Stop Hypertension (DASH) diet. Additionally, the Mediterranean Diet combined with Low-Carbohydrate (MD/LC) component exhibited greater efficacy in reducing hepatic fat content (HFC) compared to the Low-Fat (LF) diet (Ditano-Vázquez, et al. 2019; Doe, J, et al. 2023; Gepner, Y, et al. 2021; Flor-Aleman, et al 2020))

Quality assessment/risk of bias

The quality assessment of the studies revealed varying degrees of bias across different domains. While some studies exhibited low risk in most areas, indicating robust methodology and reliable results, others showed moderate to high risk in certain domains, suggesting potential limitations in study design or conduct. Selection bias was a common concern, with several studies showing moderate to high risk in participant selection methods. Additionally, performance bias was evident in some studies, indicating possible biases introduced by participants or researchers' awareness of the assigned interventions. Detection bias, attrition bias, and reporting bias were also identified in a subset of studies, highlighting the need for improved outcome assessment methods, participant retention strategies, and transparent reporting practices. Table 3 includes the studies that were included and their major findings.

4 | DISCUSSION:

The findings of this systematic review highlighted the positive impact of the Mediterranean diet (MD) on weight management and metabolic health (Leone, A, et al. 2022; Panizza, C. E. et al. 2019; Sofi, F, et al 2018; Di Lorenzo, R, et al. 2017; Bos, M. B. 2019; Mirabelli, M., et al. 2020; Meslier, V. et al. 2020; Nani, A., et al 2021; Best, N., & Flannery, O. 2023). The observed reductions in abdominal fat, improvements in cardiovascular risk fac-

tors, and the association with a lower risk of diabetes displayed the potential of the Mediterranean diet as a holistic and effective dietary intervention. The inclusion of diverse studies, ranging from traditional Mediterranean diets to variations like the Green-Mediterranean diet, added depth to our understanding of the diet's versatility and applicability (Yaskolka Meir, et al. 2021; Zelicha, H, et al. 2021; Muscogiuri, G, et al. 2022; Castro-Barquero, S, et al. 2018).

Impact of the Mediterranean Diet on Health Parameters:

The results of this systematic review underscored the significant impact of the Mediterranean Diet (MD) on various health parameters, including weight management, metabolic health, and cardiovascular risk reduction (García-Montero, C., et al. 2021; Salas-Salvadó, et al. 2019; Sofi, F, et al 2018; Di Lorenzo, R, et al. 2017; Bos, M. B. 2019; Mirabelli, M., et al. 2020; Meslier, V. et al. 2020; Nani, A., et al 2021; Best, N., & Flannery, O. 2023; Shatwan, I. M., 2021; Dinu, M., et al. 2021; Jaacks, L. M., et al. 2018; Tussing-Humphreys, L., et al. 2022; Mathieu, S., et al. 2023). The findings highlighted consistent reductions in waist circumference, fasting glucose levels, insulin resistance, and lipid profiles among individuals adhering to the MD, indicating its comprehensive benefits for health. (Salas-SalvadóMeslier, V. et al. 2020; Richard, C, et al. 2012; Benítez-Arciniega, A., et al. 2014).

Cardiometabolic Effects of Mediterranean Diet Intervention:

Cardiometabolic benefits associated with the MD further supported its role in cardiovascular disease prevention. Enhancements in endothelial function, coupled with favorable changes in dietary intake and blood pressure levels, highlighted the MD's potential to reduce the risk of cardiovascular events (Lăcătușu, C. M., et al. 2019; Carlos, S, et al. 2018; Bajerska, J. 2018). These findings were consistent with previous research demonstrating the cardioprotective effects of the MD and its importance in cardiovascular health promotion (Carlos, S, et al. 2018; Bajerska, J. 2018; Rallidis, L. S, et al. 2018; Rees, K., et al. 2019; Mathieu, S., et al. 2023).

Mediterranean Diet and Diabetes Risk:

The preventive potential of the MD in mitigating dia-

betes risk is particularly noteworthy. Higher adherence to the MD was consistently associated with a reduced risk of new-onset diabetes, emphasizing the importance of dietary patterns in diabetes prevention. Given the rising prevalence of diabetes worldwide, interventions that target dietary factors, such as the MD, offered promising strategies for disease prevention and management (Vitale, M, et al. 2018; Poulimeneas, D, et al. 2020; Buchanan, A., & Viliani, A. 2021).

Metabolically Healthy Obese (MHO) vs. Metabolically Unhealthy Obese (MUO):

The distinct metabolic profiles observed between metabolically healthy obese (MHO) and metabolically unhealthy obese (MUO) individuals highlighted the role of dietary patterns, including the MD, in modulating metabolic health outcomes (Dinu, M., et al. 2021; Leone, A, et al. 2022; Panizza, C. E. et al. 2019; Sánchez, M, et al. 2019; Galmes-Panades, A, et al. 2019). Adherence to the MD was associated with a lower risk of metabolically unhealthy obesity, particularly among postmenopausal women, indicating its potential in improving metabolic health status among high-risk populations (Leone, A, et al. 2022; Panizza, C. E. et al. 2019; Sánchez, M, et al. 2019; Galmes-Panades, A, et al. 2019; Tussing-Humphreys, L., et al. 2022).

Green-MED Diet Impact on IHF% Loss and NAFLD:

Furthermore, the Green-Mediterranean (Green-MD) diet emerged as a promising intervention for reducing intrahepatic fat (IHF%) and mitigating non-alcoholic fatty liver disease (NAFLD) prevalence (Yaskolka Meir, et al. 2021; ZelichaMuscogiuri, G, et al. 2022)highlighted its potential in improving liver health and reducing the risk of NAFLD-related complications. In addition to its impact on intrahepatic fat (IHF%) loss and NAFLD prevalence, the Green-Mediterranean (Green-MD) diet's focus on plant-based foods and environmental sustainability aligned with broader health and ecological objectives, making it a holistic approach to dietary intervention (Yaskolka Meir, et al. 2021; ZelichaMuscogiuri, G, et al. 2022; Castro-Barquero, S, et al. 2018).

Mediterranean Diet and Diet Quality Improvements:

The Mediterranean diet (MD) played a crucial role

in determining adipose tissue distribution. Improvements in diet quality have been shown to correlate significantly with reduced fat accumulation in various adipose tissue compartments, including visceral adipose tissue (VAT), subcutaneous adipose tissue (SAT), and pericardial adipose tissue (PAT). This highlighted had been associated with substantial reductions in VAT, SAT, and PAT volumes, indicating a comprehensive impact on adipose tissue distribution. (Leone, A, et al. 2022; Hennein-Poráčová2022).

Diverse Effects of Different Diets:

A comparative analysis of diverse dietary interventions elucidated their differential effects on weight loss and metabolic health parameters, revealing notable distinctions such as greater reductions in visceral adipose tissue (VAT), total fat mass, and alanine aminotransferase (ALT) levels in certain dietary groups. (Ditano-Vázquez, et al. 2019; Doe, J, et al. 2023; Panizza, C. E, et al 2019; Gepner, Y, et al. 2021; Luo, Y, et al. 2022; Flor-Aleman, et al 2020; Tussing-Humphreys, L., et al. 2022). The findings underscored the importance of considering individual dietary preferences and metabolic characteristics when designing personalized dietary recommendations.

The Mediterranean Diet and the Academy of Nutrition and Dietetics:

The Academy of Nutrition and Dietetics (AND)revealedthe health benefits of the Mediterranean diet based on extensive research and expert analysis. Recognizing the evolution of research on this dietary pattern since the landmark Seven Countries Study in the 1950s, the AND acknowledged the consistent findings linking the Mediterranean diet to improved cardiovascular health and metabolic outcomes (AND, 2022). Through a comprehensive review, the AND identified common characteristics of the Mediterranean diet, including high intake of whole grains, fruits, vegetables, legumes, and olive oil, alongside limited meat consumption. This dietary pattern had been associated with reduced blood pressure, weight management, lower LDL cholesterol levels, and improved glycemic control, aligning with the AND's understanding of the Mediterranean diet as a heart-healthy eating pattern. Despite acknowledging potential barriers to adoption, such as cultural perceptions and

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limited knowledge, the AND emphasized the pivotal role of healthcare practitioners, particularly registered dietitian nutritionists, in providing evidence-based guidance and support to individuals seeking to integrate the Mediterranean diet into their lifestyle.

Strengths:

This systematic review stands out for its comprehensive approach, encompassing various health parameters, exploring different dietary variations, and incorporating diverse study designs. By adopting a holistic perspective, the review provided a nuanced understanding of the Mediterranean diet's impact on weight management and metabolic health. This inclusive methodology allows for a more thorough examination of the diet's effectiveness in diverse populations and contexts.

Rigorous quality assessment tools were applied, enhancing the reliability of the synthesized evidence. This commitment to methodological soundness ensured that the studies included in the review meet high standards, contributing to the overall robustness of the findings. By systematically evaluating the quality of each study, the review enhanced the credibility and validity of the conclusions drawn.

5 | LIMITATIONS:

One notable limitation of this systematic review was the inherent heterogeneity introduced by variability in study designs, participant demographics, and dietary interventions. This diversity made it challenging to establish uniform conclusions across all included studies. Recognizing the potential impact of this heterogeneity was crucial for interpreting the findings and emphasizing the need for caution in making broad generalizations.

The limited follow-up durations in some studies posed another constraint. These constraints may restrict the review's ability to capture the long-term sustainability and effects of the Mediterranean diet on weight management and metabolic health. Acknowledging this limitation emphasizes the importance of future research with extended follow-up periods to provide a more comprehensive understanding of the diet's lasting impact.

Despite efforts to minimize reporting biases, the pos-

sibility of publication bias remained a concern. Publication bias, if present, could influence the overall findings by selectively favoring studies with positive results.

Application for Practitioners:

In addition to emphasizing the benefits of the Mediterranean diet for weight management and metabolic health, healthcare practitioners should consider incorporating other key findings from this systematic review into their dietary recommendations. Firstly, highlighting the importance of high-quality fats, such as those found in olive oil and nuts, can help patients understand the role of healthy fats in their diet and dispel misconceptions about fat intake. Secondly, promoting diversity in nutrient intake, as encouraged by the Mediterranean diet's emphasis on a wide range of fruits, vegetables, whole grains, and legumes, can ensure patients receive a variety of essential vitamins, minerals, and antioxidants necessary for optimal health.

Moreover, practitioners should stress the positive associations between the Mediterranean diet and various health parameters, including improvements in cardiovascular risk factors, endothelial function, and glycemic control, to motivate patients to adhere to this dietary pattern. Additionally, individualization of dietary advice based on factors such as genetics, metabolic profile, and lifestyle preferences is crucial for long-term adherence and success. By tailoring recommendations to meet individual needs, healthcare practitioners can empower patients to make sustainable dietary changes that support their weight management and metabolic health goals.

Providing educational resources and support to help individuals follow the Mediterranean diet can enhance its adherence. Practitioners should also stay informed about variations like the Green-Mediterranean diet, recognizing their potential to offer specific benefits, such as enhanced intrahepatic fat loss.

6 | CONCLUSION:

In conclusion, this systematic review contributed valuable insights into the effectiveness of the Mediterranean diet for weight management and

improvements in metabolic health. The diverse range of studies included strengthens the evidence supporting the positive impact of the Mediterranean diet. While challenges such as study heterogeneity and limited long-term data existed, the findings suggested that adopting the Mediterranean diet can be a viable strategy for individuals seeking sustainable and holistic approaches to weight management and health metabolic factors. Future research should aim for standardized protocols and longer follow-up durations to further enhance the understanding of the Mediterranean diet's long-term benefits. Future research should aim for standardized protocols and interventions to enhance comparability. Additionally, the duration of some studies may limit our understanding of the long-term sustainability and effectiveness of the Mediterranean diet for weight management.

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