



Systematic Review

Effectiveness of Strategies for Nutritional Therapy for Patients with Type 2 Diabetes and/or Hypertension in Primary Care: A Systematic Review and Meta-Analysis

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Abstract: A central aspect to the management of type 2 Diabetes Mellitus (T2DM) and hypertension is promoting a healthy lifestyle, and nutritional therapy (NT) can support patients achieving glycemic control and blood pressure targets. This systematic review aimed to evaluate the effectiveness of NT in the management of patients with T2DM and/or hypertension in primary care. Primary outcomes were HbA1c, systolic blood pressure (SBP) and diastolic blood pressure (DBP). Thirty-nine studies were included, thirty on T2DM and nine on hypertension. With a moderate quality of evidence, educational/counseling programs and food replacement programs in primary care likely reduce HbA1c on patients with T2DM (mean difference (MD): -0.37 , 95% CI: -0.57 to -0.17 , 7437 patients, 27 studies; MD: -0.54 , 95% CI: -0.75 to -0.32 , 440 patients, 2 studies, respectively). Mediterranean diet for T2DM was accessed by one study, and no difference between the groups was found. Educational and counseling programs likely reduce DBP in patients with hypertension (MD: -1.79 , 95% CI: -3.46 , -0.12 , 2840 patients, 9 studies, moderate quality of the evidence), but the effect in SBP was unclear due to risk of bias and imprecision. Nutritional therapy strategies (i.e., educational/counseling programs and food replacement programs) in primary care improved HbA1c in patients with T2DM and DBP in individuals with hypertension.

Keywords: chronic disease; health services research; type 2 diabetes mellitus; hypertension; primary care; nutrition therapy



Citation: Simões Corrêa Galendi, J.; Leite, R.G.O.F.; Banzato, L.R.; Nunes-Nogueira, V.d.S. Effectiveness of Strategies for Nutritional Therapy for Patients with Type 2 Diabetes and/or Hypertension in Primary Care: A Systematic Review and Meta-Analysis. *Int. J. Environ. Res. Public Health* **2022**, *19*, 4243. <https://doi.org/10.3390/ijerph19074243>

Academic Editor: Paul B. Tchounwou

Received: 18 January 2022

Accepted: 7 March 2022

Published: 2 April 2022

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1. Introduction

Hypertension and diabetes mellitus (DM) are leading causes of cardiovascular disease and premature death. The total number of patients with diabetes mellitus has quadrupled in the past three decades, and it now affects approximately 1 in 11 adults worldwide [1], while the prevalence of hypertension is estimated at 31.1% among adults [2]. Besides, 11.3% of global deaths in 2019 among adults between 20 and 79 years-old were attributed to diabetes [3], and 14% of deaths globally to hypertension, according to data from 2015 [4].

In addition to the high mortality, the morbidity associated with hypertension and diabetes represent a significant economic burden for patients, caretakers, and health systems. The estimated global cost of DM in 2015 was USD 1.31 trillion or 1.8% of global gross domestic product, and 34% of this was attributed to indirect costs such as loss of productivity [5]. Moreover, hypertension and DM are the health conditions with the highest absolute increase in annual US healthcare expenditure over the past three decades [6].

Despite the increasing investments on chronic disease management, an expressive number of patients do not reach treatment targets. A multicenter, cross-sectional,

questionnaire-based study conducted in 9 Latin American countries showed that 56.8% of patients with type 2 DM (T2DM) had poor glycemic control (i.e., HbA1c \geq 7%) [7]. The lowest treatment success was identified in Peru, where only 7.5% achieved metabolic and blood pressure levels as recommended by the American Diabetes Association (ADA) [8]. Likewise, only 13.8% of adults with hypertension in 2010 had their BP controlled worldwide [9]. Although the management of hypertension and T2DM are well established, there is a gap between knowledge and attitude that hinders the implementation of successful management strategies [10]. Hence, the coordination of care and patient self-management are the two utmost important aspects that can be promoted in primary care [11].

A central aspect to the management of T2DM and hypertension is providing healthy lifestyle education. Nutrition therapy (NT) consists of education and support to help patients adopt healthy eating pattern, what plays a fundamental role in the management of T2DM and hypertension, and its complications [12–14]. The ADA recommends that NT should generally promote dietary quality and energy restriction and combine patient preferences and metabolic needs [12]. With regard to dietary quality, several approaches have been studied, such as the Mediterranean diet, the Dietary Approaches to Stop Hypertension (DASH), a low carbohydrate diet and a vegetarian diet [12]. A network meta-analysis has shown that all dietary approaches are effective to improve glycemic control, but the Mediterranean diet had the more significant effect [15]. The DASH and Mediterranean diets also contribute to BP reduction [16].

Systematic reviews have demonstrated the effectiveness of NT and lifestyle education on the management of T2DM [17–20] and hypertension [21,22]. These systematic reviews either restricted the inclusion criteria to group-based educational programs [20]; or did not consider antihypertensive medications as part of the standard care [22]; or were conducted on specific populations, such as young adults [21], obese patients [17], patients at risk for T2DM [19]. However, none of them exclusively focused on the primary care setting. Hence, the objective of this systematic review was to evaluate the effectiveness of NT programs delivered exclusively in the primary care setting in the management of adult patients with T2DM and/or hypertension.

2. Materials and Methods

This systematic review was conducted following the Cochrane collaboration handbook [23], and is reported according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) Statement [24]. The protocol was published elsewhere [25], and had been previously registered with the international Prospective register of Systematic Reviews (PROSPERO) under registration number CRD42018118117.

2.1. Inclusion and Exclusion Criteria

We sought to include randomized controlled trials that met the following inclusion criteria (PICO):

Participants (P): adult patients (i.e., aged \geq 18) diagnosed with T2DM and or hypertension. The diagnosis of T2DM should have been established according to the ADA criteria (i.e., fasting glycaemia $>$ 200 mg/dL associated with classic T2DM symptoms; glycaemia 2 h after overload with 75 g of glucose \geq 200 mg/dL; HbA1c \geq 6.5%) [12]. Hypertension should be characterized by persistent systolic blood pressure (SBP) \geq 140 mmHg and/or diastolic blood pressure (DBP) \geq 90 mmHg [26].

Types of intervention (I): Nutritional therapy (NT) programs delivered in a primary care setting which focused on stimulating healthy nutrition for a minimum duration of four months. We considered the nutritional strategies that were provided in addition to, and not instead of, the regular pharmacological treatment to T2DM and/or hypertension. We included: (i) educational or counseling programs addressing nutritional recommendations to reduce calories and dietary fat and lifestyle healthy behaviors, (ii) food replacement program followed by stepped reintroduction of meals; (iii) Mediterranean diet, (iv) DASH diet, (v) low carbohydrate diet, (vi) vegetarian diet, (vii) low glycemic index diet, (viii)

high protein diet. The educational and counseling interventions could be delivered by any health care professional, such as dietitians, physical educators, nurses, psychologists, health educators, physicians, and peer-supporters (i.e., trained in some way in the context of the intervention, although having no formal professional or paraprofessional certificated or degree tertiary education).

Comparison (C): Conventional treatment for T2DM and hypertension, which consisted of pharmacological treatment and general healthy lifestyle advice. An episodic consultation with a dietician, nurse, physical trainer, or educator in diabetes for general healthy lifestyle advice or general nutritional orientation were considered conventional treatment if the patients were not provided subsequent follow up.

Outcomes (O): Primary outcomes were glycemic control and blood pressure control, which were measured by HbA1c (%) and SBP/DBP (mmHg), respectively. The secondary outcomes were frequency of cardiovascular events (acute myocardial infarction and stroke), weight loss (measured as change in weight or in BMI) and death. Outcomes were evaluated at 6, 12 and more than 12 months.

We excluded studies that included patients aged <18 years old, pregnant women, diagnosis of secondary hypertension. Further exclusion criteria were if the intervention was based exclusively on dietary supplements, too low energy diets (less than 600 kcal/day), if the intervention was not delivered in a primary care setting (i.e., studies that recruited patients in the primary setting, but delivered the intervention elsewhere were excluded), and if there was a cointervention not common to both groups.

2.2. Identification of Studies

General search strategies were developed for the main electronic health databases: Embase (1980–2019), Medline through PubMed (1966–2019), LILACS (through Virtual Health Library, 1982–2019) and CENTRAL (Cochrane Collaboration Controlled Trials Register, 1982–2019). A second search on the previously mentioned databases was conducted on 27 December 2021. Search strategies included the following descriptors and synonyms: T2DM OR hypertension—AND—primary health care OR community health planning—AND—nutritional therapy OR lifestyle—AND randomized controlled trial. In PubMed and Embase a filter for randomized controlled trials were applied. There was no language restriction. The full search strategy is on the Supplementary Material (Table S1).

The databases searched for eligible studies included: Trip database, SCOPUS, Web of Science, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Australasian Medical Index, and Chinese Biomedical Literature Database. Furthermore, we searched for studies on [ClinicalTrials.gov](https://www.clinicaltrials.gov), the Brazilian Registry of Clinical Trials (Rebec) and grey literature, through abstracts published in annals and lectures. References of relevant primary or secondary studies were screened to identify additional eligible studies. Endnote software was used to download references and remove duplicates.

Two reviewers (RGOFL and JSCG) independently performed the initial screening of titles and abstracts using the software Rayyan QCRI [27]. The studies selected for full-text review were subsequently assessed for adequacy to the proposed PICO. In case of disagreement, there was a consensus meeting between the reviewers and the project coordinator (VdSN-N) for a final decision.

2.3. Data Extraction and Risk of Bias of Included Studies

Two reviewers (LRB and JSCG) used a standardized form to extract relevant data of the included studies (i.e., study identification, publication date, country, sample size, follow up, type of intervention and control, baseline characteristics of patients, and outcome results). To assess the risk of bias of included studies, the same two reviewers used the revised version of the Cochrane tool (RoB 2), which considers bias arising from five domains: (i) the randomization process; (ii) due to deviations from intended interventions (including blinding of patients and personnel, balanced baseline characteristics, and report of measurement of compliance with the intended intervention); (iii) due to missing outcome

data; (iv) in measurement of the outcome; and (v) in selection of the reported result. To ensure consistency between reviewers, a calibration exercise was performed and in the case of disagreement, a consensus meeting with the project coordinator (VdSN-N) was made. For domain (iii), while we considered a loss of follow up of more than 20% as high risk of bias for RCTs, we allowed a loss of follow up of 30% for pragmatic trials. It was also considered high risk if the loss of follow up was unbalanced between the two groups. For domain (iv) it was considered high risk of bias when the data collection on the outcomes of interest was performed based on patient records instead of a standardized data collection. Finally, for domain (v) we also tracked the published protocols and trials registrations, when available.

2.4. Synthesis and Analysis of Data

The unit of analysis was the data published in the included studies. Similar outcomes in at least 2 studies were plotted in random-effect meta-analyses using the Stata Statistical Software 17 (StataCorp LLC, College Station, TX, USA). The random effects model was chosen as the analytic model for the meta-analysis. Continuous data were expressed as means and SD and the differences between means with 95% CIs were used as estimate of intervention effect. The mean adjusted differences (MAD) were preferred when available. For studies that reported median and interquartile range, the estimated mean of the sample and SD were obtained from Hozo et al. [28].

For the cluster randomized trials, we used a formula suggested by the Cochrane handbook to find the trial's effective sample size, which is its original sample size divided by the "design effect." The design effect can be calculated by:

$1 + (M - 1) \times ICC$, where M is the average cluster size and ICC is the intracluster correlation coefficient [29].

Inconsistencies between the results of the included studies were ascertained by visual inspection of forest plots (no overlap of CIs around the effect estimates of the individual studies) and by Higgins or I^2 statistic, in which $I^2 > 50\%$ indicates a moderate probability of heterogeneity, and by χ^2 tests, where $p < 0.10$ indicates heterogeneity. In the case of statistical heterogeneity, we used meta-regression to explore the causes of the inconsistency. Meta-regression models (with random effects) were adjusted with the MD as a dependent variable; and months of follow-up, type of intervention, risk of bias, if MAD was used and characteristics of the baseline participants as moderator variables (mean age and mean HbA1c). The Knapp–Hartung correction was used to calculate the significance of the meta-regression coefficients.

2.5. Quality of Evidence

The quality of the evidence of the intervention's effect estimate was assessed according to the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodological guideline [30]. To assess the domain imprecision the optimal information size (OIS) was calculated using the Stata Statistical Software 17 (StataCorp LLC, College Station, TX, USA). A change of 0.5% for the outcome HbA1c, 4 mmHg for the outcome SBP, and 3 mmHg for the outcome DBP were considered to be clinically significant. For all outcomes, 0.05 alpha error and 0.20 beta were assumed. The quality of the evidence was rated down for imprecision if the OIS criterion was not met [30].

3. Results

We identified 6363 references on the first search and 1099 references on the second search, following the removal of duplicates. After reading the title and abstract, 124 references were selected for full reading. The 85 excluded references, and the reasons for exclusion are detailed on Table S2 on the supplementary material. The main reasons for exclusion were non-randomized trial (3 studies), patients did not meet eligibility criteria (8 studies), wrong intervention (10 studies) or intervention inferior to 4 months (14 studies), intervention not delivered in primary care setting (36 studies), wrong com-

parator (7 studies), wrong outcome (3 studies), cointervention not common to both groups (3 studies) or study protocol (1 study). Figure 1 shows the study selection process.

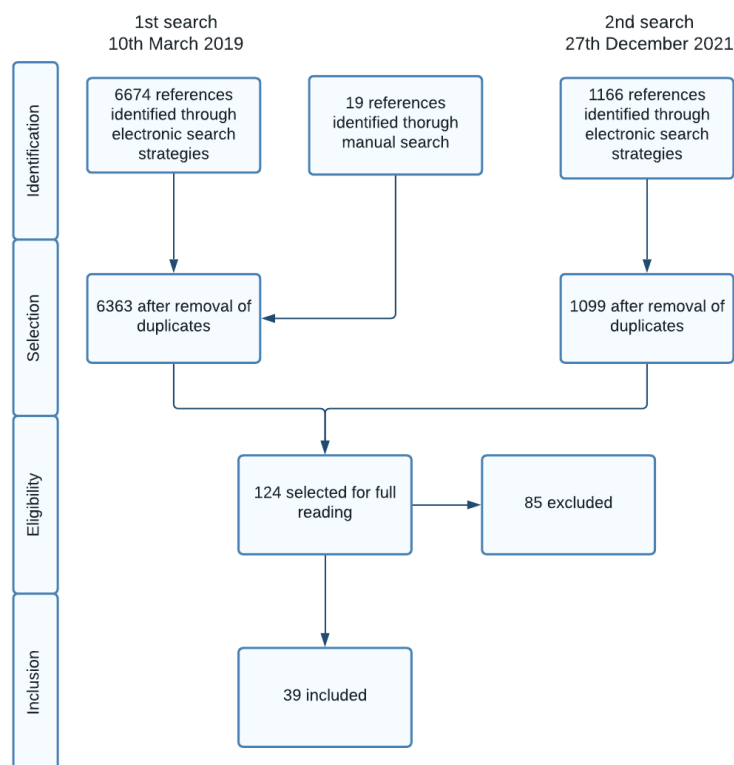


Figure 1. Study selection process.

3.1. Characteristics of Included Studies

Thirty-nine studies met our eligibility criteria and were therefore included [31–69]. Among the included studies, nine evaluated NT primarily for hypertension [61–69], 30 evaluated NT primarily for T2DM [31–60]. The characteristics of included studies according to the inclusion criteria are detailed in Appendixes A and B.

Nine studies assessed the effect of NT on patients primarily diagnosed with hypertension [61–69]. While most studies excluded patients with T2DM, 2 of these studies allowed for patients with concomitant diagnosis of hypertension and T2DM [65,67]. All of the interventions consisted of counseling or educational programs delivered in groups or individually by practice nurses (six studies) [61,62,64,66,68,69], dietitians (two studies) [63,65] and health educators (one study) [67].

Thirty studies included patients primarily diagnosed with T2DM, and in all of the studies a proportion of included patients had concomitant diagnosis of hypertension [31–60]. The interventions studies consisted of educational and counseling programs in 27 studies [31–45,47–55,57,59,60], food substitution program in two studies [46,56], and only one studied assessed the effect of Mediterranean diet [58]. The educational/counseling programs were delivered by multi-professional teams in eight studies [35,36,39,41,47,48,53,54], practice nurse in six studies [37,38,40,42,43,59], dietitians (i.e., nutritionists) in five studies [31,34,44,52,60], pharmacists in two studies [45,50], peer supporters in two studies [49,55] and therapists in one study [51]. In three studies, the intervention was delivered by specialists in diabetes or population health management [32,33,57]. Eight studies were cluster randomized trials [31,33,36,48,49,55,63] and three studies despite the cluster randomization, individual patient data were used for the analysis [32,43,50].

3.2. Risk of Bias

Risk of bias of included studies is shown in Figure 2 and Figure S1 (Supplementary material). For the (ii) domain (i.e., deviation from the intended intervention) there were some concerns for most studies, given the behavioral nature of the educational and counseling interventions and lack of blinding of patients and personnel. Among the studies rated as high risk for the (i) domain (i.e., randomization process), three lacked blinding of allocation [44,45,62], and two had unbalances in baseline characteristics (Höchsmann et al. allocated more diabetic patients to the intervention arm and Tejada Tebayas et al. the intervention group had a lower educational profile) [57,63].

For the domain missing outcome data, four studies were rated as high risk of bias due to high and unbalanced dropout rates, suggesting that the loss of follow-up was related to the intervention [38,45,48,54].

3.3. Meta-Analysis of NT for Hypertension

The meta-analysis showed an association between NT and reduction in DBP, MD: -1.79 , 95% CI: -3.46 to -0.12 , I^2 : 88.1%, 2840 patients, 9 studies, moderate quality of the evidence, Figure 3A, Table 1). However, meta-analysis did not indicate any clear effect of NT in patients primarily diagnosed with hypertension on SBP (MD: -2.17 , 95%CI -6.81 , 2.46 , 4518 patients, 9 studies, I^2 : 88.8%, low quality of the evidence, Figure 3B, Table 1). After visual inspection of the forest plot, the high heterogeneity in both meta-analyses was attributed to one study that overestimated the effect of the intervention [62]. In a sensitivity analysis without Hacıhasanoğlu et al. [62], the intervention effect on DBP remained in favor of the intervention, and the MD in SBP still crossed the line of null effect (Figure S2 Supplementary material).

Subgroup analyses performed according to length of follow-up and sensitivity analyses separating studies that presented the results as MAD or post-intervention values, and according to risk of bias did not change the effect on blood pressure (Figures S3–S5 on the Supplementary material, respectively).

3.4. Meta-Analysis of NT for T2DM

Meta-analysis of studies assessing the effect of counseling and educational programs on HbA1c favored the intervention (MD: -0.37 , 95% CI: -0.57 , -0.17 , I^2 : 85.8%, 7437 patients, 27 studies, moderate quality of the evidence, Figure 4A). We investigated heterogeneity using meta-regression. The joint and individual tests for categorical and no categorical covariates gave us a p -value higher than 0.05, indicating no association between these covariates and the size of the treatment effect (Figures S6 and S7 on the Supplementary material). However, through visual inspection of the forest plot, we asserted that two studies overestimated the effect of the intervention [43,45]. A sensitivity meta-analysis excluding these two studies resolved the heterogeneity and still favored the intervention (MD: -0.25 , 95% CI: -0.35 , -0.16 , I^2 : 24%, 7094 patients, 25 studies, Figure S8 on the Supplementary material).

Subgroup analyses performed according to length of follow-up and sensitivity analyses separating studies that presented the results as MAD or post-intervention values, and according to risk of bias did not change the effect on HbA1c (Figures S9–S11 on the supplementary material, respectively).

Meta-analysis of studies assessing the effect of food replacement on HbA1c favored the intervention (MD: -0.54 , 95% CI: -0.75 , -0.32 , I^2 : 0%, 440 patients, 2 studies, Figure 4B, moderate quality of the evidence, Table 1).

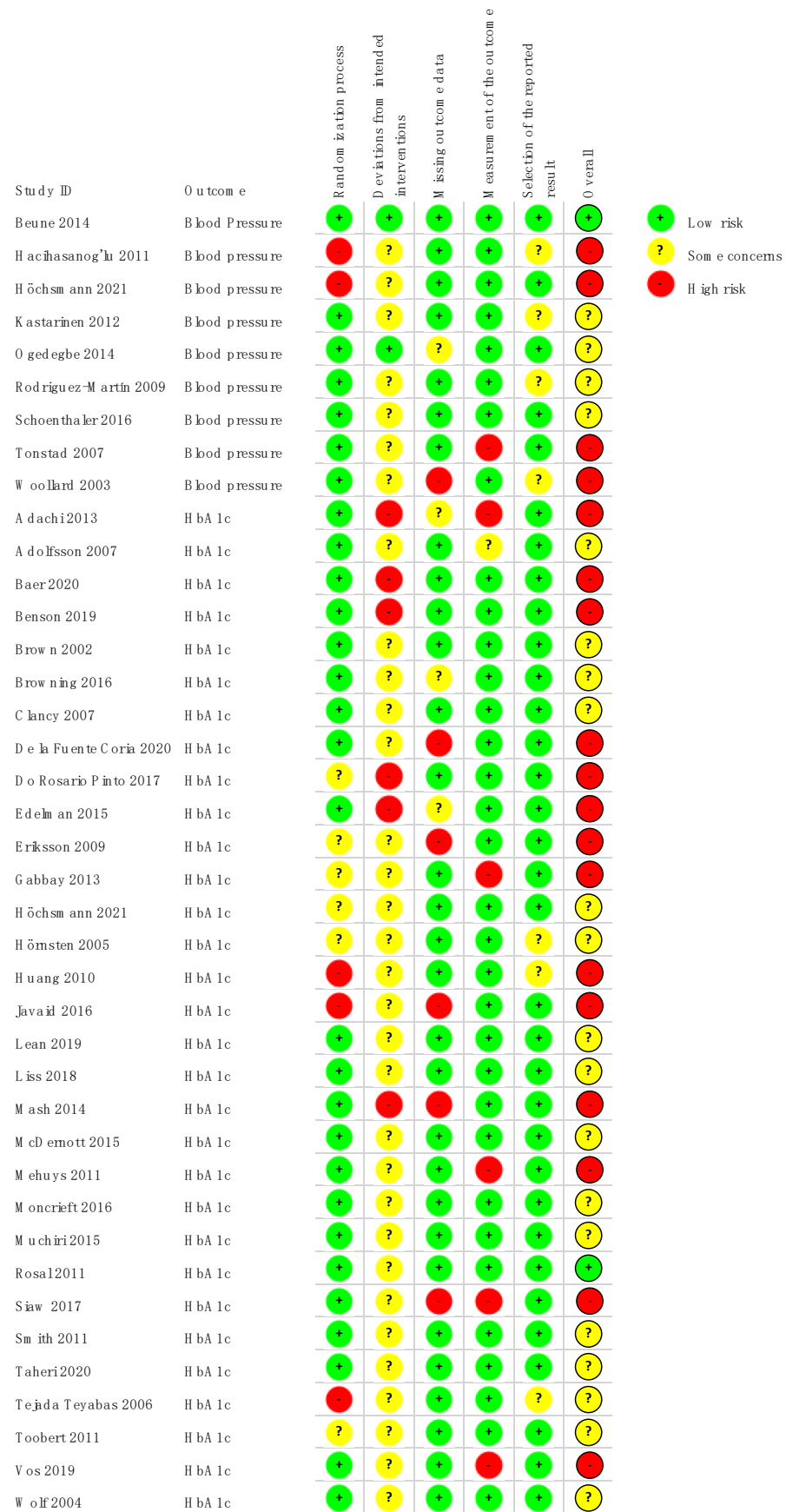


Figure 2. Risk of bias of included studies according to the main outcomes analyzed.

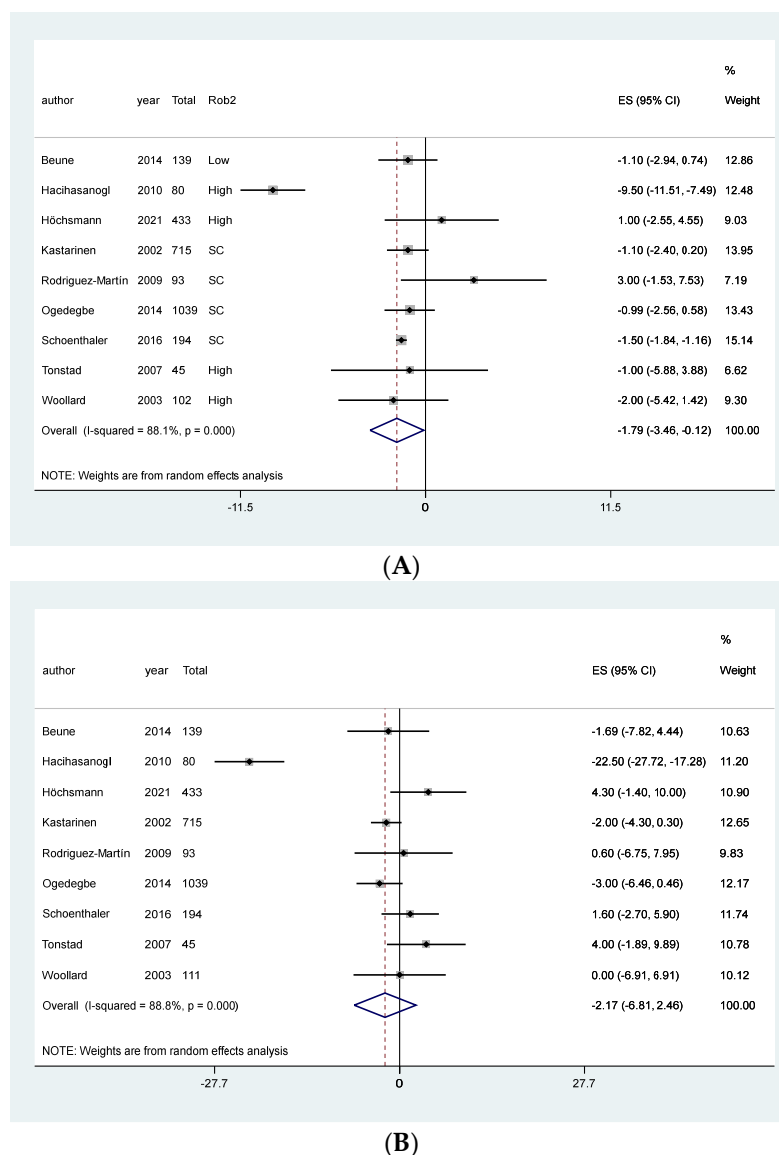


Figure 3. Meta-analysis of the effect of NT on blood pressure in patients primarily diagnosed with hypertension. (A) Diastolic blood pressure, (B) Systolic blood pressure.

Secondary Outcomes

Among studies assessing educational and counseling NT for T2DM, the meta-analyses of DBP and BMI did not show a statistical difference between groups (MD: -0.84 , 95% CI: $-1.85, 0.16$, $I^2: 44.8\%$, 5508 patients, 14 studies, Figure S12 on the Supplementary Material; MD: 0.07 95%CI: $-0.19, 0.05$, $I^2: 24.5\%$, 2378 patients, 11 studies, Figure S13 on the Supplementary Material, respectively). For SBP, a trend of no effect was identified (MD: -2.56 , 95% CI: -5.5 to 0.38 , $I^2: 83.6\%$, 5508 patients, 15 studies, Figure S14 on the Supplementary Material), but in a sensitivity analysis without Javaid et al. [45] (a study which overestimated the intervention), the heterogeneity was resolved and the reduction in SBP showed to be significant (MD: -1.68 , 95% CI: $-2.98, -0.38$, $I^2: 0\%$, 5264 patients, 14 studies, Figure S15 on the Supplementary Material).

3.5. Publication Bias

Publication bias was investigated for HbA1c outcome. Since asymmetries in the funnel plot was not observed, the Egger test was performed ($p: 0.988$, Figure S16 on the Supplementary Material), indicating no publication bias.

Table 1. Summary of findings and quality of the evidence.

Nutrition Therapy Compared to Usual Care for Type 2 Diabetes and/or Hypertension						
Patient or population: Patients with type 2 diabetes and/or hypertension.						
Setting: Primary care						
Intervention: Nutrition therapy (counseling/educational programs in type 2 diabetes; food substitution).						
Comparison: Usual care						
Outcomes	Anticipated Absolute Effects * (95% CI)		Relative Effect (95% CI)	N ^o of Participants (Studies)	Certainty of the Evidence (GRADE)	Comments
	Risk with Usual Care	Risk with Nutrition Therapy				
HbA1c (%) in counseling/educational programs follow-up: mean 14 months		MD 0.37 lower (0.57 lower to 0.17 lower)	-	7437 (27 RCTs)	⊕⊕⊕○ Moderate ^{a,b}	In primary care, counseling/educational programs likely result in a reduction in HbA1c (%) in type 2 diabetes patients.
HbA1c (%) in food replacement follow-up: mean 18 months		MD 0.54 lower (0.75 lower to 0.32 lower)	-	440 (2 RCTs)	⊕⊕⊕○ Moderate ^c	In primary care, food replacement likely results in reduction in HbA1c (%) in type 2 diabetes patients.
Systolic blood pressure in participants with hypertension follow-up: mean 14 months		MD 2.17 lower (6.81 lower to 2.46 higher)	-	4518 (9 RCTs)	⊕⊕○○ Low ^{d,e}	
Diastolic blood pressure in participants with hypertension follow-up: mean 14 months		MD 1.79 lower (3.46 lower to 0.12 lower)	-	2840 (9 RCTs)	⊕⊕⊕○ Moderate ^{d,f}	In primary care, counseling/educational programs likely reduce slightly diastolic blood pressure in participants with hypertension.

GRADE Working Group grades of evidence**High certainty:** we are very confident that the true effect lies close to that of the estimate of the effect.**Moderate certainty:** we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.**Low certainty:** our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.**Very low certainty:** we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.**Explanations**

- All included studies were classified as having either some concerns or high risk of bias according to RoB2.
- Although the meta-analysis showed a high statistic heterogeneity (I-squared = 85.8%), it was attributed to two studies that overestimated the intervention effect. The meta-analysis without these two studies maintained the effect in favor of the intervention (supplementary file). As a result of this the quality of evidence was not rate down due to inconsistency.
- The two included studies were classified as having some concerns according to RoB2
- Most included studies were classified as having high risk of bias according to RoB2. The 95% CI overlaps no effect, but it fails to exclude important benefit.
- The summary effect crossed the line of the null effect. Although the meta-analysis showed a high statistic heterogeneity (I-squared = 88.8%), it was attributed to a study that overestimated the intervention effect. The meta-analysis without this study maintained the null effect (supplementary file). As a result of this the quality of evidence was not rate down due to inconsistency.
- Although the meta-analysis showed a high statistic heterogeneity (I-squared = 88.1%), it was attributed to a study that overestimated the intervention effect. The meta-analysis without this study maintained the effect in favor of the intervention (supplementary file). As a result of of this the quality of evidence was not rate down due to inconsistency.

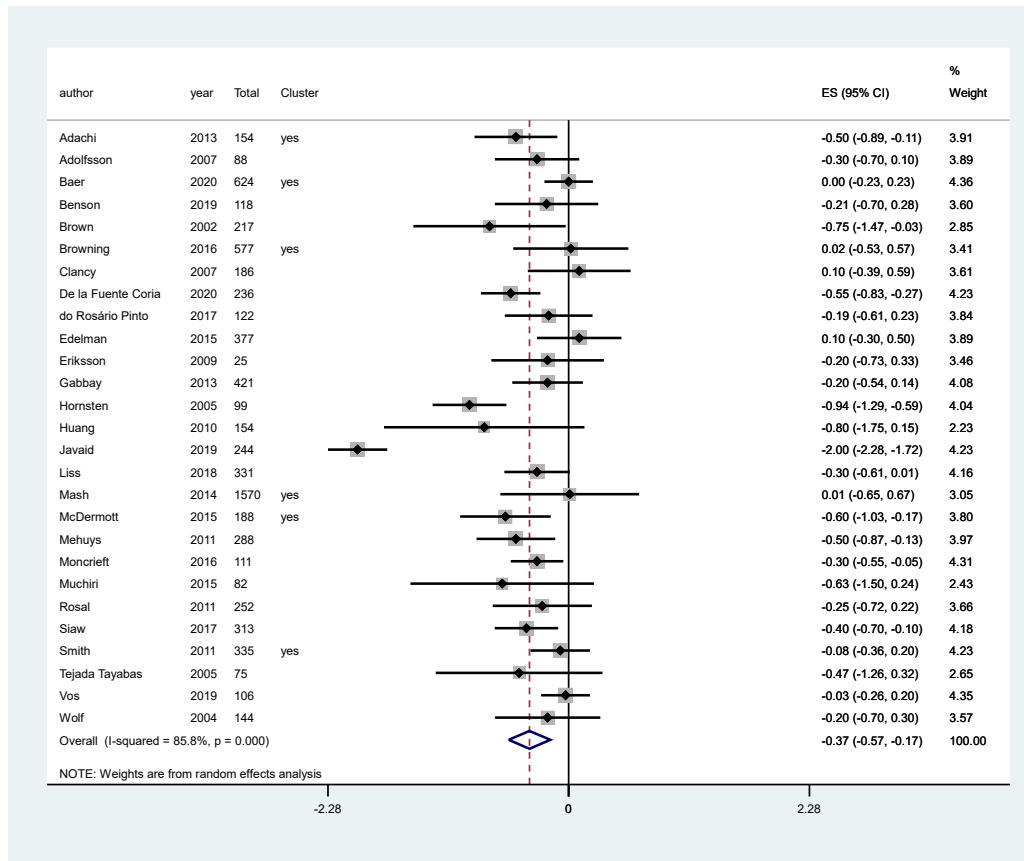
* The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI). Abbreviations: CI: confidence interval; MD: mean difference.

3.6. Studies Not Included in the Meta-Analysis

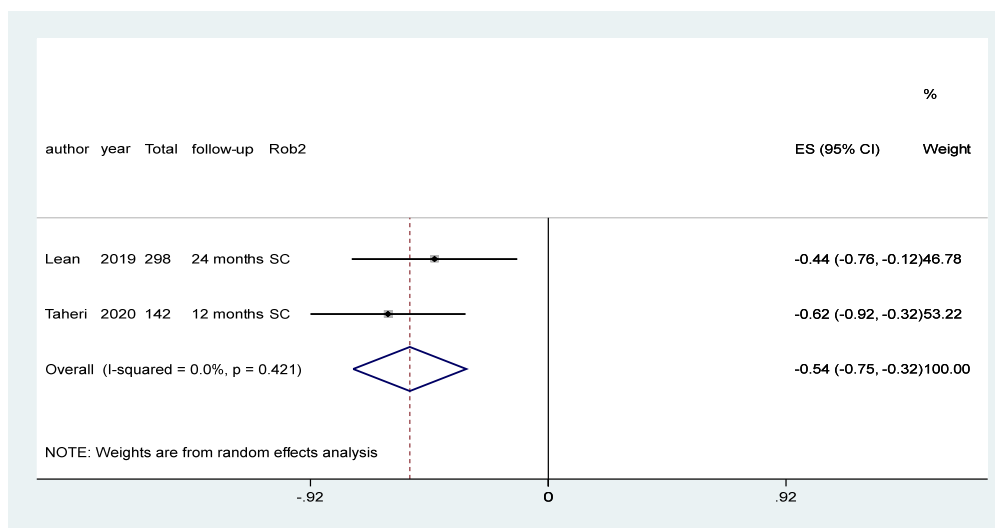
Only 1 study assessed the effect of Mediterranean diet on T2DM, and therefore it was not possible to perform a meta-analysis [58]. Toobert et al. investigated the effect of a nutritional therapy based on Mediterranean diet on 280 patients aged ≥ 30 and < 75 and with Latino ethnicity and the primary outcomes were self-efficacy and behaviour change

and HbA1c as secondary outcome. Patients in the intervention groups presented mean HbA1c of 8.4 (standard error (SE): 0.003), which dropped to 7.8 (SE: 0.03) after 6 months, but it was not maintained (i.e., mean HbA1c at 12 and 24 months were both 8.4, SE: 0.03).

The secondary outcomes mortality and frequency of cardiovascular events were not evaluated by the primary studies included in this review, and therefore, were not assessed.



(A)



(B)

Figure 4. Meta-analysis of the effect of NT on HbA1C in patients primarily diagnosed with type 2 Diabetes Mellitus according to the type of intervention. (A) Counseling and educational programs, (B) Food replacement.

4. Discussion

In this systematic review, we identified three NT strategies evaluated in primary care: counseling and educational programs, food replacement programs and Mediterranean diet. Only one study on Mediterranean diet in primary care was identified [58], and it was not included in a meta-analysis. The included studies reported the metabolic targets as main outcomes, such as glycemic control, blood pressure reduction and BMI. However, no study reported the outcomes mortality or frequency of cardiovascular events.

According to the meta-analyses, NT in primary care likely reduces HbA1c in patients with T2DM. With moderate quality of the evidence, counseling and educational programs were associated with a mean change of -0.37 in HbA1c and food replacement programs with a mean change in HbA1c of -0.54 , both when compared to usual care. In addition, counseling and educational programs slightly reduce DBP (MD: -1.79) in patients with hypertension when compared to usual care. It was not possible to ascertain an association of NT with change in SBP.

The effectiveness of NT in the management of T2DM and hypertension have been investigated in systematic reviews, although none had focused exclusively on the primary care setting. Patients with T2DM and hypertension are mostly managed in the primary healthcare level, and access to specialized medical nutritional therapy is limited [18]. The lack of training on nutritional advice and patient overload often makes lifestyle interventions challenging for primary care nurses and physicians [11].

The systematic review by Kalyoncu et al. investigated the effectiveness of nutrition-based practices in prevention of hypertension but focused on healthy young adults [21]. Nicolson et al. performed a meta-analysis of five studies comparing antihypertensive medication versus lifestyle interventions (without antihypertensive), and likewise had inconclusive results on SBP reduction [22]. However, distinct from the review form Nicolson et al., in our review NT was often offered in combination to antihypertensive medications as part of the standard care at the primary care clinic. Besides, our review included more studies published after 2004.

Previous systematic reviews investigating the effectiveness of NT in T2DM had focused mainly on weight loss among obese patients [17], or T2DM prevention among healthy patients at risk for T2DM [19]. In addition, the benefit of group-based self-management education in reducing HbA1c had been previously indicated in a systematic review [20]. However, the inclusion criteria of this previous systematic review were restricted to group-based educational programs [20]. Moreover, two robust studies were published after this systematic review was carried out, which were now included in our analyses [34,47]. Furthermore, García-Molina et al. conducted a meta-analysis of studies assessing the effectiveness of lifestyle intervention (educational programs) in T2DM management [18]. García-Molina et al. found a weighted mean difference of -0.51 in HbA1c, a reduction that is more pronounced than the results from our meta-analysis. Although the inclusion criteria were similar to those used in our review, our review excluded studies conducted in settings other than the primary care, assessed separately patients with hypertension and applied the GRADE methodology to assess the quality of the evidence.

Among the studies included in our meta-analyses, three studies had clustered samples (i.e., subjects were randomized at a group level), but the results were analyzed at an individual level [32,43,50]. By not taking clustering into account, the results may show significance where none exists [70]. Moreover, in one study there was no allocation concealment (i.e., subjects with even numbers were allocated to the intervention arm, while odd number subjects to the control arm) [45]. The individual-level analysis in a clustered sample in Hörnsten et al. [43], and the lack of allocation concealment in Javaid et al. [45], may explain the overestimated effect on HbA1c in both studies identified in the meta-analysis. Hence, we conducted sensitivity analysis, and the effect in favor of the intervention was maintained.

Some limitations to our results must be acknowledged. First, we could not evaluate the effect of NT on hard outcomes such as mortality and frequency of cardiovascular

events. The surrogate continuous outcomes evaluated allow a limited interpretation of the real clinical impact of the interventions. For HbA1c, a change of 0.5% is considered as clinically significant [71,72]. For blood pressure, a reduction of 10 mmHg is associated with a reduction of 17% in coronary artery disease incidence, 27% in stroke, 28% in heart failure and 13% in all-cause mortality [73]. When considering these cutoffs to extrapolate the correlation of blood pressure and HbA1c reduction on long term complications and mortality, the effect of NT is arguable. For instance, the mean change in DBP in patients with hypertension identified in our meta-analysis, although statistically significant, was notably lower than what could be regarded as clinically significant. Second, during data extraction, it was not possible to ensure that the studies considered equivalent variables for the calculation of the MAD.

Third, there was noticeable variability among the educational programs provided by the included studies, regarding intensity of the intervention, the professional responsible for delivering the intervention and the content of the intervention. While some educational interventions followed a nutrition education curriculum [48,52], others were based on motivational interviewing [42], or culturally tailored self-management interventions [35,53,58]. Moreover, some programs provided broad lifestyle modification advice, entailing promotion of regular physical activity. The choice of the best suited intervention might be influenced by previous local practices, logistic capacities, and cultural aspects, although the common aspect of these educational and counseling programs was that the NT was offered as part of a coordinated care in a primary setting [11].

Lifestyle modification is a central aspect to the management of patients with T2DM and hypertension [12]. Although the implementation of lifestyle and nutritional interventions in the primary care setting is challenging, the effect of educational programs on the management of hypertension (i.e., reduction in DBP) and T2DM, and food replacement for the management of T2DM have been extensively studied, although future studies could help establish the effect of NT on SBP. These results may contribute to further implementing NT in the primary care setting. Moreover, NT programs tailored for the primary care should be encouraged.

5. Conclusions

Nutritional therapy strategies (i.e., educational/counseling programs and food replacement programs) in primary care improved the glycemic control in patients with T2DM and educational programs in primary care improved DBP in individuals with hypertension. NT programs tailored for the primary care should be encouraged.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/ijerph19074243/s1>, Table S1 Search Strategy PubMed; Table S2 Excluded studies and main reason for exclusion; Figure S1 Summary of risk of bias; Figure S2 Meta-analysis of nutritional therapy for hypertension, sensitivity analysis without Hacıhasanoğlu. A. effect on systolic blood pressure, B. effect on diastolic blood pressure; Figure S3 Meta-analysis of nutritional therapy for hypertension for primary outcome (systolic blood pressure), subgroup analysis according to length of follow-up; Figure S4 Meta-analysis of nutritional therapy for hypertension for primary outcome (systolic blood pressure), subgroup analysis according to risk of bias. Abbreviations: SC: some concerns; Figure S5 Meta-analysis of nutritional therapy for hypertension for primary outcome (systolic blood pressure) separating studies that presented the results as mean adjusted difference (i.e., change score) or post-intervention values; Figure S6 Meta-regression assessing follow up as modifier of the effect of nutritional therapy on HbA1c; Figure S7 Meta-regression assessing mean age and mean HbA1cs as modifiers of the effect of nutritional therapy on HbA1c; Figure S8 Meta-analysis of nutritional therapy for diabetes mellitus for primary outcome (HbA1c) without Javaid et al. and Hörnstein et al.; Figure S9 Meta-analysis of nutritional therapy for diabetes mellitus for primary outcome (HbA1c), subgroup analysis according to length of follow up; Figure S10 Meta-analysis of nutritional therapy for diabetes mellitus for primary outcome (HbA1c), subgroup analysis separating studies that presented the results as mean adjusted difference (i.e., change score) or post-intervention values; Figure S11 Meta-analysis of nutritional therapy for diabetes mellitus for

primary outcome (HbA1c), subgroup analysis according to risk of bias; Figure S12 Meta-analysis of nutritional therapy for diabetes mellitus. Secondary outcome: systolic blood pressure; Figure S13 Meta-analysis of nutritional therapy for diabetes mellitus without Javaid et al. Secondary outcome: systolic blood pressure; Figure S14 Meta-analysis of nutritional therapy for diabetes mellitus. Secondary outcome: diastolic blood pressure; Figure S15 Meta-analysis of nutritional therapy for diabetes mellitus. Secondary outcome: body mass index; Figure S16 Funnel plot assessing publication bias on the meta-analysis of nutritional therapy for diabetes mellitus for the primary outcome (i.e., HbA1c).

Author Contributions: Conceptualization, V.d.S.N.-N.; methodology, V.d.S.N.-N. and J.S.C.G.; formal analysis, V.d.S.N.-N., L.R.B., R.G.O.F.L. and J.S.C.G.; resources, V.d.S.N.-N.; writing—original draft preparation, V.d.S.N.-N. and J.S.C.G.; writing—review and editing, V.d.S.N.-N., L.R.B., R.G.O.F.L. and J.S.C.G.; supervision, V.d.S.N.-N.; project administration, V.d.S.N.-N.; funding acquisition, V.d.S.N.-N. and R.G.O.F.L. All authors have read and agreed to the published version of the manuscript.

Funding: This project was partially funded by the Call for Financial Support for Studies in Health Technology Assessment of German Hospital Oswaldo Cruz in partnership with the Brazilian Health Ministry through the Program of Support for the Institutional Development of the Unified Health System (PROADI-SUS) (DECIT/SCTIE/MS-PROADI-SUS, 2018), Grant number 25000.009785/2018-44. The São Paulo Research Foundation, FAPESP, supported Luiza Rocco Banzato during the conduction of this study (Undergraduate research project, process 2018/25035-5).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: All the data generated during this study is provided in the main manuscript and its supplementary material.

Acknowledgments: The authors would like to thank Lehana Tabane for the support during the conduction of this study.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Characteristics of included studies according to the eligibility criteria for studies offering nutritional therapy primarily for hypertension.

Study/Year	Study Design	Country	Setting	Inclusion Criteria ^a	Intervention	Intensity of Intervention ^b	Control	Outcomes	Follow Up
Beune 2014	Cluster RCT	The Netherlands	4 PHCC	Aged ≥ 20 , SBP ≥ 140 mmHg at the last office visit, Ghanaian or Surinamese origin	Counseling program delivered by a trained practice nurse	Three 30-min sessions over 5 months	Usual care	(i) Proportion of patients with a SBP reduction in at least 10 mmHg; (ii) mean between-group differences in changes in SBP and DBP; (iii) adherence to lifestyle and medication recommendations (MMAS-8 score)	6 months
Hacihasanoğlu 2011	RCT	Turkey	3 PHCC	Aged ≥ 35 , had blood pressure $\geq 140/90$ mmHg, were prescribed antihypertensive medication	Counseling program delivered by a practice nurse	Six monthly sessions for 6 months	Usual Care (Monthly monitoring of blood pressure)	(i) mean between-group differences in changes in SBP and DBP; (ii) medication compliance (MASES score) and (iii) lifestyle behaviours (HPLP score).	6 months
Höchsmann 2021	RCT	USA	18 PHCC	Aged ≥ 20 and <75 , BMI ≥ 30 –50 kg/m ²	Educational program delivered by dietitians, physical education	Sixteen face-to-face and six telephone sessions over 6 months, monthly sessions for 18 months	Usual care, printed educational material	(i) changes in fasting glucose and lipid profile; (ii) blood pressure	24 months

Table A1. Cont.

Study/Year	Study Design	Country	Setting	Inclusion Criteria ^a	Intervention	Intensity of Intervention ^b	Control	Outcomes	Follow Up
Kastarinen 2002	RCT	Finland	10 PHCC	Aged ≥ 25 and <74 , had SBP ≥ 140 and <179 , DBP ≥ 90 and <109 mmHg, were prescribed antihypertensive medication	Educational program delivered by trained practice nurses	Four sessions over 12 months followed by 3 sessions in the 2nd year.	Usual care	(i) mean between-group differences in changes in SBP and DBP; (ii) changes in BMI, waist and hip circumference, lipid profile, alcohol consumption, urinary sodium and potassium excretion	24 months
Ogedegbe 2014	RCT	USA	30 PHCC	Aged ≥ 18 , HTN diagnosed at least 6 months prior to inclusion, blood pressure $\geq 140/90$ mmHg, were prescribed antihypertensive medication	Educational program delivered by dietitians and health educators	Six monthly sessions for 6 months	Printed educational material and four group educational sessions about mineral and vitamin replacement	(i) Proportion of patients with a BP reduction to at least 140/90 mmHg (or to 130/80 mmHg for those with DM and KD); (ii) mean within-patient changes in SBP and DBP; (iii) cost-effectiveness	12 months
Rodriguez-Martin 2009	RCT	Spain	1 PHCC	HTN diagnosed at least 6 months prior to inclusion	Educational program delivered by trained practice nurses in groups	Twelve monthly sessions for 12 months	Usual care	(i) mean between-group differences in changes in SBP and DBP; (ii) level of physical activity; (iii) Quality of life (SF-36 questionnaire); (iv) Cardiovascular risk (Framingham score)	24 months
Schoenthaler 2016	RCT	USA	1 PHCC	Aged ≥ 18 , blood pressure $\geq 140/90$ mmHg (or to 130/80 mmHg for those with DM and KD), identified as Black of African Americans	Counseling program delivered by trained health educators	Ten weekly group sessions for 3 months, followed by monthly telephone sessions for 3 more months.	Usual care and printed educational material	(i) within patient change in SBP and DBP; (ii) adherence to lifestyle and medication recommendations (MMAS-8 score)	6 months
Tonstad 2007	RCT	Norway	1 PHCC	Aged ≥ 30 and <69 , SBP > 140 or DBP > 90 mmHg	Counseling program delivered by trained practice nurses	Monthly sessions	Usual care and one session for general healthy lifestyle advice	(i) within patient change in SBP and DBP, waist circumference, lipid profile; (ii) Cardiovascular risk (Framingham score)	6 months
Woollard 2003	RCT	Australia	4 PHCC	Aged ≥ 20 and <75 , SBP ≥ 140 or DBP ≥ 90 mmHg or were prescribed antihypertensive medication	Counseling program delivered by trained practice nurses	Twelve monthly sessions for 12 months	Usual care	(i) mean between-group differences in changes in SBP and DBP, weight, BMI, urinary sodium and potassium (ii) Proportion of patients with a BP reduction to at least 130/85 mmHg	12 and 18 months

^a Inclusion criteria besides having a diagnosis of hypertension. ^b Interventions were offered individually, unless stated otherwise. Abbreviations. RCT: randomized controlled trial; PHCC: primary health care center; HTN: hypertension; SBP: systolic blood pressure; DBP: diastolic blood pressure; BMI: body mass index; KD: kidney disease; MMAS-8: Morisky medication adherence scale; MASES: Medication adherence and self-efficacy scale; HPLP: health promotion life-style profile scale.

Appendix B

Table A2. Characteristics of included studies according to the eligibility criteria for studies offering nutritional therapy primarily for type 2 diabetes mellitus.

Study/Year	Study Design	Country	Setting	Inclusion Criteria ^a	Intervention	Intensity of Intervention	Control	Outcomes	Follow Up
Adachi 2013	Cluster RCT	Japan	11 PHCC	Aged ≥ 20 and <79 , with clinically documented diagnosis of T2DM (i.e., HbA1c $\geq 6.5\%$)	Educational program delivered by dietitians	Three to 4 sessions over 6 months	Usual care and one session with dietitian for general nutritional advice	(i) changes in HbA1c; (ii) changes in weight, BMI, confidence in diabetes knowledge, satisfaction with daily life	6 months

Table A2. Cont.

Study/Year	Study Design	Country	Setting	Inclusion Criteria ^a	Intervention	Intensity of Intervention	Control	Outcomes	Follow Up
Adolfsson 2007	Cluster RCT	Sweden	18 PHCC	Aged < 75, HbA1c between 6.5% and 10%, diagnosed with T2DM at least 1 year before inclusion	Educational program delivered by physicians and diabetes specialists	Four to 5 sessions over 7 months	Usual care	(i) changes in HbA1c; (ii) changes in blood pressure, BMI, fasting plasma glucose, lipid profile, dietary intake	12 months
Baer 2020	Cluster RCT	USA	15 PHCC	Aged ≥ 20 and <70, BMI between 27 and 40, diagnosed with either HTN or T2DM	Educational program delivered by a non-clinical populational health manager	Access to an online weight management program, monthly check in calls for 12 months and one consultation with a dietitian at month 6	Usual care	(i) weight change; (ii) proportion of patients with weight loss > 5%, changes in SBP and DBP, lipid profile, HbA1C, quality of life, level of physical activity and confidence in ability to lose weight.	12 months
Benson 2019	RCT	USA	2 PHCC	Aged ≥ 45 and <75, meeting three or less optimal care measures (HbA1c < 8%, blood pressure < 140/90 mmHg, not using tobacco, taking a statin and aspirin as appropriate)	Educational program delivered by a dietitian	Monthly telephone coaching for 12 months	Usual care	(i) composite number of diabetes optimal care goals met; (ii) changes in BMI, LDL, HbA1c	12 months
Brown 2002	RCT	USA and Mexico	Community spaces	Aged ≥ 35 and <70, diagnosis of T2DM after 35 years old	Educational program delivered by nurses, dietitians, and community workers	Weekly two-hour individual sessions for three months followed by biweekly group sessions for six months	Usual care (wait list)	(i) diabetes-related knowledge, changes in HbA1c, fasting blood glucose, lipid profile, BMI	12 months
Browning 2016	Pragmatic cluster RCT	China	39 PHCC	Aged ≥ 50 registered in one of the participating PHCC	Educational program delivered by community physicians, nurses and psychologists	Monthly telephone and in person sessions for 12 months	Usual care	(i) changes in HbA1c; (ii) changes in SBP and DBP, BMI, waist and hip circumference, fasting plasma glucose, lipid profile, psychosocial and selfcare behavior outcomes	12 months
Clancy 2007	RCT	USA	1 PHCC	Aged ≥ 18 and HbA1c > 8%	Educational program delivered by internal medicine physicians and practice nurses	Monthly group sessions for 12 months	Usual care	(i) changes in HbA1c; (ii) changes in SBP and DBP, lipid profile	12 months
De la Fuente Coria 2020	RCT	Spain	1 PHCC	Aged ≥ 18 and <80	Educational program delivered by a trained practice nurse	Six 30-min sessions over 6 months, followed by two sessions at month 12 and month 18	Usual care	(i) changes in HbA1c, SBP, DBP, lipid profile; (ii) achievement of T2DM control targets (i.e., HbA1c < 7%, fasting glucose < 130 mg/dL)	12 months and 24 months
do Rosário Pinto 2017	RCT	Portugal	1 CHC	Middle-aged patients with HbA1c > 7.5%	Educational program delivered by doctors, nurses, psychologists, dietitians, pharmacists	Six sessions of individual or in group over 6 months	Usual care	(i) Changes in HbA1C, BMI and blood pressure, (ii) changes in self-care activities	6 months
Edelman 2015	RCT	USA	9 PHCC	Aged ≥ 18, diagnosis of T2DM (and HbA1C > 7.5%) concomitant to HTN, in use of hypertensive medication	Educational program delivered by a trained practice nurse	Twelve telephone sessions every two months for 24 months	Usual care, printed educational material	(i) changes in HbA1c and changes in SBP; (ii) changes in DBP, weight, lipid profile	24 months

Table A2. Cont.

Study/Year	Study Design	Country	Setting	Inclusion Criteria ^a	Intervention	Intensity of Intervention	Control	Outcomes	Follow Up
Eriksson 2009	RCT	Sweden	1 PHCC	Aged ≥ 18 and <65 , with clinically documented diagnosis of HTN, T2DM, obesity dyslipidaemia or any combination of the beforementioned	Educational program delivered by dieticians and physical educators in groups	Five sessions over 3 months, followed by 6 sessions within the 1st year, 4 sessions over the 2nd year and 2 over the 3rd year.	Usual care and printed educational material	(i) changes in anthropometry (BMI, weight, waist, waist-to-hip ratio), self-reported physical activity, blood pressure, lipid profile, fasting blood glucose, glucose tolerance, and HbA1c	3 years
Gabbay 2013	Pragmatic RCT	USA	12 PHCC	Aged ≥ 18 and <75 , with HbA1c: 8.5% or blood pressure: 140/90 mmHg or LDL:103	Counseling program delivered by trained practice nurses	Six sessions over 12 months	Usual care	(i) changes in HbA1c, LDL and blood pressure, satisfaction with diabetes regimen (DTSQ), quality of life (ADDQoL), depression symptoms (CES-D), diabetes self-management (SDSCA)	24 months
Hörnsten 2005	Cluster RCT	Sweden	4 PHCC	Aged ≥ 40 and <80 , diagnosed with T2DM within the last 2 years	Educational program delivered by a diabetes expert and practice nurses	Ten group sessions over 9 months	Usual care	(i) changes in HbA1c; (ii) overall well-being, treatment satisfaction, lipid profile, BMI, blood pressure	12 months
Huang 2010	Cluster RCT	Taiwan	5 PHCC	Aged ≥ 30 and <70 , registered at one of the participating centers	Educational program delivered by a dietician	Sessions every 3 months for 12 months	Usual care	(i) changes in HbA1c; (ii) changes in fasting plasma glucose, SBP, DBP, BMI, lipid profile	12 months
Javaid 2019	RCT	Pakistan	1 PHCC	Aged ≥ 18 and HbA1c $> 8\%$	Educational program delivered by a pharmacist	Monthly sessions form 15 to 30 min duration	Usual care	(i) changes in fasting plasma glucose and HbA1c; (ii) changes in blood pressure, lipid profile	9 months
Lean 2019	Cluster RCT	United Kingdom	49 PHCC	Aged ≥ 20 and <65 , diagnosed with T2DM within the last 6 years, BMI of 27–45 kg/m ²	Food substitution program followed by gradual reintroduction of meals	Formula diet for 3–5 months, stepped food reintroduction for 6–8 weeks, support for weight maintenance for 24 months	Usual care	(i) reduction in body weight of 15 kg or more, HbA1c $< 6.5\%$; (ii) changes in weight and HbA1c and number of antihypertensive drugs and antidiabetic drugs	24 months
Liss 2018	Cluster RCT	USA	2 CHC	Aged ≥ 18 and BMI ≥ 24 kg/m ²	Educational program delivered by wellness instructors	Weekly group sessions over 6 months, followed by 24 sessions over the second year	Usual care	(i) change in body weight; (ii) changes in HbA1c, SBP, total cholesterol and HDL cholesterol	12 months
Mash 2014	Pragmatic cluster RCT	South Africa	34 CHC	Adult patients registered at the participating community centers	Educational program delivered by health educators	Four group sessions during between 60–120 min	Usual care	(i) improved diabetes self-care activities, 5% weight loss and 1% reduction in HbA1c; (ii) changes in blood pressure, weight, waist circumference, HbA1c, lipid profile and quality of life	12 months
McDermott 2015	Pragmatic cluster RCT	Australia	12 Indigenous communities	Aged ≥ 18 , HbA1c $\geq 8.5\%$ and at least one major comorbidity	Educational program delivered to case workers from the community	Home visits and out-of-clinic care according to the patients' preferences	Usual care	(i) changes in HbA1c; (ii) Changes in blood pressure, weight, height, lipid profile; (iii) Quality of life	18 months
Mehuys 2011	Cluster RCT	Belgium	66 community pharmacies	Aged ≥ 45 and <74 , BMI ≥ 25 kg/m ² in use of hypoglycaemic medication for at least 12 months	Counseling program delivered by pharmacists	Monthly sessions over 6 months for healthy lifestyle advice including nutrition advice	Usual pharmacist care	(i) changes in fasting plasma glucose, HbA1c; (ii) Adherence to oral hypoglycaemic agents, self-management and knowledge about diabetes	6 months

Table A2. Cont.

Study/Year	Study Design	Country	Setting	Inclusion Criteria ^a	Intervention	Intensity of Intervention	Control	Outcomes	Follow Up
Moncrieft 2016	RCT	USA	CHC	Aged ≥ 18 and <70 , BMI ≥ 27 kg/m ² and significant depressive symptoms	Educational program delivered by therapists	Seventeen sessions over 12 months including nutrition advice (first 6 months) and behavioral maintenance strategies	Usual care	(i) Changes in weight, HbA1c and depressive symptoms; (ii) Glomerular filtration rate	6 and 12 months
Muchiri 2015	RCT	South Africa	2 CHC	Aged ≥ 40 and <70 , diagnosed with T2DM at least 1 year before inclusion, without insulin therapy	Educational program delivered by dieticians	Eight weekly sessions (2 h duration), followed by four monthly and two bimonthly groups sessions	Usual care, printed educational material	(i) Change in HbA1c; (ii) change in BI, blood pressure and lipid profile; (iii) dietary behaviors	6 and 12 months
Rosal 2011	RCT		CHC	Aged ≥ 18 and registered in the participating clinics	Educational program delivered by nutritionists and health educators	12 month	Usual care	(i) changes in HbA1c and BMI	4 and 12 months
Siaw 2017	RCT	Singapore	4 outpatient health-care institutions	Aged ≥ 21 , with HbA1c $> 7\%$, polypharmacy (taking > 5 medications) and multiple comorbidities	Educational program delivered by pharmacists, nurse educators and dieticians	30 min sessions monthly over 6 month	Usual care	(i) changes in HbA1c, SBP, lipid profile; (ii) Diabetes treatment satisfaction questionnaire	3 and 6 months
Smith 2011	Cluster RCT	Ireland	20 PHCC	Aged ≥ 18 and registered in the participating clinics	Educational program delivered by peer supporters	Nine sessions over two years	Usual care	(i) changes in HbA1c, blood pressure, cholesterol concentration and well-being; (ii) BMI, diabetes self-care activities, self-efficacy, adherence to medications	24 months
Taheri 2020	RCT	Qatar	1 PHCC	Aged ≥ 18 and <50 , diagnosed at most three years before inclusion, BMI > 27 kg/m ²	Food substitution program followed by gradual reintroduction of meals	12 week meal replacement, followed by 12-week stepped food reintroduction and maintenance counseling for 6 months	Usual care, standard diet and activity advice	(i) changes in weight; (ii) changes in HbA1c and proportion of patients in diabetes remission (HbA1c $< 6.5\%$ without antidiabetic medication)	12 months
Tejada Tayabas 2006	RCT	Mexico	1 PHCC	Aged ≥ 18 , diagnosed at most four years before inclusion, without comorbidities	Educational program delivered by the investigators	Five group monthly sessions followed by four monthly individual counseling sessions	Usual Care	(i) changes in HbA1c	9 months
Toobert 2011	RCT	USA	9 PHCC and 1 CHC	Aged ≥ 30 and <75 , Latino ethnicity, diagnosed at least six months before inclusion	Mediterranean Diet	2 1/2-day retreat followed by weekly meetings over 6 months, that became less frequent until bi-monthly from month 18 to 24	Usual care	(i) Self-efficacy and behavior change; (ii) BMI, HbA1c, cardiovascular risk	12 and 24 months
Vos 2019	RCT	The Netherlands	43 PHCC	Aged ≥ 18 and <75 , diagnosed at least 3 months and at most 5 years before inclusion	Educational program delivered by a nurse	Two individual and 5 groups sessions over 12 weeks, followed by a booster session at month 12	Usual care	(i) change in BMI; change in HbA1c, SBP, lipid profile, self-management behavior, medication adherence, health status, diabetes-related quality of life and cost-effectiveness	30 months

Table A2. Cont.

Study/Year	Study Design	Country	Setting	Inclusion Criteria ^a	Intervention	Intensity of Intervention	Control	Outcomes	Follow Up
Wolf 2004	RCT	USA	1 general practice research center	Aged ≥ 20 , BMI ≥ 27 kg/m ² , in use of antidiabetic medication	Counseling program delivered by a dietician	Six individual sessions and 1 group session over 12 months	Usual care, printed educational material	(i) changes in weight and waist circumference; (ii) changes in HbA1c, lipid profile, use of prescription medications and quality of life	6 and 12 months

^a Inclusion criteria besides having a diagnosis of type II diabetes mellitus. Abbreviations. RCT: randomized controlled trial; PHCC: primary health care center; CHC: community health center; HTN: hypertension; SBP: systolic blood pressure; DBP: diastolic blood pressure; BMI: body mass index; LDL: low-density lipoprotein cholesterol; DTSQ: Diabetes treatment satisfaction questionnaire; ADDQoL: Audit of Diabetes Dependent Quality of Life questionnaire; CES-D: Center for Epidemiologic Studies Depression scale; SDSCA: Summary of Diabetes Self-Care Activities questionnaire.

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