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TITLE PAGE

Title. Social Network Interventions for Dietary Adherence among Adults with Type 2 Diabetes: A Systematic Review and Meta-Analysis Protocol.

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ABSTRACT

Introduction. Optimal adherence to recommended diets is crucial to achieving long-term glycemic control among individuals with type 2 diabetes (T2D) individuals. However, there is limited evidence on the effectiveness of interventions that target dietary adherence through social networks. Since social networks can influence individuals' health behaviors, it is important to thoroughly evaluate the impact of social network interventions on dietary adherence in adults with T2D. This systematic review protocol aims to provide insights into future interventions and improve diabetes management strategies.

Method and Analysis. PubMed, Embase, CINAHL Complete, Cochrane Central Register of Controlled Trials, ProQuest Dissertations and Theses, and Google Scholar will be searched from inception to date for relevant randomized and non-randomized controlled trials of at least three months duration. In addition, studies that compared interventions involving the social networks (families, friends, and peers) of T2D adults with interventions without social networks will be included. Two reviewers will independently screen search outputs according to inclusion and exclusion criteria, critically evaluate the selected literature, and extract data on the study setting, design, participants' characteristics, interventions, controls, and duration of follow-up, using a standard data extraction form. Quantitative data analysis will be performed where studies are homogenous in characteristics and provide adequate outcome data for meta-analysis. Otherwise, data will be synthesized using narrative synthesis. Finally, trials will be assessed for bias risk and overall evidence certainty using the GRADE system.

Ethics and dissemination. Ethical approval is not required for literature-based studies. The results will be disseminated through peer-reviewed publications.

PROSPERO registration number. CRD42023441223

Keywords: Type 2 diabetes; dietary adherence; social network or support; controlled trials.

STRENGTHS AND LIMITATIONS OF THIS STUDY

1. Food culture is an important determinant of health, and people's social networks have an important influence on their food-related beliefs and practices. Yet, there is a paucity of evidence on the effect of social networks' interventions on dietary adherence among adults with type 2 diabetes. This review will provide evidence to inform interventions that enhance dietary adherence to manage T2D.
2. Studies conducted in languages other than English, including French, and Spanish will be included if available, which may limit language bias.
3. High-quality intervention studies may not be widely available, which may limit the contribution of the review to policy and practice.

INTRODUCTION

Type 2 diabetes (T2D) presents a significant challenge to public health, burdening individuals, communities, healthcare systems, and societies worldwide.[1-4] Despite medical treatments, poor dietary intake remains critical to unfavorable outcomes for T2D patients, affecting sustained glycemic control and long-term health outcomes.[5-7] A healthy diet is crucial for adults with T2D as it contributes to optimal weight control, body mass index (BMI), and hemoglobin A1c (HbA1c), which indicate long-term glycemic conditions.[8-10]

Although adherence to dietary recommendations plays a crucial role in sustained dietary control and long-term diabetes outcomes, dietary adherence among T2D patients is disconcertingly low, with only 25% of T2D patients following their recommended dietary plans.[11,12] Factors such as competing demands, emotional distress, low self-commitment, low self-efficacy, and insufficient social support contribute to this challenge.[13,14] Therefore, achieving a healthy diet and maintaining a sustainable lifestyle necessitates significant resources and individual commitment. In addition, social support is crucial in helping individuals manage the self-management workload associated with these efforts.[15,16] In this context, social networks have emerged as an opportunity for innovative interventions to catalyze and sustain behavioral changes in individuals with T2D.[17]

Social networks encompass the intricate web of social relationships surrounding individuals, connecting them with family, friends, coworkers, and neighbors. For T2D patients, these networks are critical for providing social, psychological, and behavioral support.[17,18] Social networks often offer functional and structural support that assists decision-making and enhances mental and physical resilience, enabling individuals to cope better with the lifelong burden of diabetes.[19-22] When it comes to implementing behavioral changes, social networks serve as a source of encouragement, helping to reduce the risk of relapse and maintain positive diet and lifestyle habits.[22,23]

Previous studies have explored the connection between social networks and health, suggesting two main hypotheses (**Figure 1**): the stress-buffering or stress-exacerbating hypothesis and the social contagion or behavioral hypothesis.[21,24,25] Among patients with T2D, social network interventions have proven effective in promoting immediate self-management behaviors.[17,22,31-34] In a meta-analysis of 19 randomized controlled trials (RCTs) conducted by Spencer-Bonilla et al.,[34] social networks were linked to enhanced social

support and lower levels of HbA1c after three months. Additionally, other studies have shown that social support positively increases self-efficacy for diabetes management, such as maintaining healthy diets and regular physical exercise.[27-29] Finally, T2D patients with supportive families are more likely to adhere to dietary recommendations [30-32] and have greater self-efficacy, leading to improved adherence to diet recommendations.[33]

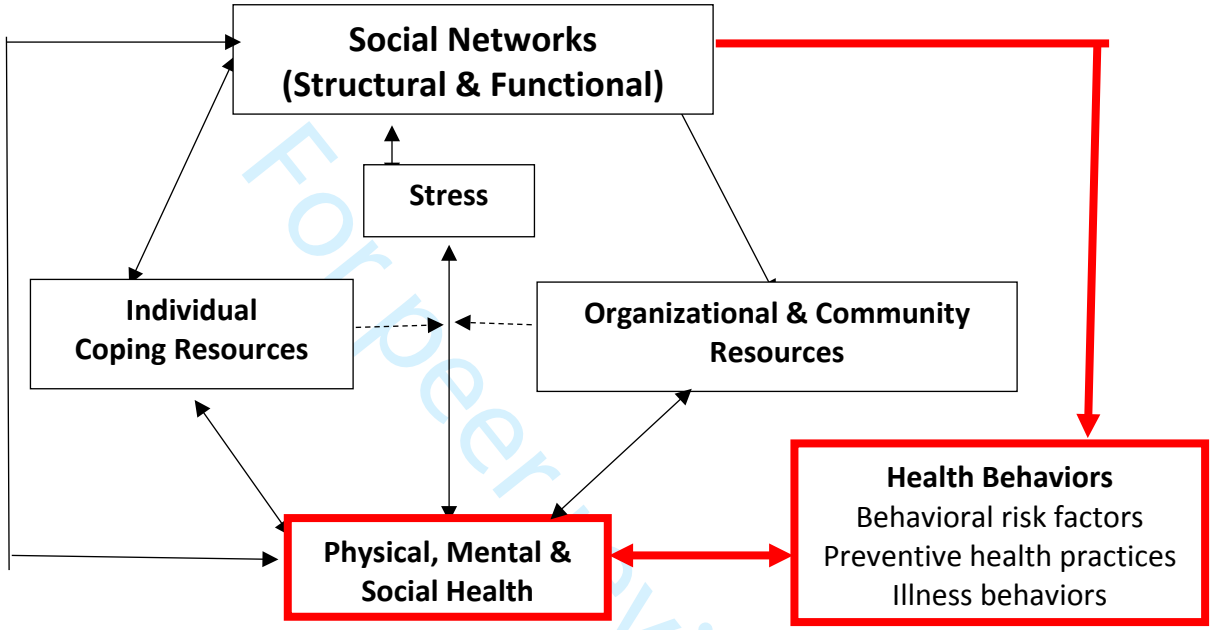

Figure 1. Conceptual framework for the relationship of social networks to health [21,24]

According to Koetsenruijter et al.[26] having an extensive informational and emotional support network can significantly improve the self-management abilities of individuals with T2D. However, previous reviews have not explored the impact of informal relationships on diabetes care or evaluated the effects of social network interventions on dietary adherence, which is crucial for maintaining glycemic control. Additionally, it is unclear which approaches to social network interventions are most effective.[35,36] To address these gaps, this review aims to assess the effectiveness of social network interventions, such as involving families, friends, and peers, in improving dietary adherence and glycemic control among those with T2D. We will compare interventions involving patients' social networks and those that do not examine the characteristics of social network interventions that improve dietary adherence and long-term glycemic control. By doing so, this systematic review will provide a better understanding of network interventions and how they can enhance diabetes outcomes among T2D patients through the social contagion behavioral pathway.

METHODS AND ANALYSIS

Our review will follow the guidelines outlined in the Cochrane Handbook while adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Checklist, which is provided as an additional file.[37] In addition, this protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO; CRD42023441223).

Criteria for considering studies for this review.

Types of studies. Studies that utilized experimental and quasi-experimental study designs, including randomized controlled trials (RCTs) and non-randomized controlled studies (NRS), will be selected for the systematic review. In the absence of RCTs and NRS, we will consider the following observational studies: 1) Cohort studies (prospective or retrospective); 2) Case-control studies; 3) controlled before-and-after study (CBA); and 4) Interrupted time series studies. We will exclude reviews, cross-sectional studies, qualitative studies, conference proceedings, studies with incomplete data, and authors who cannot be contacted.

Participants. The study population will be adults aged ≥18 years, with a diagnosis of T2D, as defined by the World Health Organization (WHO) (HbA1C ≥6.5% or fasting blood glucose ≥126 mg/dl mg/dl or an oral glucose tolerance test (OGTT) two-hour blood glucose ≥ 200 mg/dl or a random plasma glucose test ≥ 200 mg/dl),[38] or American Diabetes Association (ADA) (fasting blood glucose ≥7.0 mmol/l (whole blood ≥ 6.1 mmol/l) or an OGTT two-hour blood glucose ≥ 11.1 mmol/l or a random plasma glucose test ≥ 11.1 mmol/l).[39] We will exclude studies of individuals with prediabetes, and metabolic syndrome without a definitive diagnosis of T2D, Type 1 diabetes, and gestational diabetes.

Interventions. The intervention must include a social network component. 'Social network components' (or parts of interventions) that engage participants' social networks to facilitate diet and behavior change. This could include advising, arranging, or providing social support through the participant's existing social network (like partners, family, and friends) or creating new social networks (like other intervention participants or peer mentors). The social network support interventions can be direct, i.e., directly involving networks (e.g., partners attending classes) or indirect (e.g., participants are told to enlist relatives' support for healthy eating). Diet, or diet and physical activity components, must be a part of the intervention, and diet

change or dietary adherence must be one of the outcomes. Interventions may be individualized, or group based.

The intervention must be conducted for at least three months. Since the long-term diabetes biomarker, HbA1c is only sensitive over 2-3 months.[40] Studies with intervention less than a 12-week follow-up period will be excluded. Also, studies involving support solely from staff or health professionals or looking at group-based interventions without explicit mention of social support or social networks will be excluded. Finally, studies with pharmacological and medical interventions devoid of diet modification as a critical component will be excluded.

Comparators. Comparators will include no intervention, standard management for T2D, or other interventions without a social network component.

Outcome measures. This review will consider studies that include the following primary outcomes: 1) documented and evaluated dietary changes, including adherence to dietary recommendations or prescribed diet plans. Dietary adherence can reflect selective and predefine diets, for example, Mediterranean or vegetarian diets, or focused on single calorific attributes (such as foods or food groups - carbohydrates, fruit, vegetables, fiber, sugar-free, oils, or fats).[41-43] 2) Glycemic control is assessed using hemoglobin A1c (HbA1c), fasting blood glucose, or random plasma glucose test.

Secondary outcomes will include 1) social network measures; 2) social support; 3) physical measures (body mass index (BMI, kg/m^2), weight (kg), blood pressure (systolic and diastolic (mmHg)); 4) diet and diabetes knowledge; 5) symptoms, for example, reduction in polyuria, polydipsia, fatigue; 6) diabetic complications, for example, cardiovascular events, retinopathy, diabetic foot, nephropathy, neuropathy, hypoglycemia, and hyperglycemia; 7) psychological effects including quality of life; and 8) metabolic outcomes (lipids - total cholesterol (mmol/L), HDL cholesterol (mmol/L), LDL cholesterol (mmol/L), triglycerides (mmol/L).

Search methods for identification of studies.

Electronic searches. We will search the following databases from inception to July 31, 2023. The Cochrane Library – Central Register of Controlled Trials (CENTRAL) and Cochrane Database of Systematic Reviews; PUBMED, EMBASE, EPOC (Effective Practice and Organization of Care), LILACS, Open Grey, ProQuest Dissertations and Theses, and Google Scholar. We will also check the reference lists of retrieved studies for additional reports of

relevant studies. There will be no language restrictions. We will use the PRISMA-P (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guideline and flow diagram to report the search and selection of studies.[44]

Search strategy. Our search strategy aims to identify published and unpublished studies and will consist of three steps. First, working with a librarian, an initial limited search using PubMed will be undertaken, followed by an analysis of the text in the title and abstract and the index terms used to describe the articles. Search terms will be classified into four categories: (1) T2D, (2) social network intervention(s), (3) diet change or adherence, and (4) study design. Then, with the strategy developed using PubMed, a second search will be conducted using all identified keywords and index terms across all included databases. The specific terms and concepts that will be searched are shown in **Table 1**.

Table 1: Pubmed search strategy.

("social support"[mesh] OR "social support"[tiab] OR ((social[tiab] OR famil*[tiab] OR parent*[tiab] OR OR peer[tiab] OR spous*[tiab] OR neighbor*[tiab] OR friend*[tiab] OR child*[tiab] OR coworker*[tiab] OR co-worker*[tiab] OR colleague*[tiab]) AND (support*[tiab] OR network*[tiab] OR encourage*[tiab]))) AND ("Diet, Food, and Nutrition"[Mesh] OR diet*[tiab] OR nutrition*[tiab] OR alimentary[tiab] OR meal*[tiab] OR food*[tiab] OR eating[tiab]) AND ("Diabetes Mellitus, Type 2"[mesh] OR diabet*[tiab]) AND (control*[tiab] OR cohort[tiab] OR "interrupted time-series"[tiab])

Study Selection

After the search, all identified records will be retrieved and uploaded to Covidence, and duplicate references and abstracts will be deleted. Two reviewers will independently screen titles and abstracts to assess the inclusion criteria for the review. Potentially relevant studies will be retrieved for full-text review and will undergo critical approval using the checklist of eligibility characteristics (participants, intervention, comparators, outcomes, and study design (PICOS) (**Table 2**). Full-text articles that meet the inclusion criteria will undergo a full-text review. For excluded studies, reasons for exclusion will be provided in an appendix to the final systematic review report. Search results will be fully reported in the final review and

presented in the PRISMA flow chart.[44] Any reviewers' disagreements regarding study eligibility will be resolved through discussion with a third reviewer.

Table 2: Eligibility screening form

Study Characteristics	Yes	No	Unclear
1. Study design A) Randomized controlled trial B) Non-randomized comparative trial C) Observational studies			
2. Study participants A) Adults ≥18 years? (and/or) B) Diagnosis of T2D based on WHO criteria C) Diagnosis of T2D based on ADA criteria			
3. Intervention A) Intervention involving social networks Duration ≥ 3 months B) Did the intervention include? • family (spouses, children, parents, etc.) • laypersons (friends, coworkers, neighbors) • peers (with type 2 diabetes)			
4. Control A) No intervention B) Usual treatment and care C) Intervention without social networks			
***5. Outcome measures** A) Were any of the following outcomes reported? • diet changes or dietary adherence • glycemic control (HbA1c, fasting blood glucose, OGTT, or a random plasma glucose test) • physical measures (BMI and blood pressure), • diet and diabetes knowledge • symptoms (reduction in polyuria, polydipsia, fatigue) • diabetic complications (CVD, retinopathy, diabetic foot, nephropathy, neuropathy, and hyperglycemia) • psychological and adverse effects (quality of life) • metabolic outcomes (lipids)			
6. Decision A) Include? …… B) Exclude? …… C) UNCLEAR? ……			
7. Comments/Reasons for Exclusion			

NOTE: A) include if all is "YES"; B) Exclude if 2A, 2B, 3A, 3B, 5A are" NO" C) Otherwise " UNCLEAR"
*Note that the absence of outcome measure is not an exclusion criterion at this stage of eligibility screening; simply indicate outcomes assessed in each included study.

Data extraction

Two reviewers will independently extract data from each eligible study using the Cochrane Collaboration's standard data extraction form.[45] We will resolve differences through

discussion and consensus among all reviewers. We will extract data on the study setting, design, participants' characteristics, interventions, controls, and follow-up duration. We will also extract data on sample size, age, and data collection methods. Whenever possible, we will retrieve qualitative information on the context and potential confounding factors. As indicated earlier, we will collect data on the primary and secondary outcomes. Where necessary, we will contact the authors of the included studies for additional information or missing data. This review will not require Internal Review Board approval as no human subjects will be directly involved.

Assessment of risk of bias in included studies.

Two review authors will independently assess the risk of bias of each included study, using a 'Risk of bias' form. We will attempt to contact the study authors if the necessary information is not specified or is unclear. We will resolve any disagreements by discussion between review authors. For RCTs or quasi-RCTs, we will use the Cochrane Risk of Bias tool for RCTs.[46] For observational studies with a control group, we will use the Cochrane Risk Of Bias In Non-randomized Studies – of Interventions (ROBINS-I).[47]

We will assess whether the study authors have employed methods to control selection bias at the design stage (e.g., matching or restriction to subgroups) and their analysis methods (e.g., stratification or regression modeling). For studies with a separate control group (randomized controlled trials, non-randomized controlled trials, controlled before-after studies), we will assess eight components: generation of the randomization sequence; allocation concealment; blinding (performance and detection bias); baseline outcome measurement; similarity in baseline characteristics; incomplete outcome data; selective outcome reporting; and other biases.

Seven standard criteria will be used for all Intermittent Time Series (ITS) studies. We will assess the independence of the intervention; pre-specification of the intervention effect; the likelihood of the intervention affecting data collection; blinding; incomplete outcome data; selective outcome reporting; and other biases. Judgments of 'yes', 'no', and 'unclear' will indicate a low, high, or unclear risk of bias. We will present the assessment results in a 'Risk of bias' graph, Risk of bias tables, and a summary. Finally, the risk of bias in systematic reviews will be assessed using the ROBIS tool.[48]

Data synthesis and analysis

We will perform quantitative data synthesis where studies are homogenous in characteristics and provide adequate outcome data for meta-analysis. Intervention effects from the included trials will be calculated and presented as odds ratios (for categorical outcomes) or standardized mean differences (for continuous outcomes) with 95% confidence intervals. We will pool the results using a random-effects meta-analysis to address heterogeneity for quantitative studies with the same outcome and similar population, intervention, and comparator. Statistical analyses will be calculated using the Cochrane statistical package, Review Manager.[49] A summary of the findings table will present the findings for each primary and secondary outcome.

Assessment of heterogeneity. Heterogeneity between the results of the primary studies will be assessed using Cochran's Q test and quantified with the I^2 statistics. A p-value of less than 0.1 will be considered to suggest statically significant heterogeneity, considering a category of a small number of studies and their heterogeneity in design.[50] Heterogeneity will take low, moderate, and high categories when the I^2 values are below 25%, between 25% and 75%, and above 75%, respectively.[51,52] Thus, the random effect model will pool the proportion of dietary adherence if the studies are found to be heterogeneous. The random effect model accounts for heterogeneity among study results beyond the variation associated with chance, unlike the fixed-effect model.[53]

We will investigate sources of heterogeneity using subgroup analysis. Random-effects meta-regression will take primary study characteristics such as region, study setting, and outcome. The meta-regression analysis will be weighted to account for the residual between-study heterogeneity (i.e., heterogeneity not explained by the covariates in the regression).[54]

Narrative synthesis. If meta-analysis is not possible due to substantial heterogeneity, we will conduct a narrative synthesis using the framework developed by the Economic and Social Research Council.[55] This approach includes four stages: 1) developing a theory of how the interventions work, 2) conducting a preliminary synthesis of included studies, 3) exploring the relationships in the data, and 4) assessing the robustness of the synthesis. We will also use text and tables to summarize and group findings by population characteristics (e.g., region); intervention type (e.g., existing social networks versus created social networks); intervention

characteristics (e.g., social network functions intensity and duration of intervention); and outcome measures (e.g., diet changes, dietary adherence, glycemic control).

Analysis of subgroups or subsets. If sufficient data are available, subgroup analyses will be conducted on the following factors:

- social network members: family members, friends, or peers of patients
- intervention types: existing or created social networks, diet only, or diet and exercise.

Publication bias assessment. Publication bias will be assessed by visual inspection of funnel plots based on the shape of the graph (subjective assessment). The symmetrical graph will be interpreted to suggest an absence of publication bias, whereas an asymmetrical one indicates the presence of publication bias. On the other hand, qualitatively (objective evaluation), Egger's weighted regression tests will be used to assess publication bias, and a p-value less than 0.1 considered indicative of a statistically significant publication bias.[56]

Sensitivity analysis. A sensitivity analysis will be done to estimate whether the pooled effect size was affected by single studies. A leave-one-out sensitivity analysis will be performed by removing studies with a 'high risk of bias' and by removing outliers contributing to statistical heterogeneity. We will also assess evidence of publication bias.

Assessment of quality of evidence. The GRADE method for assessing confidence in the quality of the evidence will be used for this review, and the results will be displayed in the Summary of Findings created using GRADEpro (McMaster University, ON, Canada).[57] The Summary of Findings will present the following information, where appropriate: absolute risks for the treatment and control, estimates of relative risk, and a ranking of the quality of the evidence based on the risk of bias, directness, heterogeneity, precision, and risk of publication bias of the review results.

DISCUSSION

This review will highlight the extent to which interventions involving social networks that have a significant effect on health behaviors and outcomes can improve dietary adherence among patients with T2D. Increasing understanding of the structure, characteristics, and functions of social networks and their impact on health behaviors will provide structured evaluation and information on effective interventions to improve dietary adherence.[17] Where data permits,

this review will summarize how to effectively apply social network intervention approaches to increase dietary adherence. As a result, this review will strengthen the knowledge base on dietary adherence, a topic of critical importance for patients, dietitians, and other healthcare professionals. The findings of this review will also provide directions for future research and provide practitioners with a better understanding of social networks. Since dietary adherence is considered a mediating factor in long-term diabetes management, results from this proposed study will be useful for developing interventions that leverage individuals' social networks for long-term benefits, potentially preventing further type 2 diabetes complications.

Patient and public involvement

Since this study is a secondary study based on other studies, there will be no direct patient or public involvement in this study.

Ethics and dissemination

Because no patients were involved, ethical approval was not required. The final results of this research will be submitted to a peer-reviewed journal or presented at relevant conferences, and any deviations from this protocol will be recorded and explained in the final report.

Contributors. The original idea was conceived by HA. HA and AO drafted the manuscript for this protocol. HA, AO, SY, JM and JE participated in the design of the study and the setting of the inclusion and exclusion criteria. AO and SY will perform the literature screening and data extraction. WAH and JE will review and provide critical input to all drafts of the review, including the final version. HA is the guarantor.

Funding. This work was supported by the National Institutes of Health Fogarty International Center (Award number K01TW012422). The founder had no role in the design of the planned research or the writing of the protocol.

Competing interests. None declared.

Patient and public involvement. Patients and/or the public were not involved in the design, conduct, reporting, or dissemination plans of this research.

Patient consent for publication. Not applicable.

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TITLE PAGE

Title. Social Network Interventions for Dietary Adherence among Adults with Type 2 Diabetes: A Systematic Review and Meta-Analysis Protocol.

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ABSTRACT

Introduction. Optimal adherence to recommended diets is crucial to achieving long-term glycemic control among individuals with type 2 diabetes (T2D) individuals. However, there is limited evidence on the effectiveness of interventions that target dietary adherence through social networks. Since social networks can influence individuals' health behaviors, it is important to thoroughly evaluate the impact of social network interventions on dietary adherence in adults with T2D. This systematic review protocol aims to provide insights into future interventions and improve diabetes management strategies.

Method and Analysis. PubMed, Embase, CINAHL Complete, Cochrane Central Register of Controlled Trials, ProQuest Dissertations and Theses, and Google Scholar will be searched from inception to December 2023 for relevant randomized and non-randomized controlled trials of at least three months duration. In addition, studies that compared interventions involving the social networks (families, friends, and peers) of T2D adults with usual care, no intervention, or an intervention with no explicit social network component, will be included. Two reviewers will independently screen search outputs according to inclusion and exclusion criteria, critically evaluate the selected literature, and extract data on the study setting, design, participants' characteristics, interventions, controls, social network functions, and duration of follow-up, using a standard data extraction form. Quantitative data analysis will be performed where studies are homogenous in characteristics and provide adequate outcome data for meta-analysis. Otherwise, data will be synthesized using narrative synthesis. Finally, trials will be assessed for bias risk and overall evidence certainty using the GRADE system.

Ethics and dissemination. Ethical approval is not required for literature-based studies. The results will be disseminated through peer-reviewed publications.

PROSPERO registration number. CRD42023441223

Keywords: Type 2 diabetes; dietary adherence; social network or support; controlled trials.

STRENGTHS AND LIMITATIONS OF THIS STUDY

1. This review will provide the most comprehensive systematic review of the effectiveness of social network interventions on dietary adherence to date among adults with type 2 diabetes.
2. We will use the rigorous methodology in accordance with the Cochrane handbook and the results will be reported as stated by Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.
3. Studies conducted in languages other than English, including French, and Spanish will be included if available, which may limit language bias.
4. High-quality intervention studies may not be widely available, which may limit the contribution of the review to policy and practice.

INTRODUCTION

Type 2 diabetes (T2D) presents a significant challenge to public health, burdening individuals, communities, healthcare systems, and societies worldwide.[1-4] Despite medical treatments, poor dietary intake remains critical to unfavorable outcomes for T2D patients, affecting sustained glycemic control and long-term health outcomes.[5-7] A healthy diet is crucial for adults with T2D as it contributes to optimal weight control, body mass index (BMI), and hemoglobin A1c (HbA1c), which indicate long-term glycemic conditions.[8-10]

Although adherence to dietary recommendations plays a crucial role in sustained dietary control and long-term diabetes outcomes, dietary adherence among T2D patients is disconcertingly low, with only 25% of T2D patients following their recommended dietary plans.[11,12] Factors such as competing demands, emotional distress, low self-commitment, low self-efficacy, and insufficient social support contribute to this challenge.[13,14] Therefore, achieving a healthy diet and maintaining a sustainable lifestyle necessitates significant resources and individual commitment. In addition, social support is crucial in helping individuals manage the self-management workload associated with these efforts.[15,16] In this context, social networks have emerged as an opportunity for innovative interventions to catalyze and sustain behavioral changes in individuals with T2D.[17]

Social networks encompass the intricate web of social relationships surrounding individuals, connecting them with family, friends, coworkers, and neighbors. For T2D patients, these networks are critical for social, psychological, and behavioral support.[17,18] According to Koetsenruijter et al.,[19] having a comprehensive informational and emotional support network can significantly enhance their self-management abilities. Social networks often provide functional and structural support that aids decision-making and strengthens mental and physical resilience, enabling individuals to better cope with diabetes lifelong challenges.[20-23] When it comes to making behavioral changes, social networks serve as a source of encouragement, reducing the likelihood of relapse and maintaining healthy lifestyles.[23,24]

Previous studies have explored the connection between social networks and health, suggesting two main hypotheses (**Figure 1**): the stress-buffering or stress-exacerbating hypothesis and the social contagion or behavioral hypothesis.[22,25,26] Among patients with T2D, social network interventions have proven effective in promoting immediate self-management behaviors.[17,23,27-30] In a meta-analysis of 19 randomized controlled trials (RCTs)

conducted by Spencer-Bonilla et al.,[30] social networks were linked to enhanced social support and lower levels of HbA1c after three months. Additionally, other studies have shown that social support positively increases self-efficacy for diabetes management, such as maintaining healthy diets and regular physical exercise.[31-33] Finally, T2D patients with supportive families are more likely to adhere to dietary recommendations [34-36] and have greater self-efficacy, leading to improved adherence to diet recommendations.[37]

Unfortunately, previous systematic reviews and meta-analyses focused on glycemic control but did not thoroughly investigate the effectiveness of social network interventions for dietary adherence despite its social nature and importance in maintaining glycemic control.[17,30,38,39] There is also a need to explore the impact of different network intervention approaches, which these reviews have not covered. Additionally, while increasing evidence supports the role of non-healthcare professionals such as peers in diabetes management and education,[40] these reviews did not explore the impact of informal and interpersonal relationships on diabetes care. To address these gaps, this review aims to assess the effectiveness of social network interventions, such as engaging families, friends, and peers, in improving dietary adherence among T2D patients. We will include randomized trials (RCTs), non-randomized trials (NRTs) and controlled before-and-after (CBAs) studies that compared a social network intervention against the following comparators: usual care, no intervention, or an intervention with no explicit social network component. We will also examine whether different network interventions approaches—individual, segmentation, induction, or alteration—vary in their effectiveness.[41] As a result, this review will provide a better understanding of how network interventions can improve health behaviors and outcomes among T2D patients.

METHODS AND ANALYSIS

Our review will follow the guidelines outlined in the Cochrane Handbook while adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Checklist, which is provided as an additional file (**see S1 PRISMA Checklist**).[42] In addition, this protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO; CRD42023441223).

Criteria for considering studies for this review.

Types of studies. Studies that utilized experimental and quasi-experimental study designs, including randomized controlled trials (RCTs) and non-randomized controlled studies (NRTs), will be selected for the systematic review. In the absence of RCTs and NRTs, we will consider controlled before-and-after (CBAs) studies. We will exclude observational studies, reviews, cross-sectional studies, qualitative studies, conference proceedings, studies with incomplete data, and authors who cannot be contacted.

Participants. The study population will be adults aged ≥18 years, with a diagnosis of T2D, as defined by the World Health Organization (WHO) (HbA1C ≥6.5% or fasting blood glucose ≥126 mg/dl mg/dl or an oral glucose tolerance test (OGTT) two-hour blood glucose ≥ 200 mg/dl or a random plasma glucose test ≥ 200 mg/dl),[43] or American Diabetes Association (ADA) (fasting blood glucose ≥7.0 mmol/l (whole blood ≥ 6.1 mmol/l) or an OGTT two-hour blood glucose ≥ 11.1 mmol/l or a random plasma glucose test ≥ 11.1 mmol/l).[44] We will exclude studies of individuals with prediabetes, and metabolic syndrome without a definitive diagnosis of T2D, Type 1 diabetes, and gestational diabetes.

Interventions. The intervention must include a social network component. 'Social network components' (or parts of interventions) that engage participants' social networks to facilitate diet and behavior change. This could include advising, arranging, or providing social support through the participant's existing social network (like partners, family, and friends) or creating new social networks (like other intervention participants or peer mentors). The social network support interventions can be direct, i.e., directly involving networks (e.g., partners attending classes) or indirect (e.g., participants are told to enlist relatives' support for healthy eating). Diet, or diet and physical activity components, must be a part of the intervention, and diet change or dietary adherence must be one of the outcomes. Interventions may be individualized, or group based.

The intervention must be conducted for at least three months. Since the long-term diabetes biomarker, HbA1c is only sensitive over 2-3 months.[45] Studies with intervention less than a 12-week follow-up period will be excluded. Also, studies involving support solely from staff or health professionals or looking at group-based interventions without explicit mention of social support or social networks will be excluded. Finally, studies with pharmacological and medical interventions devoid of diet modification as a critical component will be excluded.

Comparators. Comparators will include no intervention, standard management for T2D, or other interventions with no explicit social network component.

Outcome measures. This review will consider studies that include the following primary outcomes: 1) documented and evaluated dietary changes, including adherence to dietary recommendations or prescribed diet plans. Dietary adherence can reflect selective and predefine diets, for example, Mediterranean or vegetarian diets, or focused on single calorific attributes (such as foods or food groups - carbohydrates, fruit, vegetables, fiber, sugar-free, oils, or fats).[46-48] 2) Glycemic control is assessed using hemoglobin A1c (HbA1c), fasting blood glucose, or random plasma glucose test.

Secondary outcomes will include 1) physical measures (body mass index (BMI, kg/m^2), weight (kg), blood pressure (systolic and diastolic (mmHg)); 2) diet and diabetes knowledge; 3) symptoms, for example, reduction in polyuria, polydipsia, fatigue; 4) diabetic complications, for example, cardiovascular events, retinopathy, diabetic foot, nephropathy, neuropathy, hypoglycemia, and hyperglycemia; 5) psychological effects including quality of life; and 6) metabolic outcomes (lipids - total cholesterol (mmol/L), HDL cholesterol (mmol/L), LDL cholesterol (mmol/L), triglycerides (mmol/L).

Search methods for identification of studies.

Electronic searches. We will search the following databases from inception to December 2023. The Cochrane Library – Central Register of Controlled Trials (CENTRAL) and Cochrane Database of Systematic Reviews; PUBMED, EMBASE, EPOC (Effective Practice and Organization of Care), LILACS, Open Grey, ProQuest Dissertations and Theses, and Google Scholar. We will also check the reference lists of retrieved studies for additional reports of relevant studies. There will be no language restrictions. We will use the PRISMA-P (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guideline and flow diagram to report the search and selection of studies.[49]

Search strategy. Our search strategy aims to identify published and unpublished studies and will consist of three steps. First, working with a librarian, an initial limited search using PubMed will be undertaken, followed by an analysis of the text in the title and abstract and the index terms used to describe the articles. Search terms will be classified into four categories: (1) T2D, (2) social network intervention(s), (3) diet change or adherence, and (4) study design. Then, with the strategy developed using PubMed, a second search will be

conducted using all identified keywords and index terms across all included databases. The specific terms and concepts that will be searched are shown in **Table 1**. Examples of the search strategy for all databases were also provided in **S2 Table All databases search strategy**.

Table 1: PubMed search strategy.

("social support"[mesh] OR "social support"[tiab] OR ((social[tiab] OR famil*[tiab] OR parent*[tiab] OR OR peer[tiab] OR spous*[tiab] OR neighbor*[tiab] OR friend*[tiab] OR child*[tiab] OR coworker*[tiab] OR co-worker*[tiab] OR colleague*[tiab]) AND (support*[tiab] OR network*[tiab] OR encourage*[tiab])))
AND
("Diet, Food, and Nutrition"[Mesh] OR diet*[tiab] OR nutrition*[tiab] OR alimentary[tiab] OR meal*[tiab] OR food*[tiab] OR eating[tiab])
AND
("Diabetes Mellitus, Type 2"[mesh] OR diabet*[tiab])
AND
(control*[tiab] OR cohort[tiab] OR "interrupted time-series"[tiab])

Study Selection

After the search, all identified records will be retrieved and uploaded to Covidence, and duplicate references and abstracts will be deleted. Two reviewers will independently screen titles and abstracts to assess the inclusion criteria for the review. Potentially relevant studies will be retrieved for full-text review and will undergo critical approval using the checklist of eligibility characteristics (participants, intervention, comparators, outcomes, and study design (PICOS) (**Table 2**). Full-text articles that meet the inclusion criteria will undergo a full-text review. For excluded studies, reasons for exclusion will be provided in an appendix to the final systematic review report. Search results will be fully reported in the final review and presented in the PRISMA flow chart.[49] Any reviewers' disagreements regarding study eligibility will be resolved through discussion with a third reviewer.

Table 2: Eligibility screening form

Study Characteristics	Yes	No	Unclear
1. Study design A) Randomized controlled trial B) Non-randomized comparative trial C) Observational studies			

2. Study participants A) Adults ≥18 years? (and/or) B) Diagnosis of T2D based on WHO criteria C) Diagnosis of T2D based on ADA criteria			
3. Intervention A) Intervention involving social networks Duration ≥ 3 months B) Did the intervention include? • family (spouses, children, parents, etc.) • laypersons (friends, coworkers, neighbors) • peers (with type 2 diabetes)			
4. Control A) No intervention B) Usual treatment and care C) Intervention without social networks			
***5. Outcome measures** A) Were any of the following outcomes reported? • diet changes or dietary adherence. • glycemic control (HbA1c, fasting blood glucose, OGTT, or a random plasma glucose test) • physical measures (BMI and blood pressure), • diet and diabetes knowledge. • symptoms (reduction in polyuria, polydipsia, fatigue) • diabetic complications (CVD, retinopathy, diabetic foot, nephropathy, neuropathy, and hyperglycemia) • psychological and adverse effects (quality of life) • metabolic outcomes (lipids)			
6. Decision A) Include? …… B) Exclude? …… C) UNCLEAR? ……			
7. Comments/Reasons for Exclusion			

NOTE: A) include if all is "YES"; B) Exclude if 2A, 2B, 3A, 3B, 5A are" NO" C) Otherwise " UNCLEAR"
*Note that the absence of outcome measure is not an exclusion criterion at this stage of eligibility screening; simply indicate outcomes assessed in each included study.

Data extraction

Two reviewers will independently extract data from each eligible study using the Cochrane Collaboration's standard data extraction form.[50] We will resolve differences through discussion and consensus among all reviewers. We will extract data on the study setting, design, participants' characteristics, interventions, controls, and follow-up duration. We will also extract data on sample size, age, and social network functions. Whenever possible, we will retrieve qualitative information on the context and potential confounding factors that can explain contradictory outcome results. As indicated earlier, we will collect data on the primary (diet changes or dietary adherence and glycemic control) and secondary outcomes (physical

measures, blood pressure, diet and diabetes knowledge, symptoms, diabetic complications, and metabolic outcomes). Where necessary, we will contact the authors of the included studies for additional information or missing data. This review will not require Internal Review Board approval as no human subjects will be directly involved.

The umbrella term "Social Network Functions" will be used to describe the core elements of the intervention approaches, including the network intervention strategy used, the underlying theoretical mechanisms, the definition of the social network, network recruitment methods (if applicable), training methods, and any details about the structure and characteristics of the social network, or changes in the social network described using network parameters.

Assessment of risk of bias in included studies.

Two review authors will independently assess the risk of bias of each included study, using a 'Risk of bias' form. We will attempt to contact the study authors if the necessary information is not specified or is unclear. We will resolve any disagreements by discussion between review authors. For RCTs or quasi-RCTs, we will use the Cochrane Risk of Bias tool for RCTs.[51] For NRTs and controlled before-after studies (CBAs), we will use the Cochrane Risk Of Bias In Non-randomized Studies – of Interventions (ROBINS-I).[52]

We will assess whether the study authors have employed methods to control selection bias at the design stage (e.g., matching or restriction to subgroups) and their analysis methods (e.g., stratification or regression modeling). For studies with a separate control group (RCTs, NRTs, controlled before-after studies), we will assess eight components: generation of the randomization sequence; allocation concealment; blinding (performance and detection bias); baseline outcome measurement; similarity in baseline characteristics; incomplete outcome data; selective outcome reporting; and other biases. Judgments of 'yes', 'no', and 'unclear' will indicate a low, high, or unclear risk of bias. We will present the assessment results in a 'Risk of bias' graph, Risk of bias tables, and a summary. Finally, the risk of bias in systematic reviews will be assessed using the ROBIS tool.[53]

Data synthesis and analysis

We will perform quantitative data synthesis where studies are homogenous in social network characteristics (family, friends, or peer) and study design (RCTs, NRTs and controlled before-and-after studies) and provide adequate outcome data for meta-analysis. Review Manager (version 5.4) will be utilized to perform fixed or random effect model meta-analysis.[54]

Intervention effects will be presented as odds ratios (for categorical outcomes) or mean differences (for continuous outcomes) with 95% confidence intervals.

Assessment of heterogeneity. Heterogeneity will be assessed using Cochran's Q test and quantified with the I^2 statistics. A p-value of less than 0.1 will be considered to suggest statically significant heterogeneity, considering a category of a small number of studies and their heterogeneity in design.[55] Heterogeneity will take low, moderate, and high categories when the I^2 values are below 25%, between 25% and 75%, and above 75%, respectively.[56-58]

We will examine sources of heterogeneity using subgroup analysis. If sufficient data are available, subgroup analyses will be performed for interventions involving different social network members such family members, friends, or peers of patients, or intervention approach such individual, segmentation, induction, alteration, or intervention length (≤3 months, 3–6 months, 6–12 months, >12 months) or type of control group (usual care, no intervention, or intervention with no explicit social network component).[59,60]

Narrative synthesis. If meta-analysis is not possible due to insufficient numbers of studies for accuracy, we will conduct a narrative synthesis using the framework developed by the Economic and Social Research Council.[60] This approach includes four stages: 1) developing a theory of how the interventions work, 2) conducting a preliminary synthesis of included studies, 3) exploring the relationships in the data, and 4) assessing the robustness of the synthesis. We will also use text and tables to summarize and group findings by population characteristics (e.g., region); intervention approach (e.g., individual versus segmentation); intervention characteristics (e.g., duration of intervention); and outcome measures (e.g., diet changes, dietary adherence, glycemic control).

Publication bias assessment. Publication bias will be assessed by visual inspection of funnel plots based on the shape of the graph (subjective assessment). The symmetrical graph will be interpreted to suggest an absence of publication bias, whereas an asymmetrical one indicates the presence of publication bias. On the other hand, qualitatively (objective evaluation), Egger's weighted regression tests will be used to assess publication bias, and a p-value less than 0.1 considered indicative of a statistically significant publication bias.[61]

Sensitivity analysis. A sensitivity analysis will be done to estimate whether the pooled effect size was affected by single studies. A leave-one-out sensitivity analysis will be performed by

removing studies with a 'high risk of bias' and by removing outliers contributing to statistical heterogeneity. We will also assess evidence of publication bias.

Assessment of quality of evidence. The GRADE method for assessing confidence in the quality of the evidence will be used for this review, and the results will be displayed in the Summary of Findings created using GRADEpro (McMaster University, ON, Canada).[62] The Summary of Findings will present the following information, where appropriate: absolute risks for the treatment and control, estimates of relative risk, and a ranking of the quality of the evidence based on the risk of bias, directness, heterogeneity, precision, and risk of publication bias of the review results.

DISCUSSION

This review will highlight the extent to which interventions involving social networks that have a significant effect on health behaviors and outcomes can improve dietary adherence among patients with T2D. Increasing understanding of the structure, characteristics, and functions of social networks and their impact on health behaviors will provide structured evaluation and information on effective interventions to improve dietary adherence.[17] Where data permits, this review will summarize how to effectively apply social network intervention approaches to increase dietary adherence. As a result, this review will strengthen the knowledge base on dietary adherence, a topic of critical importance for patients, dietitians, and other healthcare professionals. The findings of this review will also provide directions for future research and provide practitioners with a better understanding of social networks. Since dietary adherence is considered a mediating factor in long-term diabetes management, results from this proposed study will be useful for developing interventions that leverage individuals' social networks for long-term benefits, potentially preventing further type 2 diabetes complications.

Patient and public involvement

Since this study is a secondary study based on other studies, there will be no direct patient or public involvement in this study.

Ethics and dissemination

Because no patients were involved, ethical approval was not required. The final results of this research will be submitted to a peer-reviewed journal or presented at relevant conferences, and any deviations from this protocol will be recorded and explained in the final report.

Contributors. The original idea was conceived by HA. HA and AO drafted the manuscript for this protocol. HA, AO, SY, JM and JE participated in the design of the study and the setting of the inclusion and exclusion criteria. AO and SY will perform the literature screening and data extraction. WAH and JE will review and provide critical input to all drafts of the review, including the final version. HA is the guarantor.

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Competing interests. None declared.

Patient and public involvement. Patients and/or the public were not involved in the design, conduct, reporting, or dissemination plans of this research.

Patient consent for publication. Not applicable.

Figure 1. Conceptual framework for the relationship of social networks to health [22,25]

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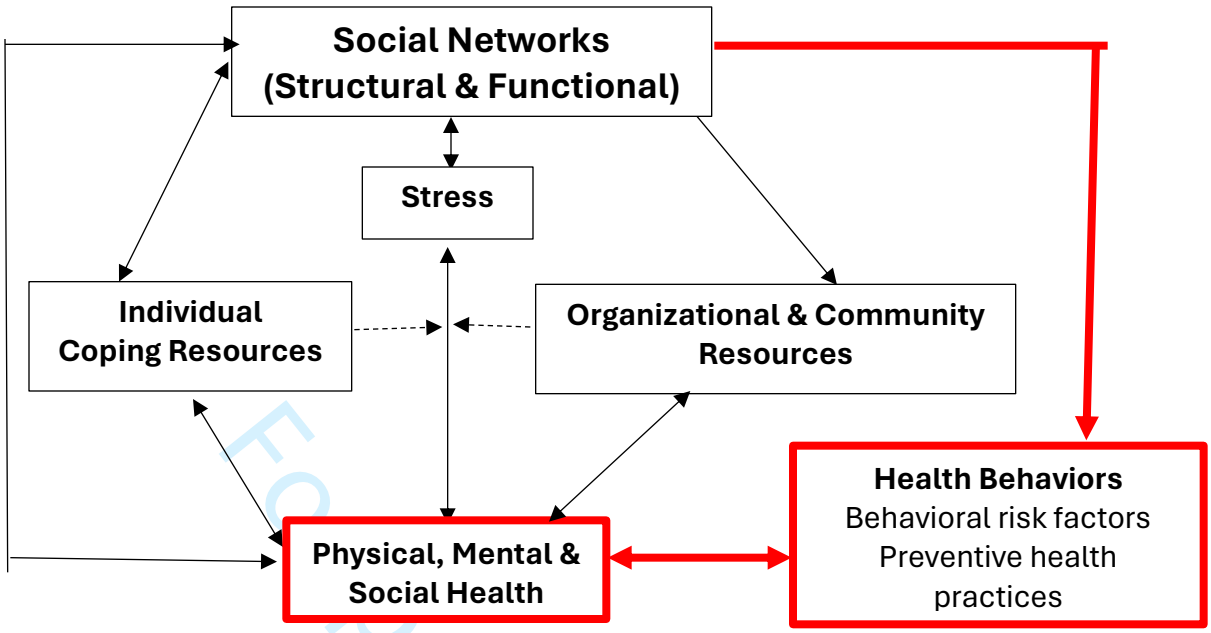

Figure 1. Conceptual framework for the relationship of social networks to health [22,25]

Reporting checklist for protocol of a systematic review and meta analysis.

Based on the PRISMA-P guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the PRISMA-Preporting guidelines, and cite them as:

Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart LA. Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2015 statement. Syst Rev. 2015;4(1):1.

		Reporting Item	Page Number
Title			
Identification	#1a	Identify the report as a protocol of a systematic review	1-2
Update	#1b	If the protocol is for an update of a previous systematic review, identify as such	
Registration			
	#2	If registered, provide the name of the registry (such as PROSPERO) and registration number	2 & 6
Authors			
Contact	#3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author	1

Contribution	#3b	Describe contributions of protocol authors and identify the guarantor of the review	13
Amendments			
	#4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	
Support			
Sources	#5a	Indicate sources of financial or other support for the review	13
Sponsor	#5b	Provide name for the review funder and / or sponsor	13
Role of sponsor or funder	#5c	Describe roles of funder(s), sponsor(s), and / or institution(s), if any, in developing the protocol	13
Introduction			
Rationale	#6	Describe the rationale for the review in the context of what is already known	4-5
Objectives	#7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	5-6
Methods			
Eligibility criteria	#8	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review	6-7
Information sources	#9	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage	8
Search strategy	#10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	8

Study records - data management	#11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	8-9
Study records - selection process	#11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)	8-9
Study records - data collection process	#11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	10
Data items	#12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications	6-7
Outcomes and prioritization	#13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	7
Risk of bias in individual studies	#14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	12
Data synthesis	#15a	Describe criteria under which study data will be quantitatively synthesised	11
Data synthesis	#15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I2, Kendall's τ)	11-12
Data synthesis	#15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)	11-12
Data synthesis	#15d	If quantitative synthesis is not appropriate, describe the type of summary planned	11-12
Meta-bias(es)	#16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)	12

Confidence in cumulative evidence	#17	Describe how the strength of the body of evidence will be assessed (such as GRADE)	12

S2 Table All databases search strategy.

PubMed

("social support"[mesh] OR "social support"[tiab] OR ((social[tiab] OR famil*[tiab] OR parent*[tiab] OR OR peer[tiab] OR spous*[tiab] OR neighbor*[tiab] OR friend*[tiab] OR child*[tiab] OR coworker*[tiab] OR co-worker*[tiab] OR colleague*[tiab]) AND (support*[tiab] OR network*[tiab] OR encourage*[tiab]))) AND ("Diet, Food, and Nutrition"[Mesh] OR diet*[tiab] OR nutrition*[tiab] OR alimentary[tiab] OR meal*[tiab] OR food*[tiab] OR eating[tiab]) AND ("Diabetes Mellitus, Type 2"[mesh] OR diabet*[tiab]) AND (control*[tiab] [tiab])

Embase

('social support'/exp OR 'social support':ab,ti OR ((social:ab,ti OR famil*:ab,ti OR parent*:ab,ti OR peer:ab,ti OR spous*:ab,ti OR neighbor*:ab,ti OR friend*:ab,ti OR child*:ab,ti OR coworker*:ab,ti OR 'co-worker*':ab,ti OR colleague*:ab,ti) AND (support*:ab,ti OR network*:ab,ti OR encourage*:ab,ti))) AND ('diet'/exp OR 'nutrition'/exp OR diet*:ab,ti OR nutrition*:ab,ti OR alimentary:ab,ti OR meal*:ab,ti OR food*:ab,ti OR eating:ab,ti) AND ('non insulin dependent diabetes mellitus'/exp OR diabet*:ab,ti) AND (control*:ab,ti)

CINAHL

((MH "Support, Social+") OR "social support" OR TI ((social OR famil* OR parent* OR peer OR spous* OR neighbor* OR friend* OR child* OR coworker* OR co-worker* OR colleague*) AND (support* OR network* OR encourage*)) OR AB ((social OR famil* OR parent* OR peer OR spous* OR neighbor* OR friend* OR child* OR coworker* OR co-worker* OR colleague*) AND (support* OR network* OR encourage*))) AND ((MH "Nutrition+") OR TI (diet* OR nutrition* OR alimentary OR meal* OR food* OR eating) OR AB (diet* OR nutrition* OR alimentary OR meal* OR food* OR eating))
AND ((MM "Diabetes Mellitus, Type 2") OR TI diabet* OR AB diabet*) AND (TI (control) OR AB (control))

Scopus

(TITLE-ABS ("social support" OR ((social OR fami* OR parent* OR peer OR spous* OR neighbor* OR friend* OR child* OR coworker* OR co-worker*) AND (support* OR network* OR encourage*))) AND TITLE-ABS (diet* OR nutrition* OR alimentary OR meal* OR food* OR eating) AND TITLE-ABS (diabet*) AND TITLE-ABS (control))

CENTRAL

("social support" OR ((social OR fami* OR parent* OR peer OR spous* OR neighbor* OR friend* OR child* OR coworker* OR co-worker*) AND (support* OR network* OR encourage*))):ti,ab,kw AND ((diet* OR nutrition* OR alimentary OR meal* OR food* OR eating)):ti,ab,kw AND (diabet*):ti,ab,kw

ProQuest Dissertations and Theses

abstract("social support" OR ((social OR famil* OR parent* OR peer OR spous* OR neighbor* OR friend* OR child* OR coworker* OR co-worker* OR colleague*) AND (support* OR network*OR encourage*))) OR title("social support" OR ((social OR famil* OR parent* OR peer OR spous* OR neighbor* OR friend* OR child* OR coworker* OR co-worker* OR colleague*) AND (support* OR network*OR encourage*))) AND (abstract(("Diet, Food, and Nutrition" OR diet* OR nutrition* OR alimentary OR meal* OR food* OR eating)) OR title(("Diet, Food, and Nutrition" OR diet* OR nutrition* OR alimentary OR meal* OR food* OR eating))) AND (abstract((diabet*)) OR title((diabet*))) AND (abstract(control* OR cohort OR "interrupted time-series") OR title(control))