BMJ Open

It takes a village: a systematic review and meta-analysis of trials of social network interventions in type 2 diabetes

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-016506
Article Type:	Research
Date Submitted by the Author:	21-Feb-2017
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Primary Subject Heading:	Diabetes and endocrinology
Secondary Subject Heading:	Patient-centred medicine, Public health, Nutrition and metabolism
Keywords:	General diabetes < DIABETES & ENDOCRINOLOGY, Diabetes & endocrinology < INTERNAL MEDICINE, PUBLIC HEALTH

Title: It takes a village: a systematic review and meta-analysis of trials of social network interventions in type 2 diabetes

Short title: Social network interventions in type 2 diabetes

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Word count: 3,108

Table and figure count: 4

Supplemental table and figure count: 6

ABSTRACT

Objectives: In the care of patients with type 2 diabetes, self-management is emphasized and studied while theory and observations suggest that patients also benefit from social support. We sought to assess the effect of social network interventions on social support, glycemic control, and quality of life in patients with type 2 diabetes.

Research Design and Methods: We searched Ovid MEDLINE, Ovid EBM Reviews, Cochrane Central Register of Controlled Trials, EMBASE, PsycINFO, and CINAHL through January 2016 for randomized trials (RCTs) of social network interventions in patients with type 2 diabetes. Reviewers working independently and in duplicate assessed eligibility and risk of bias, and extracted data from eligible RCTs. We pooled estimates using inverse variance random-effects meta-analysis.

Results: We found 15 eligible RCTs enrolling 1868 participants. Social network interventions were paradoxically commonly based on individualistic theories of self-management, were educational, and sought to engage social network members for their knowledge and experience. Interventions improved social support (0.86 standard deviations [95% CI: 0.33, 1.39], I^2=91%), and HbA1c at 3 months (-0.24 percentage points [95% CI: -0.36, -0.13], I^2=0%), but not quality of life.

Conclusions: Despite a compelling theoretical base, researchers have only minimally studied the value of interventions targeting patients' social networks on diabetes care. Although the body of evidence to date is limited, and based on individualistic theories, the results are promising. This review challenges the scientific community to design and test theory-based interventions that go beyond self-management approaches to focus on the largely untapped potential of social networks to improve diabetes care.

PROSPERO registration: CRD42016036117

ARTICLE SUMMARY

Strengths and limitations

- This systematic review and meta-analysis was strengthened by a thorough literature search, author contact, reproducible judgments about the inclusion and appraisal of the evidence, and theory-based discussion of its results.
- The review found and summarized few reports of randomized trials testing interventions with poor theoretical alignment and limited protection against bias, which produced imprecise and inconsistent estimates of effect on markers of social support and short-term diabetes control.
- These limitations notwithstanding, this first meta-analysis of randomized trials of social network interventions identified an important knowledge (and practice) gap in the care of patients with type 2 diabetes, and produced a theoretical model connecting social network interventions with outcomes in these and other patients living with chronic conditions.

1. INTRODUCTION

Patients with type 2 diabetes are expected to implement self-management practices – self-testing, diet and activity regimens, medication administration – into their daily routines, along with frequent office visits for examination and laboratory testing to reduce the risk of complications of their diabetes and its comorbidities. Patients must have sufficient capacity to shoulder this workload;[1] the workload and its impact on patient functioning and well-being reflect the burden of treatment.[2] Self-management programs based on individualistic theories of knowledge, beliefs and self-efficacy,[3 4] delegate work to patients. Without support or sufficient capacity, these delegations can overwhelm patients and contribute to burden of treatment which is associated with decreased adherence to medical recommendations and exhaustion with self-care.[2]

Patients do not enact the work of self-management in isolation. Rather, social relationships are often cited as essential to managing type 2 diabetes. Observational studies have repeatedly found that better social support is associated with effective diabetes self-management and better efficacy of self-management interventions.[5 6] Social networks can support diabetes self-management by sharing knowledge and by facilitating access to resources, but only to the extent that patients can engage and maintain productive relationships with network members (FIGURE 1).[7] Social networks may, therefore, mitigate (or exacerbate when dysfunctional) the workload patients must shoulder and impact diabetes care. Yet, social networks are not usually considered in the design and evaluation of chronic disease management interventions. Furthermore, the impact of interventions based on social theories and aimed at supporting social networks on the care and outcomes of patients with type 2 diabetes remains unknown.

In this review, we summarize the literature evaluating social network interventions tested in randomized clinical trials (RCTs) that targeted friends, families, peers and communities of patients with type 2 diabetes. We describe the interventions, their theoretical underpinnings, how social networks are involved, and the efficacy of the interventions in terms of social support, quality of life, and glycemic control relative to interventions that did not target patients' social networks.

2. METHODS

2.1 Protocol and Registration

This review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) Statement[8] and has a registered protocol (PROSPERO registration: CRD42016036117).[9]

2.2 Eligibility Criteria

We included RCTs testing interventions for type 2 diabetes management that involved patients' social networks (families, friends, peers and communities) in any capacity. RCTs had to evaluate interventions targeting dyadic (e.g. a spouse or friend) or community (ie. network of networks like neighborhoods, families and churches) networks[10] based on enduring social relationships likely to be involved in the patients' lives over the long periods of time required for self-management.[11] Thus, we excluded RCTs involving social relationships created for the trial, e.g., RCTs testing interventions enrolling and training patients with type 2 diabetes to provide peer support to other participants.

2.3 Data Sources and Searches

A comprehensive electronic search of Ovid MEDLINE, Ovid EBM Reviews, Cochrane Central Register of Controlled Trials, EMBASE, PsycINFO, and EBSCO CINAHL

was performed from inception of each database through January 2016 to identify published studies and conference abstracts. Working with an experienced medical librarian (P.J.E), G.S-B. developed a sensitive search strategy to identify eligible RCTs. Previous qualitative studies in the field [4 7 10] were used to identify relevant search terms such as descriptors of the constitution or properties of social networks (e.g. *social*, *couples*, *spouse*, *family* and *church*) and terms related to relationships (e.g. *stigma and support*). The full search strategy is available as **Supplemental Table S5**. There were no restrictions by date of publication or language. Reference lists of included articles, reviews and qualitative syntheses on the topic were hand-searched to identify any potentially eligible studies that may have been missed by our electronic search strategy. An expert in the field (A.R.) reviewed the list of included studies for missed articles.

2.4 Study Selection

Three reviewers (G.S.B, R.R-G. and O.J.P.), working independently, in pairs, and in duplicate, considered the eligibility of titles and abstracts that resulted from the search after calibrating with 20 abstracts. As part of calibration, eligibility criteria were iterated for clarity and consistency while considering examples of pre-existing and made-for-the-trial social networks.

Reviewers, working independently and in duplicate, considered all available full-text reports for eligibility, obtained if at least one reviewer considered the abstract potentially eligible. Before full-text screening, the reviewers calibrated their judgments using 10 eligible reports. Reasons for exclusion were not mutually exclusive, therefore reviewers agreed to prioritize reasons for exclusion as follows: (1) inappropriate population, (2) unsuitable study design, (3) inappropriate intervention, and (4) no outcomes of interest reported. After completion of full-text screening, chance-adjusted agreement was quantified using the kappa statistic,[12] and

disagreements resolved by discussion and consensus among the three reviewers. We subsequently searched MEDLINE with the first and last authors' last names for protocols for other relevant publications (e.g., pilots and results at different follow-up lengths) to obtain additional details about the included RCTs.

2.5 Data Extraction and Quality Assessment

The three reviewers, calibrated using two reports, performed data extraction independently and in duplicate using a standardized form. Extracted data included a full description of study characteristics: design, setting where recruitment took place, participant eligibility criteria, conceptual frameworks justifying the interventions, and of baseline participant characteristics. For each intervention, we sought details about who delivered the intervention, to whom (which members of the social network were involved), dose (duration and frequency of sessions, total contact time), and fidelity (monitoring of fidelity to the protocol and extent of participant attendance and reasons for non-attendance). We planned to extract the following outcomes: quality of life, social support, treatment burden, metabolic control, and diabetes-related morbidity and mortality; no trials however, reported treatment burden, or diabetes-related morbidity and mortality as outcomes measures.

Due to the heterogeneity of included interventions, we described and classified intervention and comparator components using modified versions of previously published frameworks.[7 13] After piloting this procedure with 2 RCTs, two reviewers classified the interventions using line-by-line coding of trial methods. Conflicts were resolved by consensus.

The three reviewers, independently and in duplicate, assessed each RCT's risk of bias using the Cochrane tool,[14] recognizing the impossibility of blinding participants and interventionists (persons delivering the intervention, e.g. physician, nurse educators) to

intervention allocation.[15] These could not be disregarded, however, because subjective and patient-reported outcomes were assessed. Publication bias could not be assessed statistically or graphically given the small number and inconsistency of included RCTs. The overall confidence in the results was rated using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach.[16]

2.6 Author Contact

For all included RCTs, we asked the corresponding author via email to complete a table of missing data and risk of bias information. Non-responders received a second communication two weeks later. Four of 15 authors responded with complete or partial data; one author reported no longer having access to necessary data.

2.7 Data Synthesis and Analysis

We used Review Manager version 5.3 to conduct meta-analyses.[17] When possible, we generated meta-analytic estimates of treatment effects using the inverse variance random-effects model. When trials had more than one comparator to the intervention of interest, we chose the arm whose procedures most resembled usual care or no intervention, as this was the most common comparator for two-arm trials. Meta-analyses generated either a weighted mean difference expressed in usual units (e.g., HbA1c) or a mean difference expressed in standard-deviation units, a common approach that enables pooling across different scales assessing the same construct (e.g., quality of life). A standardized mean difference (SDM) of 0.5 standard deviations or greater was considered important.[18]

To determine the impact of interventions on HbA1c, we pooled results at 3 months (represented by studies reporting results from 2 to 4 months of follow-up), 6 months (5-7 months of follow-up) or greater (>7 months of follow up). Otherwise, values at longest follow-up were

used for all outcomes. Missing measures of variability were imputed either from data reported at another time-point in the same trial and in the same arm (when available) or as the average standard deviation observed across all RCTs. Inconsistency for each outcome not attributable to chance was assessed visually using forest plots and estimated using the I^2 statistic. $I^2 < 25\%$ reflected low inconsistency; $I^2 > 75\%$ reflected high inconsistency.[19]

2.8 Subgroup Analyses

To understand inconsistency in results, we planned a few subgroup analyses on social support, HbA1c results and quality of life, but sparse data prevented the latter. We tested treatment interactions with risk of bias (low vs. moderate or high), level of glycemic control at baseline (mean baseline HbA1>8%), and intervention features. Network subgroups were drawn by whether the target of the intervention was (1) a patient- or an investigator-selected (by protocol, e.g., the patient's spouse) social network member; (2) a member of the patient's household or not as reported in the trial inclusion criteria; (if the social network member involved was a spouse, they were assumed to be household members); and (3) a dyadic network or a group of more than two people. We also tested subgroups based on whether the intervention was based on a specific underlying framework or not, and on the duration in contact minutes with the interventionist using a median split. For each analysis, we estimated the subgroup effect and conducted a test of interaction. Because most subgroup analyses were underpowered and exploratory, we did not adjust alpha levels for multiple comparisons.

3. RESULTS

3.1 Study Selection

Figure 2 demonstrates the study selection process. We found 1024 records (7 of which were identified through hand-search); 113 were identified as potentially eligible for inclusion after title and abstract screening. We reproducibly (k=.81) included 15 trials; 13 patient-randomized trials [20-29] [30-32] and 2 cluster-randomized trials [33] [34]; overall these trials enrolled 1868 participants.

3.2 Study Characteristics

Supplemental Table S1 describes these RCTs. Eight of the 15 RCTs reported an underlying framework for the intervention either in publication or after author contact.[20] [23] [24] [27] [30] [31] [34] While variability in all study characteristics was the norm, most RCTs took place in the community, with the experimental intervention delivering education, information transfer, goal-setting and problem solving (**Figure 3**). Social networks -- family members, spouses or partners -- were most commonly employed to share knowledge and experience. Overall chance-adjusted agreement for classification of intervention and comparator procedures (**Figure 3**) was good (kappa=.77); comparators used in trials were heterogeneous. **Supplemental Table S2** describes baseline characteristics of RCT participants. One RCT only enrolled patients with diabetes and a history of an acute coronary event;[30] another required participants to also have uncontrolled hypertension.[35] Two trials only enrolled women.[25] [28]

3.3 Risk of Bias

The overall risk of bias was judged to be moderate for all outcomes (**Supplemental Figure S1, Table S3**). Allocation concealment and blinding of outcome assessor were often unclear; some studies lost up to one third of participants to follow-up. Outcome reporting was deemed complete for most trials. When considering the body of evidence, unexplained inconsistency in results across RCTs further reduced confidence in the overall results, particularly for the social support outcome.

3.4 Meta-analysis

3.4.1 Self-reported outcomes

After pooling the results from the 6 RCTs reporting social support (775 total participants), we found a large increase in self-reported social support, SDM 0.86 (95% CI, 0.33 to 1.39), with high inconsistency in results across trials (I^2=91%) (**Figure 4**). A larger effect was demonstrated for studies enrolling patients with mean baseline HbA1c >8% (**Supplemental Table S4**). Inconsistency remained otherwise unexplained.

Both wellbeing and self-rated health (with mental and physical score components) scales assessed quality of life. When pooled, neither well-being scales (2 trials, 282 participants; SMD 0.62 [95% CI, -0.13 to 1.37], I^2=91%) nor the physical (3 trials, 470 participants; SMD 0.04 [95% CI, -0.14 to 0.22], I^2=0%) and mental (3 trials, 470 participants; SMD -0.02 [95% CI, -0.22 to 0.17], I^2=14%) self-rated health measures showed significant improvements (**Figure 4**).

3.4.2 Biomedical outcomes

When pooled, the 6 trials reporting HbA1c at 3 months, showed significant lowering (684 participants; mean difference (MD) -0.24 [95% CI, -0.36 to -0.13]) with minimal inconsistency across trials (I^2=0%). No significant differences in HbA1c were evident at 6 months (8 trials, 1193 participants; MD -0.22 [95% CI, -0.54 to 0.09], I^2=87%), >6 months after baseline (3 trials, 674 participants; MD -0.10 [95% CI, -0.84 to 0.64], I^2=99%), or when considering the HbA1c available at the point of longest follow-up (13 trials, 1731 participants; MD -0.12 [95% CI, -0.32 to 0.07], I^2=56%) with moderate to high inconsistency across trials at all time-points (**Figure 4**). Subgroup analyses did not reveal important interactions (**Supplemental Table S4**).

4. DISCUSSION AND CONCLUSION

4.1 Discussion

4.1.1 Summary of findings

We uncovered a nascent body of evidence, small, sparse, and heterogeneous, at moderate risk of bias, reporting favorable effects on social support and short-term HbA1c and no significant effect on quality of life of social network interventions in patients with type 2 diabetes. Although no trial evaluated treatment burden directly, these findings are broadly consistent with our logic model (**Figure 1**) suggesting benefit of interventions to promote social network support in patients with type 2 diabetes.

4.1.2 Comparisons with Previous Studies

To our knowledge, we provide the first meta-analysis of the effects of social network interventions in the management of type 2 diabetes. In concordance with the findings of a previous systematic review on social support in diabetes, studies were highly heterogeneous in their intervention components with limited details reported about these interventions.[36] A recent meta-synthesis of qualitative literature reports that some group-based initiatives use individualistic rather than social approaches.[4] This is reflected in our findings; three out of the eight trials reported the underlying framework for their social network intervention to be based on individualistic theories such as self-efficacy and self-regulation. Similarly, only one intervention employed all aspects of social support identified in diabetes management (**Figure 3**).

4.1.3 Strengths and Limitations of this Review

Our search strategy was designed to balance rigor with feasibility; thus, it may have missed reports which did not mention the social support component of the intervention in the title or abstract. We may have overestimated the risk of bias of these RCTs because of their unclear reporting of trial methods.[37] When seen as a review of an evolving field in its infancy, its

limitations apply almost exclusively to the meta-analytical portion of the systematic review: the heterogeneity of methods and results, while informative, questions the wisdom of pooling. We could not assess for publication bias; our results could represent an overly sanguine view of the possibilities associated with social network interventions.

Conversely, our review has several strengths, such as a thorough search and reproducible judgments about inclusion, and network and intervention classifications. Pooling was followed by a parsimonious set of exploratory pre-specified subgroup analyses to explore inconsistency in results across RCTs. Overall, we are confident we represent here the emerging body of evidence about interventions directed at social networks in support of patients with type 2 diabetes.

4.2 Implications for Research and Practice

Future research should clearly identify and report the explanatory frameworks, mechanisms, and theories for the social network interventions being tested. Ideally, the theory should be social and predict the impact of social network interventions on care and outcomes.

A recent meta-analysis reported decreased mortality in persons with higher social support.[38] Studies in patients with diabetes[39] and older adults[40] have found social support to be predictive of morbidity and mortality, after adjusting for differences in health behaviors. Proposed mechanisms for the protective effects include modulation of physiologic stress responses.[41-43] Emerging literature also highlights network composition (type and number relationships rather than quality of relationships) as important for health and self-management.[40] [44] Social networks can affect diabetes self-management by impacting the workload patients must enact by providing opportunities to share knowledge and by facilitating access to resources.[7] In turn, access to these networks requires patients to work to be aware and to deal with network relationships.[7] The effects on workload are likely to interact with the theory of physiological

stress modulation, as access to healthcare and changes in self-efficacy affect psychosocial stress. This is especially pertinent for people with limited access to formal health care; they may be more likely to present to care with higher allostatic load and to depend critically on personal social networks.[4 7] Therefore, the effects of involving social networks in diabetes management on intermediate outcomes such as *allostatic load*, treatment workload and treatment burden should be tested in future randomized trials to uncover the impact of social support on these and on health outcomes apparent in observational studies.

Although it may be premature to translate this evidence into practice, the preceding observational and qualitative research and the evolving experimental research summarized here suggest an important but underexploited role for social networks in supporting the work patients do to manage type 2 diabetes. Care approaches that consider social networks as targets of interventions, as mediators of knowledge and access to resources and which help patients to deal with network relationships may prove more valuable than interventions supporting self-management alone. Such promise awaits further development and evaluation.

4.3 Conclusion

Despite a compelling theoretical base, researchers have barely studied the value of interventions targeting patient social networks on diabetes care. Although the body of evidence to date is limited, and based on individualistic theories, the results are promising. This review challenges the scientific community to design and test theory-based interventions that go beyond self-management approaches to focus on the largely untapped potential of social networks to improve diabetes care.

Funding: GS-B was supported by CTSA Grant Number TL1TR000137 from the National Center for Advancing Translational Science (NCATS) and grant number 3R01HL131535-01S1 from the National Heart Lung and Blood Institute (NHLBI). VMM was partially supported by Grant Number UL1TR000135 from the National Center for Advancing Translational Science (NCATS), a component of the National Institutes of Health (NIH). Its contents are solely the responsibility of the author and do not necessarily represent the official view of the NIH. The funder had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Author contributions: GS-B, OJP, PJE, RR-G and VMM designed the protocol. GS-B and PJE searched the literature; GS-B, OJP, and RR-G extracted the data. GS-B, NA-V and VMM analyzed the data. GS-B, OJP, RR-G, NA-V, PJE, LL-M, AR and VMM interpreted the data and critically revised the report.

Conflicts of Interest Disclosure: No competing financial interests exist.

Availability of data and material: Datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

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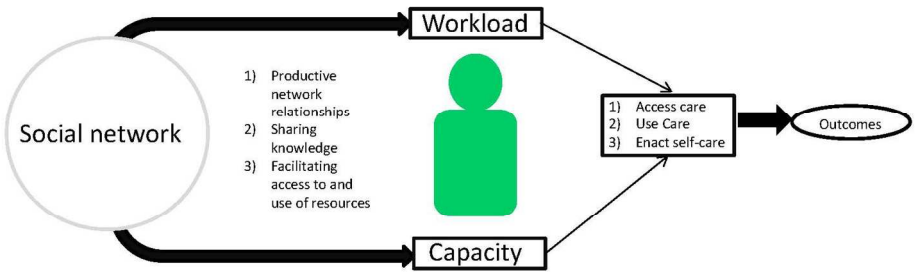


Figure 1. Logic Model of Social Self-management

Figure 1. Logic Model of Social Self-management

234x118mm (200 x 200 DPI)

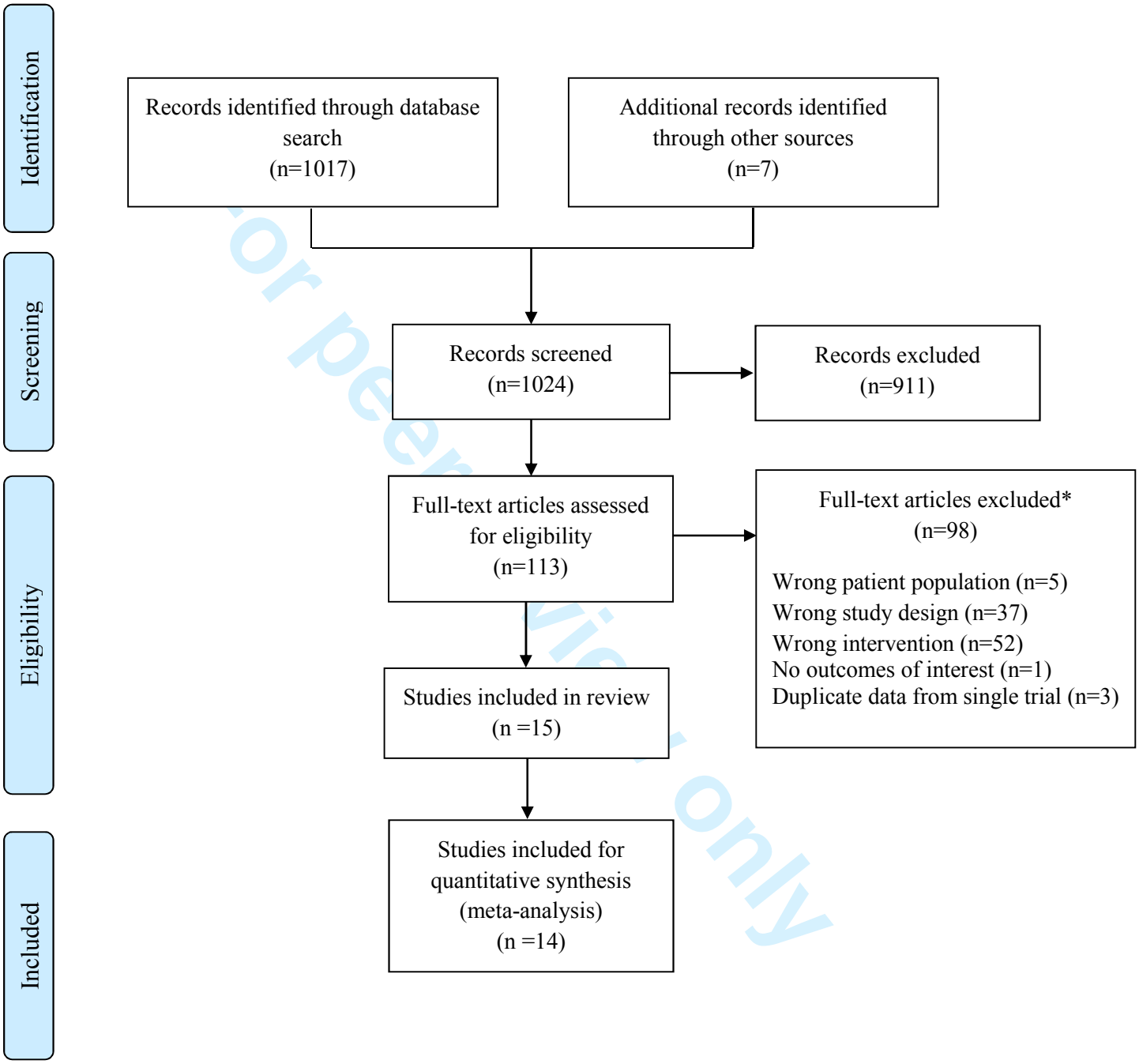


Figure 1. PRISMA flow chart
*reasons not mutually exclusive

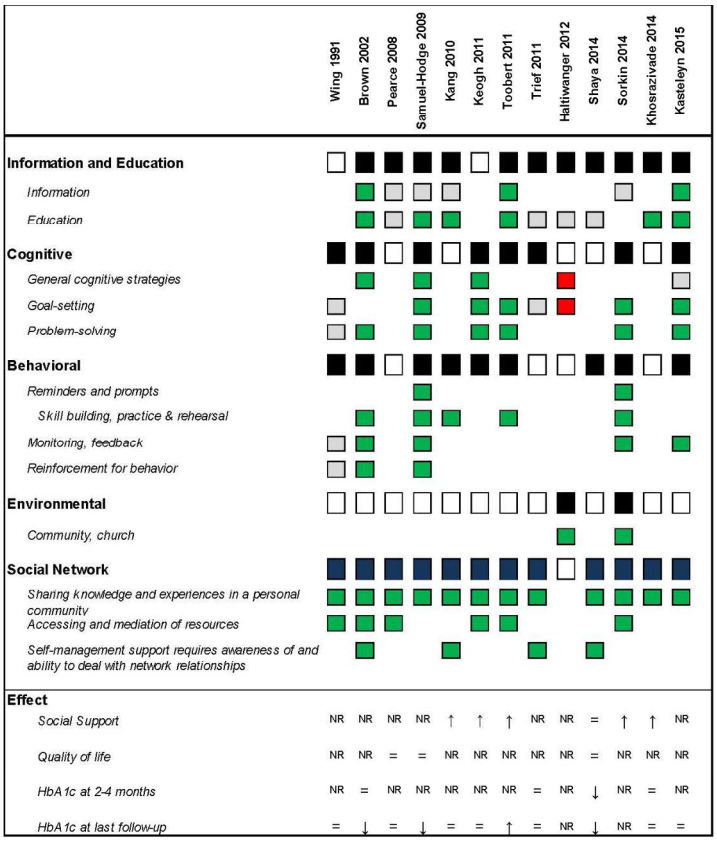


Figure 1. Intervention and comparator components. NR: not reported, ↑: higher in social network arm, ↓: lower in social network arm, =: no significant difference between arms. Abstracts not included.

Figure 3. Intervention and comparator components

215x279mm (200 x 200 DPI)

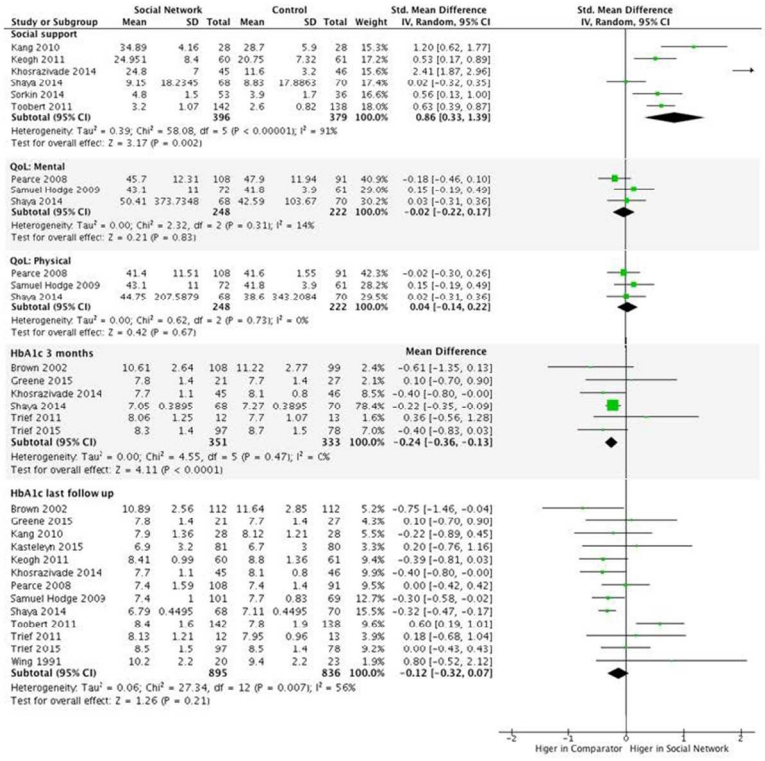


Figure 4. Effect of social network interventions on social support, quality of life (QoL) and HbA1c

Figure 4. Effect of social network interventions on social support, quality of life (QoL) and HbA1c

215x279mm (110 x 110 DPI)

Supplemental Material

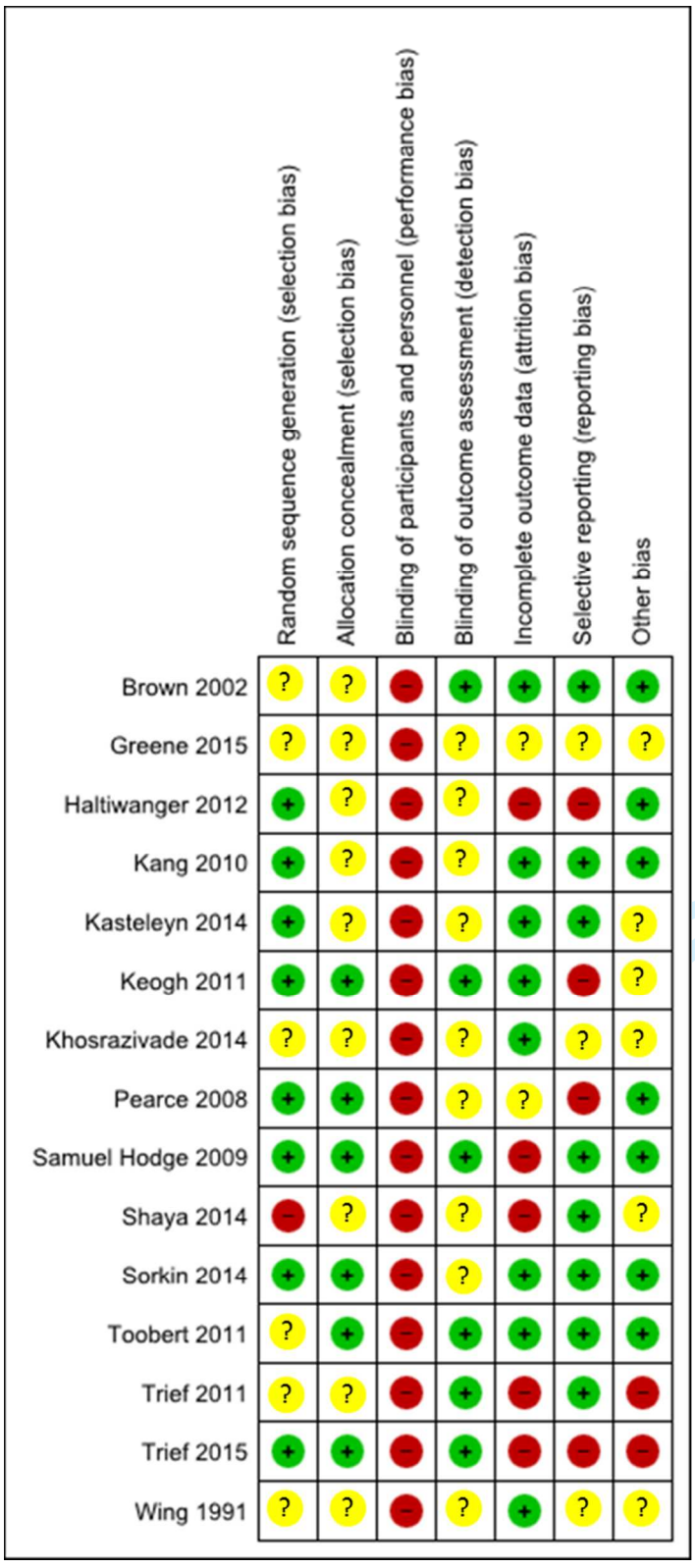
It takes a village: a systematic review of social network interventions in patients with type 2 diabetes

Study	Notable inclusion criteria	Underlying framework	Support network involved	Intervention deliverer(s)	Setting where intervention was delivered	Length (months)	Intervention contact time (minutes)
Wing 1991	>20% above ideal above weight	Behavioral marital therapy	Spouse	Staff and physicians	NR	5	960
Brown 2002	None	NR	Close family member or close friend	Clinicians and community health workers	Community	12	120
Pearce 2008	A1C>8%	Health belief model	Relative or friend	Nurse practitioner educator	Community	12	NR
Samuel - Hodge 2009	No history of ketoacidosis	Behavior change and adult education	Church community	Church diabetes advisor (CDA) and a health professional	Community	12	1140-1500
Kang 2010	At least two of last three A1C reading >=7%; used oral antidiabetic agents only	NR	Household amily member	Clinicians and social workers	Community	6	450
Keogh 2011	2 out of 3 LAST A1Cs >8%	Self-regulation of health and illness	Family member	Psychologist	Home	0.75	100
Toobert 2011	Latinas	NR	Family members	Group leader	Community	NR	NR
Trief 2011	Married for >1 year; A1C>7.3%	Social learning theory	Spouse/Partner	Diabetes educator and marriage/family therapist	Telephone	3	NR
Haltiwanger 2012	>60 years old; Mexican American; documented difficulties with helath habits	NR	Spouse	Health educator	NR	2	720
Khosravizade 2014	>30 years old; medium or low adherence; low social support	NR	Household family member	Researchers	NR	3	NR
Shaya 2014	A1C>7% or FBS >110mg/dl	Education and medication therapy management	Peers	Nurse practitioner educator	Community	6	NR
Sorkin 2014	Latina; mother to overweight woman	Lifestyle changes	Daughter	Lifestyle community coach	Community	4	NR
Greene 2015	African American	NR	Household family member or companion	Unclear	NR	2	3120
Kasteleyn 2015	>35 years old; within 2 weeks from hospital discharge after first acute coronary event	Self-efficacy	Spouse/Partner	Diabetes Nurse practitioner	Home	2	155
Trief 2015	Married or with partner for >1 year; A1C>7.5%	Interdependence theory and social learning theory	Spouse/Partner	Diabetes educator or counselor	Telephone	3	720

Supplemental Table S1. Trial characteristics

Study	Intervention			Control		
	N	Mean Age in years (SD)	Mean duration of T2DM in years (SD)	N	Mean Age in years (SD)	Mean duration of T2DM in years (SD)
Wing 1991	25	53.6 (7.7)	NR	24	51.2 (7.3)	NR
Brown 2002	128	54.7 (8.2)	7.6 (5.8)	128	53.3 (8.3)	8.1 (6.9)
Sammuel - Hodge 2002	117	57 (9.7)	9 (NR)	84	61.3 (11.9)	11 (NR)
Pearce 2008	108	61.2 (10.59)	NR	91	63.1 (8.63)	NR
Kang 2010	33	55.3 (7.7)	3.8 (3.2)	34	51.7 (8.5)	4.4 (3)
Toobert 2011	142	55.6 (9.7)	8.4 (6.5)	138	58.7 (10.3)	10.4 (9.8)
Greene 2015	21	NR	NR	27	NR	NR
Keogh 2011	60	59.96 (11.67)	9.17 (7.1)	61	57.9 (11.34)	9.65 (6.45)
Trief 2011	12	60.33 (8.63)	8.63 (NR)	12	61.08 (9.27)	9.27 (NR)
Haltiwanger 2012	12	NR	NR	36	NR	NR
Khosravizade 2014	45	52.93 (7.62)	9.71 (6.75)	46	54.13 (7.56)	11.39 (5.4)
Shaya 2014	68	53.9 (NR)	9.2 (8.6)	70	51.9 (NR)	8.8 (8.2)
Sorkin 2014	53	52.7 (6.9)	9.8 (NR)	36	52.7 (6.9)	9.8 (NR)
Kasteleyn 2015	101	66 (9.3)	7.0 (2.8-16)	100	65.6 (9.4)	8.5 (5-15)
Trief 2015	97	57.8 (10.8)	12.8 (NR)	78	56.9 (10.4)	12.6 (NR)

Supplemental Table S1. Trial participant baseline characteristics



Supplemental Figure S1. Risk of bias of included trials (Cochrane risk of bias tool)

Assessing confidence in the estimates of effect: GRADE

Quality assessment							№ of patients		Effect	Quality	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Social network interventions	Any comparator	Absolute (95% CI)		
Social Support											
6	randomised trials	serious [1]	serious [2,3]	not serious	Serious4	strong association	396	379	SMD **0.86 higher** (0.33 higher to 1.39 higher)	Low to moderate	IMPORTANT

CI: Confidence interval; **SMD:** Standardised mean difference

1. unclear blinding of outcome assessors
2. I2=91%
3. non-overlapping CIs
4. confidence interval or estimate effect includes non-important change as well as very important change

Quality assessment							№ of patients		Effect	Quality	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Social network interventions	Any comparator	Absolute (95% CI)		
A1C 2-4 months											
6	randomised trials	serious [1]	not serious	not serious	not serious	None	351	333	MD **0.24 lower** (0.36 lower to 0.13 lower)	Low to very low	IMPORTANT
A1C 5-7 Months											
8	randomised trials	serious [1]	serious [2]	not serious	not serious	None	608	585	MD **0.22 lower** (0.54 lower to 0.09 higher)	Low to very low	IMPORTANT
A1C 8+ months											

Quality assessment							№ of patients		Effect	Quality	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Social network interventions	Any comparator	Absolute (95% CI)		
3	randomised trials	serious [1]	very serious [2]	not serious	serious [3]	None	355	319	MD **0.1 lower** (0.84 lower to 0.65 higher)	Low to very low	IMPORTANT
Last A1C											
13	randomised trials	serious [1]	not serious	not serious	not serious	None	895	836	MD **0.12 lower** (0.32 lower to 0.07 higher)	Low to very low	IMPORTANT

CI: Confidence interval; **MD:** Mean difference

1. unclear allocation concealment
2. high I2
3. large CI

Quality assessment							№ of patients		Effect	Quality	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Social network interventions	Any comparator	Absolute (95% CI)		
Well-being											
2	randomised trials	serious [1]	very serious [2,3]	not serious	very serious [4]	None	141	141	SMD **0.62 higher** (0.13 lower to 1.37 higher)	Low to very low	IMPORTANT
Quality of Life: Physical Component											
3	randomised trials	serious [1]	not serious	not serious	not serious	None	248	222	SMD **0.04 higher** (0.14 lower to 0.22 higher)	Low to very low	IMPORTANT
Quality of Life: Mental Component											

Quality assessment							№ of patients		Effect	Quality	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Social network interventions	Any comparator	Absolute (95% CI)		
2	randomised trials	serious [1]	not serious	not serious	not serious	None	140	131	SMD **0.02 lower** (0.22 lower to 0.17 higher)	Low to very low	IMPORTANT

CI: Confidence interval; **SMD:** Standardised mean difference

1. unclear allocation concealment
2. high I2
3. differences in scales used
4. very wide CI

Supplemental Table S3. GRADE assessment

Subgroup Analyses						
	Hba1c at last follow-up			**Social support at last follow-up**		
	Subgroup *effect size (95% CI); I^2*	**Comparison subgroup** *effect size (95% CI); I^2*	**P-value for interaction**	**Subgroup** *effect size (95% CI); I^2*	**Comparison subgroup** *effect size (95% CI); I^2*	**P-value for interaction**
Patient characteristics						
Mean baseline HbA1c> 8%	-0.08 (-0.42, 0.26); 66%	-0.27 (-0.39, -0.15); 0%	0.31	1.04 (0.46, 1.61); NA	0.02 (-0.32, 0.35); 90%	0.003
Intervention characteristics						
Self-selected social network	-0.17 (-0.43, 0.10); 68%	-0.10 (-0.36, 0.17); 14%	0.72	0.92 (0.29, 1.56); 93%	0.56 (0.13, 1.0); NA	0.36
Household member	-0.05 (-0.30,0.21); 53%	-0.32 (-0.45, -0.18): 0%	0.07	1.16 (0.44, 1.88); 92%	0.27 (-0.26, 0.81); 74%	0.05
Contact time >840 minutes	0.27 (-0.05, 0.58); 73%	-0.23 (-0.43, -0.03); 0%	0.009	1.04 (0.19, 1.88); 95%	1.16 (0.44, 1.88); na	0.28
Underlying framework	-0.22 (-0.36, -0.07); 16%	-0.11 (-0.63, 0.4); 76%	0.7	0.36 (-0.01, 0.72); 65%	1.39 (0.32, 2.47); 94%	0.07
Dyadic social network reported	-0.17 (-0.36, 0.02); 9%	-0.04 (-0.49,0.41); 88%	0.61	1.16 (0.34, 1.97); 92%	0.33 (-0.26, 0.93); 88%	0.11
Trial characteristics						
Low risk of bias	-0.10 (-0.47, 0.26); 73%	-0.23 (-0.40, -0.07); 11%	0.52	0.59 (0.41, 0.77); 0%	1.20 (-0.27, 2.66); 96%	0.42

Supplemental Table S4. Subgroup analyses

Search Strategy

Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) 1946 to Present			
1	*diabetes mellitus, type 2/ or "type 2 diabet*".tw. or niddm.mp. or t2dm.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	114218	Advanced
2	("social network" or "social support").mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	69042	Advanced
3	1 and 2	663	Advanced
4	family relations/ or family conflict/ or intergenerational relations/ or sibling relations/	15431	Advanced
5	family/ or adult children/ or family relations/	73608	Advanced
6	family role/ or family therapy/	7952	Advanced
7	1 and (4 or 5 or 6)	536	Advanced
8	(couple or couples or married or spous* or partner*1 or household or neighbor*1).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	231588	Advanced
9	(church* or religious* or husband* or wife* or relatives or "family based").mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept	110536	Advanced

	word, rare disease supplementary concept word, unique identifier]		
10	1 and 8	749	Advanced
11	1 and 9	1089	Advanced
12	7 or 10 or 11	2151	Advanced
13	limit 12 to randomized controlled trial	87	Advanced
14	12 and intervention*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	290	Advanced
15	12 and (behavior* or behaviour* or adher* or education* or aware* or stigma*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	573	Advanced
16	13 or 14	330	Advanced
17	3 or 7 or 12	2695	Advanced
18	intervention*.mp. and 17 [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	512	Advanced
19	13 or 18	552	Advanced

20	17 and random*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	338	Advanced
21	19 or 20	676	Advanced
22	remove duplicates from 21	665	

CENTRAL – same strategy – 205

Embase 1988 to 2016 Week 04

#	Searches	Results	Search Type
1	*diabetes mellitus, type 2/ or "type 2 diabet*".tw. or niddm.mp. or t2dm.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	142471	Advanced
2	("social network" or "social support").mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	79400	Advanced
3	1 and 2	645	Advanced
4	family relations/ or family conflict/ or intergenerational relations/ or sibling relations/	69298	Advanced

5	family/ or adult children/ or family relations/	70584	Advanced
6	family role/ or family therapy/	8709	Advanced
7	1 and (4 or 5 or 6)	439	Advanced
8	(couple or couples or married or spous* or partner*1 or household or neighbor*1).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	265365	Advanced
9	(church* or religious* or husband* or wife* or relatives or "family based").mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	109824	Advanced
10	1 and 8	1041	Advanced
11	1 and 9	1305	Advanced
12	7 or 10 or 11	2620	Advanced
13	3 or 12	3134	Advanced
14	13 and intervention*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	653	Advanced
15	randomized controlled trial/	376080	Advanced
16	13 and 15	158	Advanced

17	13 and random*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	410	Advanced
18	14 or 16 or 17	847	Advanced
19	limit 18 to human	796	Advanced
20	non insulin dependent diabetes mellitus/	166150	Advanced
21	19 and 20	665	

PsycINFO 1987 to January Week 3 2016

#	Searches	Results	Search Type
1	diabetes mellitus/	4189	Advanced
2	1 and ("type 2" or noninsulin* or "non insulin" or niddm or t2d or t2dm).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures]	1815	Advanced
3	exp social support/	26965	Advanced
4	social networks/ or exp social groups/ or exp social interaction/ or exp social support/ or exp support groups/	276211	Advanced
5	2 and (3 or 4)	90	Advanced

6	exp Family Therapy/ or family.mp. or exp Family Relations/ or exp Family/ or exp Family Systems Theory/ or exp Family Structure/	282330	Advanced
7	couples/ or cohabitation/ or dyads/ or significant others/ or exp spouses/	25371	Advanced
8	2 and (6 or 7)	195	Advanced
9	5 or 8	258	Advanced
10	limit 9 to ("0830 systematic review" or 1200 meta analysis)	1	Advanced
11	9 and (intervention* or random*).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures]	78	Advanced
12	10 or 11	79	Advanced
13	limit 12 to all journals	55	

CINAHL

#	Query	Limiters/Expanders	Last Run Via	Results
S12	S8 AND S11	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	9
S11	S5 AND S10	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	78
S10	(MH "Family+") OR (MH "Family Relations+") OR (MH "Patient-Family	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search	123,032

	Relations") OR (MH "Nuclear Family+") OR (MH "Family Attitudes+")		Database - CINAHL with Full Text	
S9	S5 AND S8	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	75
S8	S6 OR S7	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	129,321
S7	(MH "Intervention Trials") OR "intervention"	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	111,076
S6	(MH "Randomized Controlled Trials")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	25,142
S5	S1 AND S4	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	385
S4	S2 OR S3	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	48,947
S3	(MH "Young Adult Social Support Index") OR (MH "Social Support Index") OR (MH "Social Support (Iowa NOC)") OR (MH "Norbeck Social Support Questionnaire")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	289
S2	(MH "Social Networks") OR (MH "Social Network Analysis (Saba CCC)") OR (MH "Support, Psychosocial+")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	48,840
S1	(MH "Diabetes Mellitus, Type 2")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	26,607

Supplement Table S5. Search strategy

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	6
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	6
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6-7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	7 and supplement
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	supplement
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	7-8
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	9
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	9-10
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	10

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	10
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	10
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	11
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	11, supp table s1
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	11, supp fig s1, supp table s3
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	11-12, fig 4
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	11-12
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	11-12, supp fig s1, supp table s3
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	11-12, sup table s4
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	13
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	13-14
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	14-16

PRISMA 2009 Checklist

FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	17

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: **www.prisma-statement.org**.

BMJ Open

A systematic review and meta-analysis of trials of social network interventions in type 2 diabetes

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-016506.R1
Article Type:	Research
Date Submitted by the Author:	24-May-2017
Complete List of Authors:	Spencer-Bonilla, Gabriela ; Mayo Clinic, Ponce, Oscar Rodriguez-Gutierrez, R; Mayo Clinic Alvarez-Villalobos, Neri Erwin, Patricia; Mayo Clinic College of Medicine Larrea-Mantilla, Laura Rogers, Anne; University of Southampton, Faculty of Health Sciences Montori, Victor; Mayo Clinic, Knowledge and Encounter Research Unit
Primary Subject Heading:	Diabetes and endocrinology
Secondary Subject Heading:	Patient-centred medicine, Public health, Nutrition and metabolism
Keywords:	General diabetes < DIABETES & ENDOCRINOLOGY, Diabetes & endocrinology < INTERNAL MEDICINE, PUBLIC HEALTH

Title: A systematic review and meta-analysis of trials of social network interventions in type 2 diabetes

Short title: Social network interventions in type 2 diabetes

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Word count: 3,252

Table and figure count: 5

Supplemental table and figure count: 7

ABSTRACT

Objectives: In the care of patients with type 2 diabetes, self-management is emphasized and studied while theory and observations suggest that patients also benefit from social support. We sought to assess the effect of social network interventions on social support, glycemic control, and quality of life in patients with type 2 diabetes.

Research Design and Methods: We searched Ovid MEDLINE, Ovid EBM Reviews, Cochrane Central Register of Controlled Trials, EMBASE, PsycINFO, and CINAHL through April 2017 for randomized trials (RCTs) of social network interventions in patients with type 2 diabetes. Reviewers working independently and in duplicate assessed eligibility and risk of bias, and extracted data from eligible RCTs. We pooled estimates using inverse variance random-effects meta-analysis.

Results: We found 19 eligible RCTs enrolling 2162 participants. Social network interventions were paradoxically commonly based on individualistic theories of self-management, were educational, and sought to engage social network members for their knowledge and experience. Interventions improved social support (0.88 standard deviations [95% CI: 0.40, 1.36], I^2=90%), and HbA1c at 3 months (-0.23 percentage points [95% CI: -0.38, -0.08], I^2=12%), but not quality of life.

Conclusions: Despite a compelling theoretical base, researchers have only minimally studied the value of interventions targeting patients' social networks on diabetes care. Although the body of evidence to date is limited, and based on individualistic theories, the results are promising. This review challenges the scientific community to design and test theory-based interventions that go beyond self-management approaches to focus on the largely untapped potential of social networks to improve diabetes care.

PROSPERO registration: CRD42016036117

ARTICLE SUMMARY

Strengths and limitations

- This systematic review and meta-analysis was strengthened by a thorough literature search, author contact, reproducible judgments about the inclusion and appraisal of the evidence, and theory-based discussion of its results.
- The review found and summarized few reports of randomized trials testing interventions with poor theoretical alignment and limited protection against bias, which produced imprecise and inconsistent estimates of effect on markers of social support and short-term diabetes control.
- These limitations notwithstanding, this first meta-analysis of randomized trials of social network interventions identified an important knowledge (and practice) gap in the care of patients with type 2 diabetes, and produced a theoretical model connecting social network interventions with outcomes in these and other patients living with chronic conditions.

1. INTRODUCTION

Patients with type 2 diabetes are expected to implement self-management practices – self-testing, diet and activity regimens, medication administration – into their daily routines, along with frequent office visits for examination and laboratory testing to reduce the risk of complications of their diabetes and its comorbidities. Patients must have sufficient capacity to shoulder this workload;[1] the workload and its impact on patient functioning and well-being reflect the burden of treatment.[2] Self-management programs based on individualistic theories of knowledge, beliefs and self-efficacy,[3 4] delegate work to patients. Without support or sufficient capacity, these delegations can overwhelm patients and contribute to burden of treatment which is associated with decreased adherence to medical recommendations and exhaustion with self-care.[2]

Patients do not enact the work of self-management in isolation. Rather, social relationships are often cited as essential to managing type 2 diabetes. Observational studies have repeatedly found that better social support is associated with effective diabetes self-management and better efficacy of self-management interventions.[5 6] Social networks can support diabetes self-management by sharing knowledge and by facilitating access to resources, but only to the extent that patients can engage and maintain productive relationships with network members (**Figure 1**).[7] Social networks may, therefore, mitigate (or exacerbate when dysfunctional) the workload patients must shoulder and impact diabetes care. Yet, social networks are not usually considered in the design and evaluation of chronic disease management interventions. Furthermore, the impact of interventions based on social theories and aimed at supporting social networks on the care and outcomes of patients with type 2 diabetes remains unknown.

In this review, we summarize the literature evaluating social network interventions tested in randomized clinical trials (RCTs) that targeted friends, families, peers and communities of patients with type 2 diabetes. We describe the interventions, their theoretical underpinnings, how social networks are involved, and the efficacy of the interventions in terms of social support, quality of life, and glycemic control relative to interventions that did not target patients' social networks.

2. METHODS

2.1 Protocol and Registration

This review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) Statement[8] and has a registered protocol (PROSPERO registration: CRD42016036117).[9]

2.2 Eligibility Criteria

We included RCTs testing interventions for type 2 diabetes management that involved patients' social networks (families, friends, peers and communities) in any capacity. RCTs had to evaluate interventions targeting dyadic (e.g. a spouse or friend) or community (ie. network of networks like neighborhoods, families and churches) networks[10] based on enduring social relationships likely to be involved in the patients' lives over the long periods of time required for self-management.[11] Thus, we excluded RCTs involving social relationships created for the trial, e.g., RCTs testing interventions enrolling and training patients with type 2 diabetes to provide peer support to other participants using online communities.

2.3 Data Sources and Searches

A comprehensive electronic search of Ovid MEDLINE, Ovid EBM Reviews, Cochrane Central Register of Controlled Trials, EMBASE, PsycINFO, and EBSCO CINAHL

was performed from inception of each database through the second week of April 2017 to identify published studies and conference abstracts. Working with an experienced medical librarian (P.J.E), G.S-B. developed a sensitive search strategy to identify eligible RCTs. Previous qualitative studies in the field [4 7 10] were used to identify relevant search terms such as descriptors of the constitution or properties of social networks (e.g. *social*, *couples*, *spouse*, *family* and *church*) and terms related to relationships (e.g. *stigma and support*). The full search strategy is available as **Supplemental Table S1**. There were no restrictions by date of publication or language. Reference lists of included articles, reviews and qualitative syntheses on the topic were hand-searched to identify any potentially eligible studies that may have been missed by our electronic search strategy. An expert in the field (A.R.) reviewed the list of included studies for missed articles.

2.4 Study Selection

Three reviewers (G.S.B, R.R-G. and O.J.P.), working independently, in pairs, and in duplicate, considered the eligibility of titles and abstracts that resulted from the search after calibrating with 20 abstracts. As part of calibration, eligibility criteria were iterated for clarity and consistency while considering examples of pre-existing and made-for-the-trial social networks.

Reviewers, working independently and in duplicate, considered all available full-text reports for eligibility, obtained if at least one reviewer considered the abstract potentially eligible. Before full-text screening, the reviewers calibrated their judgments using 10 eligible reports. Reasons for exclusion were not mutually exclusive, therefore reviewers agreed to prioritize reasons for exclusion as follows: (1) inappropriate population, (2) unsuitable study design, (3) inappropriate intervention, and (4) no outcomes of interest reported. After completion

of full-text screening, chance-adjusted agreement was quantified using the kappa statistic,[12] and disagreements resolved by discussion and consensus among the three reviewers. We subsequently searched MEDLINE with the first and last authors' last names for protocols for other relevant publications (e.g., pilots and results at different follow-up lengths) to obtain additional details about the included RCTs.

2.5 Data Extraction and Quality Assessment

The three reviewers, calibrated using two reports, performed data extraction independently and in duplicate using a standardized form. Extracted data included a full description of study characteristics: design, setting where recruitment took place, participant eligibility criteria, conceptual frameworks justifying the interventions, and of baseline participant characteristics. For each intervention, we sought details about who delivered the intervention, to whom (which members of the social network were involved), dose (duration and frequency of sessions, total contact time), and fidelity (monitoring of fidelity to the protocol and extent of participant attendance and reasons for non-attendance). We planned to extract the following outcomes: quality of life, social support, treatment burden, metabolic control, and diabetes-related morbidity and mortality; no trials however, reported diabetes-related morbidity and mortality as outcomes measures. Eligible trials reporting on at least one of these outcomes were included.

Due to the heterogeneity of included interventions, we described and classified intervention and comparator components using modified versions of previously published frameworks.[7 13] After piloting this procedure with 2 RCTs, two reviewers classified the interventions using line-by-line coding of trial methods. Conflicts were resolved by consensus.

The three reviewers, independently and in duplicate, assessed each RCT's risk of bias using the Cochrane tool,[14] recognizing the impossibility of blinding participants and interventionists (persons delivering the intervention, e.g. physician, nurse educators) to intervention allocation.[15] These could not be disregarded, however, because subjective and patient-reported outcomes were assessed. Publication bias could not be assessed statistically or graphically given the small number and inconsistency of included RCTs. The overall confidence in the results was rated using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach.[16] This approach assesses the confidence merited by the body of evidence based on the risk of bias of the individual studies, inconsistency in the results, indirectness, imprecision, and other considerations.

2.6 Author Contact

For all included RCTs, we asked the corresponding author via email to complete a table of missing data and risk of bias information. Non-responders received a second communication two weeks later. Four of 19 authors responded with complete or partial data; one author reported no longer having access to necessary data.

2.7 Data Synthesis and Analysis

We used Review Manager version 5.3 to conduct meta-analyses.[17] When possible, we generated meta-analytic estimates of treatment effects using the inverse variance random-effects model. When trials had more than one comparator to the intervention of interest, we chose the arm whose procedures most resembled usual care or no intervention, as this was the most common comparator for two-arm trials. Meta-analyses generated either a weighted mean difference expressed in usual units (e.g., HbA1c) or a mean difference expressed in standard-deviation units, a common approach that enables pooling across different scales assessing the

same construct (e.g., quality of life). A standardized mean difference (SDM) of 0.5 standard deviations or greater was considered important.[18]

To determine the impact of interventions on HbA1c, we pooled results at 3 months (represented by studies reporting results from 2 to 4 months of follow-up), 6 months (5-7 months of follow-up) or greater (>7 months of follow up). Otherwise, values at longest follow-up were used for all outcomes. Missing measures of variability were imputed either from data reported at another time-point in the same trial and in the same arm (when available) or as the average standard deviation observed across all RCTs. Inconsistency for each outcome not attributable to chance was assessed visually using forest plots and estimated using the I^2 statistic. $I^2 < 25\%$ reflected low inconsistency; $I^2 > 75\%$ reflected high inconsistency.[19]

2.8 Modifications to the registered protocol

The included trials were heterogeneous in terms of length of follow-up. In addition to performing pooled analyses for HbA1c at 3, 6, and >7 months of follow-up, to increase the power and applicability of our analyses, we also pooled all measures of HbA1c at the longest follow-up reported.

2.9 Subgroup Analyses

To understand inconsistency in results, we planned a few subgroup analyses on social support, HbA1c results and quality of life, but sparse data prevented the latter. We tested treatment interactions with risk of bias (low vs. moderate or high), level of glycemic control at baseline (mean baseline HbA1c>8%), and intervention features. Network subgroups were drawn by whether the target of the intervention was (1) a patient- or an investigator-selected (by protocol, e.g., the patient's spouse) social network member; (2) a member of the patient's household or not as reported in the trial inclusion criteria; (if the social network member

involved was a spouse, they were assumed to be household members); and (3) a dyadic network or a group of more than two people. We also tested subgroups based on whether the intervention was based on a specific underlying framework or not, and on the duration in contact minutes with the interventionist using a median split. For each analysis, we estimated the subgroup effect and conducted a test of interaction. Because most subgroup analyses were underpowered and exploratory, we did not adjust alpha levels for multiple comparisons.

3. RESULTS

3.1 Study Selection

Figure 2 demonstrates the study selection process. We found 1208 records (7 of which were identified through hand-search); 137 were identified as potentially eligible for inclusion after title and abstract screening. We reproducibly (k=.73) included 19 trials; 17 patient-randomized trials [20-29] [30-40] and 2 cluster-randomized trials [41] [42]; overall these trials enrolled 2162 participants.

3.2 Study Characteristics

Table 1 describes these RCTs. Thirteen of the 19 RCTs reported an underlying framework for the intervention either in publication or after author contact.[20] [23] [24] [27] [30] [31] [36-40] [42] While variability in all study characteristics was the norm, most RCTs took place in the community, with the experimental intervention delivering education, information transfer, goal-setting and problem solving (**Figure 3, Table 1**). Social networks -- family members, spouses or partners -- were most commonly employed to share knowledge and experience. Overall chance-adjusted agreement for classification of intervention and comparator procedures (**Figure 3**) was good (kappa=.79); comparators used in trials were heterogeneous. **Supplemental Table S2** describes baseline characteristics of RCT participants. One RCT only enrolled patients with

Study	Notable inclusion criteria	Intervention description	Underlying framework	Support network involved	Intervention deliverer(s)	Setting where intervention was delivered	Length (months)	Intervention contact time (minutes)
Wing 1991	>20% above ideal above weight	Behavioral weight loss program with calorie restriction	Behavioral marital therapy	Spouse	Staff and physicians	NR	5	960
Brown 2002	None	Instructional and support group emphasizing nutrition, monitoring and self-care	NR	Close family member or close friend	Clinicians and community health workers	Community	12	120
Pearce 2008	A1C>8%	Individualized patient education sessions and newsletters	Health belief model	Relative or friend	Nurse practitioner educator	Community and telephone	12	NR
Samuel - Hodge 2009	No history of ketoacidosis	Individualized counseling, group education sessions and phone contact	Behavior change and adult education	Church community	Church diabetes advisor (CDA) and a health professional	Community and telephone	12	1140-1500
Kang 2010	At least two of last three A1C reading >=7%; used oral antidiabetic agents only	Individualized counseling, group education sessions and phone contact	NR	Household family member	Clinicians and social workers	Hospital and telephone	6	450
Keogh 2011	2 out of 3 LAST A1Cs >8%	Individualized sessions to modify diabetes perceptions and develop action plans	Self-regulation of health and illness	Family member	Psychologist	Home	0.75	100
Toobert 2011	Latinas	Group sessions based on education and problem-solving	NR	Family members	Group leader	Community	NR	NR
Trief 2011	Married for >1 year; A1C>7.3%	Diabetes education, goal setting, and collaborative problem solving	Social learning theory	Spouse/partner	Diabetes educator and marriage/family therapist	Telephone	3	NR
Haltiwanger 2012	>60 years old; Mexican American; documented difficulties with health habits	Diabetes education group sessions	NR	Spouse	Health educator	NR	2	720
Khosravizade 2014	>30 years old; medium or low adherence; low social support	Individualized education; focus on medication adherence and family support behavior	NR	Household family member	Researchers	NR	3	NR
Shaya 2014	A1C>7% or FBS >110mg/dl	Education sessions and team building exercises	Education and medication therapy management	Peers	Nurse practitioner educator	Community	6	NR

Sorkin 2014	Latina; mother to overweight woman	Group sessions, home visits, and booster phone calls	Lifestyle changes	Daughter	Lifestyle community coach	Community, home and telephone	4	NR
Greene 2015	African American	Diabetes self-management education	NR	Household family member or companion	Unclear	NR	2	3120
Baig 2015	Diagnosis of diabetes by a physician	Group education classes focused on nutrition, physical activity and behavioral problem solving	Social cognitive theory, the transtheoretical model, and self-determination theory	Church community	Lay leaders	Community	2	720
Kasteleyn 2015	>35 years old; within 2 weeks from hospital discharge after first acute coronary event	Home visits with individualized education sessions	Self-efficacy	Spouse/partner	Diabetes Nurse practitioner	Home	2	155
Trief 2016	Married or with partner for >1 year; A1C>7.5%	Telephone calls with education and behavioral strategies with spouse	Interdependence theory and social learning theory	Spouse/partner	Diabetes educator or counselor	Telephone	3	720
McEwen 2017	Mexican American	Family-based T2DM social support intervention	Family social capital	Family member	NR	NR	3	NR
Samuel-Hodge 2017	African American; overweight or obese; A1C ≤11%	Group-based sessions focusing on group sharing and problem solving	Social interdependence and social support theories	Family member	Registered dietitians	University	5	2400
Wichit 2017	≥35 years old; T2DM duration of ≥6 months and living in Thachang District, Thailand	Group-based education sessions using workbooks	Self-efficacy theory	Household family member	Registered nurse	Diabetes clinic	3	360

Table 1. Trial and intervention characteristics

diabetes and a history of an acute coronary event;[30] one required participants to also have uncontrolled hypertension,[43] and another enrolled only patients that were overweight or obese.[33] Two trials only enrolled women.[25 28]

3.3 Risk of bias and confidence in the body of evidence

The overall risk of bias was judged to be moderate for all outcomes (**Supplemental Figure S1, Table S3**). Allocation concealment and blinding of outcome assessor were often unclear; some studies lost up to one third of participants to follow-up. Outcome reporting was deemed complete for most trials. When considering the body of evidence, unexplained inconsistency in results across RCTs further reduced confidence in the overall results, particularly for the social support outcome.

3.4 Meta-analysis

3.4.1 Self-reported outcomes

After pooling the results from the 7 RCTs reporting social support (829 total participants), we found a large increase in self-reported social support, SDM 0.88 (95% CI, 0.40 to 1.36), with high inconsistency in results across trials (I^2=90%) (**Figure 4**). Inconsistency remained unexplained after subgroup analyses (**Supplemental table S4)**.

Both wellbeing and self-rated health (with mental and physical score components) scales assessed quality of life. When pooled, neither well-being scales (2 trials, 282 participants; SMD 0.62 [95% CI, -0.13 to 1.37], I^2=91%) nor the physical (4 trials, 524 participants; SMD 0.07 [95% CI, -0.10 to 0.24], I^2=0%) and mental (4 trials, 524 participants; SMD 0.01 [95% CI, -0.18 to 0.20], I^2=14%) self-rated health measures showed significant improvements (**Figure 4**). One trial assessed the burden of treatment[38] using the 17-item Diabetes Distress scale[44] and found that the intervention group reported lower treatment burden than the control.

3.4.2 Biomedical outcomes

When pooled, the 8 trials reporting HbA1c at 3 months, showed significant lowering (924 participants; mean difference (MD) -0.23 [95% CI, -0.38 to -0.08]) with minimal inconsistency

across trials (I^2=12%). No significant differences in HbA1c were evident at 6 months (10 trials, 1347 participants; MD -0.27 [95% CI, -0.56 to 0.02], I^2=84%) (**Supplemental figure S2)**, >7 months after baseline (3 trials, 674 participants; MD -0.10 [95% CI, -0.84 to 0.64], I^2=99%) (**Supplemental figure S3)**, or when considering the HbA1c available at the point of longest follow-up (16 trials, 2025 participants; MD -0.17 [95% CI, -0.34 to 0.00], I^2=50%) with moderate to high inconsistency across trials at all time-points (**Figure 4**). Subgroup analyses did not reveal important interactions (**Supplemental table S4**).

4. DISCUSSION AND CONCLUSION

4.1 Discussion

4.1.1 Summary of findings

We uncovered a nascent body of evidence, small, sparse, and heterogeneous, at moderate risk of bias, reporting favorable effects on social support and short-term HbA1c and no significant effect on quality of life of social network interventions in patients with type 2 diabetes. Only one trial evaluated treatment burden directly, and its findings are broadly consistent with our logic model (**Figure 1**) suggesting benefit of interventions to promote social network support in patients with type 2 diabetes.

4.1.2 Comparisons with Previous Studies

To our knowledge, we provide the first meta-analysis of the effects of social network interventions in the management of type 2 diabetes. In concordance with the findings of a previous systematic review on social support in diabetes, studies were highly heterogeneous in their intervention components with limited details reported about these interventions.[45] A recent meta-synthesis of qualitative literature reports that some group-based initiatives use individualistic rather than social approaches.[4] This is reflected in our findings; seven trials

reported the underlying framework for their social network intervention to be based on individualistic theories such as self-efficacy and self-regulation. Similarly, only one intervention employed all aspects of social support identified in diabetes management (**Figure 3**).

4.1.3 Strengths and Limitations of this Review

Our search strategy was designed to balance rigor with feasibility; thus, it may have missed reports which did not mention the social support component of the intervention in the title or abstract. We may have overestimated the risk of bias of these RCTs because of their unclear reporting of trial methods.[46] When seen as a review of an evolving field in its infancy, its limitations apply almost exclusively to the meta-analytical portion of the systematic review: the heterogeneity of methods and results, while informative, questions the wisdom of pooling. We could not assess for publication bias; our results could represent an overly sanguine view of the possibilities associated with social network interventions.

Conversely, our review has several strengths, such as a thorough search and reproducible judgments about inclusion, and network and intervention classifications. Pooling was followed by a parsimonious set of exploratory pre-specified subgroup analyses to explore inconsistency in results across RCTs. Overall, we are confident we represent here the emerging body of evidence about interventions directed at social networks in support of patients with type 2 diabetes.

4.2 Implications for Research and Practice

Future research should clearly identify and report the explanatory frameworks, mechanisms, and theories for the social network interventions being tested. Ideally, the theory should be social and predict the impact of social network interventions on care and outcomes.

A recent meta-analysis reported decreased mortality in persons with higher social support.[47] Studies in patients with diabetes[48] and older adults[49] have found social support to be

predictive of morbidity and mortality, after adjusting for differences in health behaviors. Proposed mechanisms for the protective effects include modulation of physiologic stress responses.[50-52] Emerging literature also highlights network composition (type and number relationships rather than quality of relationships) as important for health and self-management.[49 53] Social networks can affect diabetes self-management by impacting the workload patients must enact by providing opportunities to share knowledge and by facilitating access to resources.[7] In turn, access to these networks requires patients to work to be aware and to deal with network relationships.[7] The effects on workload are likely to interact with the theory of physiological stress modulation, as access to healthcare and changes in self-efficacy affect psychosocial stress. This is especially pertinent for people with limited access to formal health care; they may be more likely to present to care with higher allostatic load and to depend critically on personal social networks.[4 7] Therefore, the effects of involving social networks in diabetes management on intermediate outcomes such as *allostatic load*, treatment workload and treatment burden should be tested in future randomized trials to uncover the impact of social support on these and on health outcomes apparent in observational studies.

Although it may be premature to translate this evidence into practice, the preceding observational and qualitative research and the evolving experimental research summarized here suggest an important but underexploited role for social networks in supporting the work patients do to manage type 2 diabetes. Care approaches that consider social networks as targets of interventions, as mediators of knowledge and access to resources and which help patients to deal with network relationships may prove more valuable than interventions supporting self-management alone. Such promise awaits further development and evaluation.

4.3 Conclusion

Despite a compelling theoretical base, researchers have barely studied the value of interventions targeting patient social networks on diabetes care. The body of evidence to date is limited at moderate risk of bias, heterogeneous, with inconsistent results, and based on individualistic theories. The results, however, are promising. This review challenges the scientific community to design and test theory-based interventions that go beyond self-management approaches to focus on the largely untapped potential of social networks to improve diabetes care.

Funding: GS-B was supported by CTSA Grant Number TL1TR000137 from the National Center for Advancing Translational Science (NCATS) and grant number 3R01HL131535-01S1 from the National Heart Lung and Blood Institute (NHLBI). VMM was partially supported by Grant Number UL1TR000135 from the National Center for Advancing Translational Science (NCATS), a component of the National Institutes of Health (NIH). Its contents are solely the responsibility of the author and do not necessarily represent the official view of the NIH. The funder had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Author contributions: GS-B, OJP, PJE, RR-G and VMM designed the protocol. GS-B and PJE searched the literature; GS-B, OJP, and RR-G extracted the data. GS-B, NA-V and VMM analyzed the data. GS-B, OJP, RR-G, NA-V, PJE, LL-M, AR and VMM interpreted the data and critically revised the report.

Conflicts of Interest Disclosure: No competing financial interests exist.

Availability of data and material: Datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

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Tables and Figures

Figure 1. Logic model of social self-management

Figure 2. PRISMA flow chart

Figure 3. Intervention and comparator components

Figure 4. Effect of social network interventions on social support, quality of life (QoL) and HbA1c

Table 1. Trial and intervention characteristics

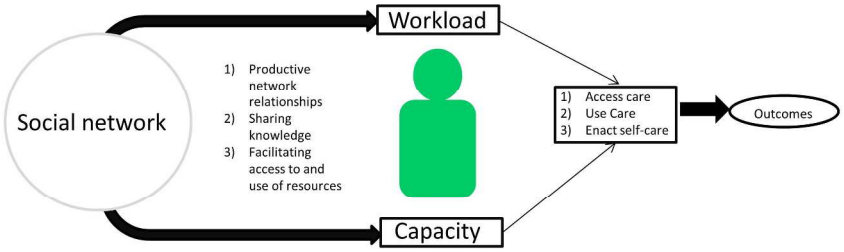

Figure 1. Logic Model of Social Self-management

Figure1. Logic model of social self-management

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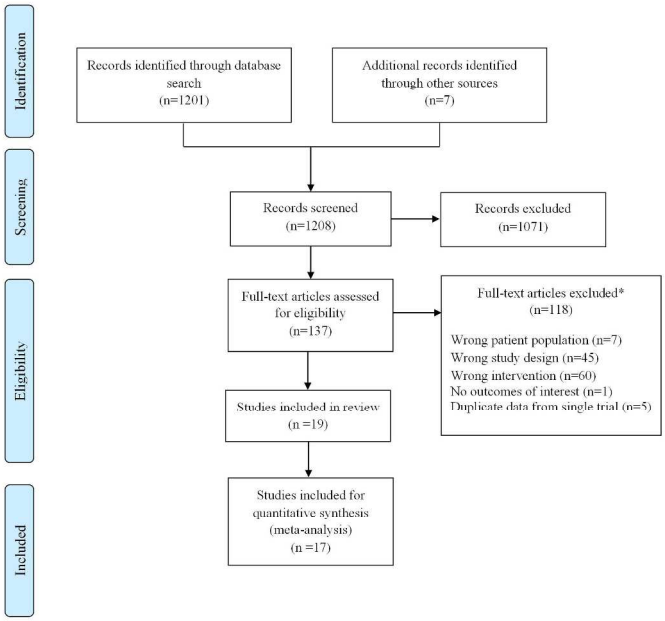


Figure 2. PRISMA flow chart
*reasons not mutually exclusive

Figure 2. PRISMA flow chart

254x190mm (300 x 300 DPI)

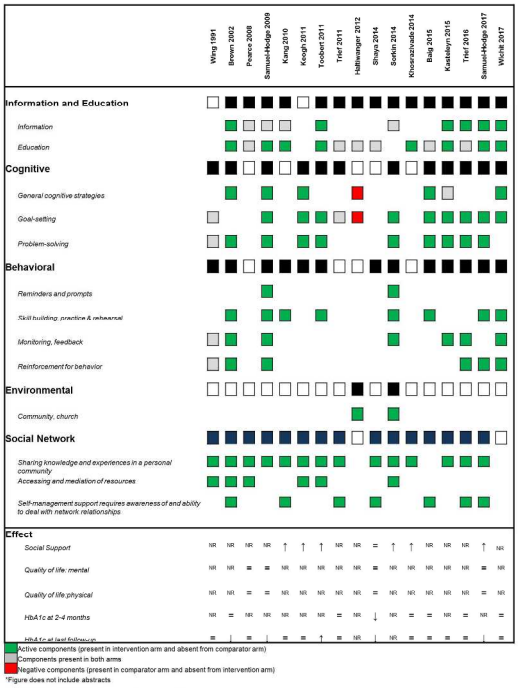


Figure 3. Intervention and comparator components

Figure 3. Intervention and comparator components

254x190mm (300 x 300 DPI)

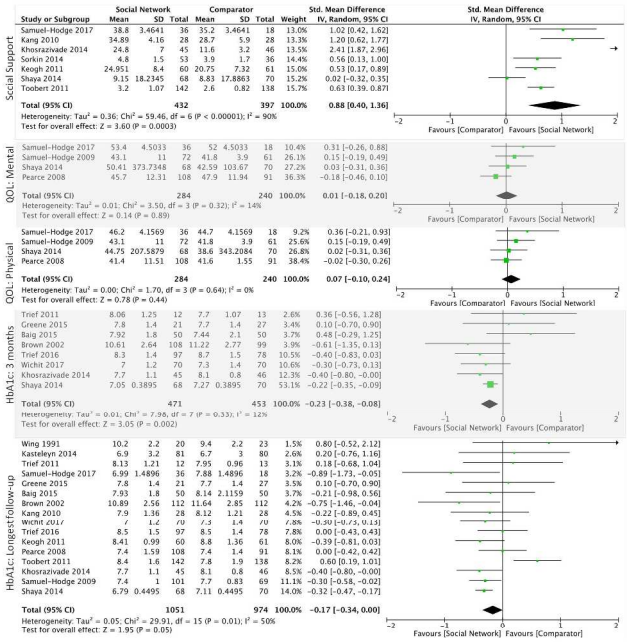


Figure 4. Effect of social network interventions on social support, quality of life (QoL) and HbA1c

Figure 4. Effect of social network interventions on social support, quality of life (QoL), and HbA1c

254x190mm (300 x 300 DPI)

Supplemental Material

A systematic review of social network interventions in patients with type 2 diabetes

Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) 1946 to Present			
1	*diabetes mellitus, type 2/ or "type 2 diabet*".tw. or niddm.mp. or t2dm.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	114218	Advanced
2	("social network" or "social support").mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	69042	Advanced
3	1 and 2	663	Advanced
4	family relations/ or family conflict/ or intergenerational relations/ or sibling relations/	15431	Advanced
5	family/ or adult children/ or family relations/	73608	Advanced
6	family role/ or family therapy/	7952	Advanced
7	1 and (4 or 5 or 6)	536	Advanced
8	(couple or couples or married or spous* or partner*1 or household or neighbor*1).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	231588	Advanced
9	(church* or religious* or husband* or wife* or relatives or "family based").mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept	110536	Advanced

	word, rare disease supplementary concept word, unique identifier]		
10	1 and 8	749	Advanced
11	1 and 9	1089	Advanced
12	7 or 10 or 11	2151	Advanced
13	limit 12 to randomized controlled trial	87	Advanced
14	12 and intervention*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	290	Advanced
15	12 and (behavior* or behaviour* or adher* or education* or aware* or stigma*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	573	Advanced
16	13 or 14	330	Advanced
17	3 or 7 or 12	2695	Advanced
18	intervention*.mp. and 17 [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	512	Advanced
19	13 or 18	552	Advanced

20	17 and random*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	338	Advanced
21	19 or 20	676	Advanced
22	remove duplicates from 21	665	

CENTRAL – same strategy – 205

Embase 1988 to 2017 Week 16

#	Searches	Results	Search Type
1	*diabetes mellitus, type 2/ or "type 2 diabet*".tw. or niddm.mp. or t2dm.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	142471	Advanced
2	("social network" or "social support").mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	79400	Advanced
3	1 and 2	645	Advanced
4	family relations/ or family conflict/ or intergenerational relations/ or sibling relations/	69298	Advanced

5	family/ or adult children/ or family relations/	70584	Advanced
6	family role/ or family therapy/	8709	Advanced
7	1 and (4 or 5 or 6)	439	Advanced
8	(couple or couples or married or spous* or partner*1 or household or neighbor*1).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	265365	Advanced
9	(church* or religious* or husband* or wife* or relatives or "family based").mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	109824	Advanced
10	1 and 8	1041	Advanced
11	1 and 9	1305	Advanced
12	7 or 10 or 11	2620	Advanced
13	3 or 12	3134	Advanced
14	13 and intervention*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	653	Advanced
15	randomized controlled trial/	376080	Advanced
16	13 and 15	158	Advanced

17	13 and random*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	410	Advanced
18	14 or 16 or 17	847	Advanced
19	limit 18 to human	796	Advanced
20	non insulin dependent diabetes mellitus/	166150	Advanced
21	19 and 20	665	

PsycINFO 1987 to April Week 2 2017

#	Searches	Results	Search Type
1	diabetes mellitus/	4189	Advanced
2	1 and ("type 2" or noninsulin* or "non insulin" or niddm or t2d or t2dm).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures]	1815	Advanced
3	exp social support/	26965	Advanced
4	social networks/ or exp social groups/ or exp social interaction/ or exp social support/ or exp support groups/	276211	Advanced
5	2 and (3 or 4)	90	Advanced

6	exp Family Therapy/ or family.mp. or exp Family Relations/ or exp Family/ or exp Family Systems Theory/ or exp Family Structure/	282330	Advanced
7	couples/ or cohabitation/ or dyads/ or significant others/ or exp spouses/	25371	Advanced
8	2 and (6 or 7)	195	Advanced
9	5 or 8	258	Advanced
10	limit 9 to ("0830 systematic review" or 1200 meta analysis)	1	Advanced
11	9 and (intervention* or random*).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures]	78	Advanced
12	10 or 11	79	Advanced
13	limit 12 to all journals	55	

CINAHL

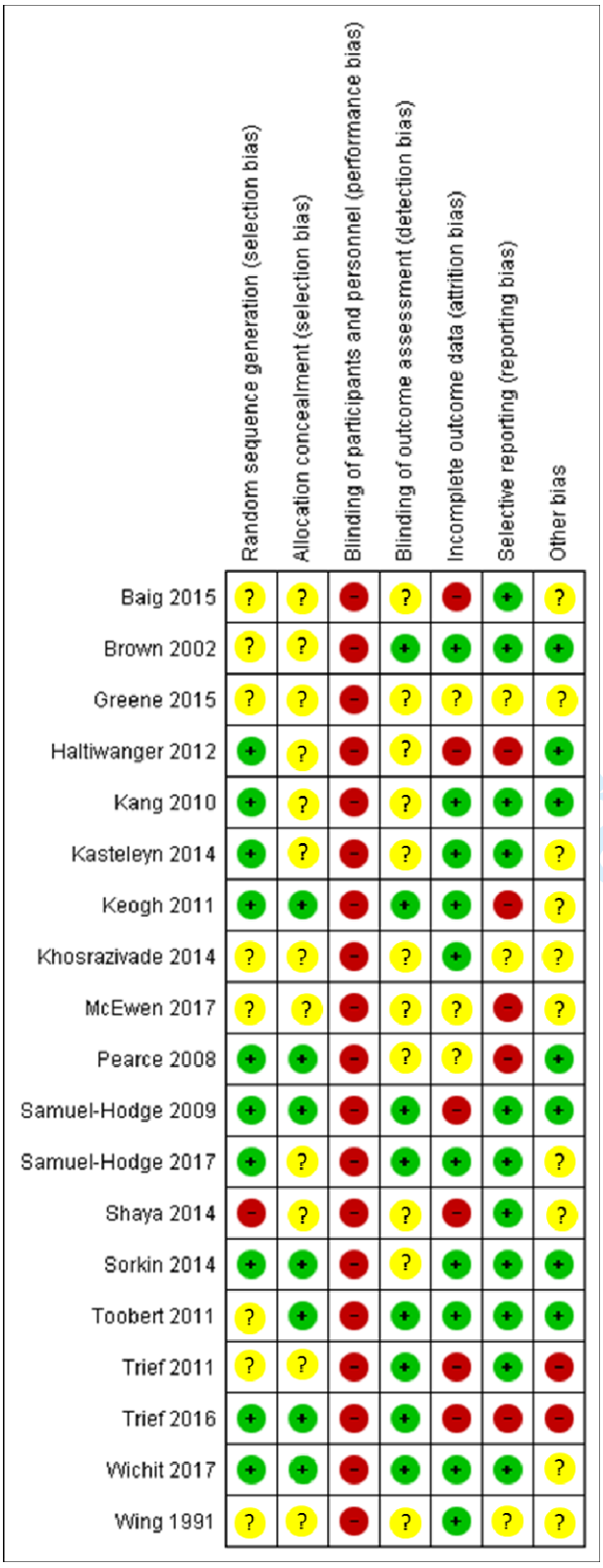
#	Query	Limiters/Expanders	Last Run Via	Results
S12	S8 AND S11	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	9
S11	S5 AND S10	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	78
S10	(MH "Family+") OR (MH "Family Relations+") OR (MH "Patient-Family	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search	123,032

	Relations") OR (MH "Nuclear Family+") OR (MH "Family Attitudes+")		Database - CINAHL with Full Text	
S9	S5 AND S8	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	75
S8	S6 OR S7	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	129,321
S7	(MH "Intervention Trials") OR "intervention"	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	111,076
S6	(MH "Randomized Controlled Trials")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	25,142
S5	S1 AND S4	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	385
S4	S2 OR S3	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	48,947
S3	(MH "Young Adult Social Support Index") OR (MH "Social Support Index") OR (MH "Social Support (Iowa NOC)") OR (MH "Norbeck Social Support Questionnaire")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	289
S2	(MH "Social Networks") OR (MH "Social Network Analysis (Saba CCC)") OR (MH "Support, Psychosocial+")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	48,840
S1	(MH "Diabetes Mellitus, Type 2")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	26,607

Supplement Table S1. Search strategy

Study	Intervention			Control		
	N	Mean Age in years (SD)	Mean duration of T2DM in years (SD)	N	Mean Age in years (SD)	Mean duration of T2DM in years (SD)
Wing 1991	25	53.6 (7.7)	NR	24	51.2 (7.3)	NR
Brown 2002	128	54.7 (8.2)	7.6 (5.8)	128	53.3 (8.3)	8.1 (6.9)
Sammuel - Hodge 2002	117	57 (9.7)	9 (NR)	84	61.3 (11.9)	11 (NR)
Pearce 2008	108	61.2 (10.59)	NR	91	63.1 (8.63)	NR
Kang 2010	33	55.3 (7.7)	3.8 (3.2)	34	51.7 (8.5)	4.4 (3)
Toobert 2011	142	55.6 (9.7)	8.4 (6.5)	138	58.7 (10.3)	10.4 (9.8)
Greene 2015	21	NR	NR	27	NR	NR
Keogh 2011	60	59.96 (11.67)	9.17 (7.1)	61	57.9 (11.34)	9.65 (6.45)
Trief 2011	12	60.33 (8.63)	8.63 (NR)	12	61.08 (9.27)	9.27 (NR)
Haltiwanger 2012	12	NR	NR	36	NR	NR
Khosravizade 2014	45	52.93 (7.62)	9.71 (6.75)	46	54.13 (7.56)	11.39 (5.4)
Shaya 2014	68	53.9 (NR)	9.2 (8.6)	70	51.9 (NR)	8.8 (8.2)
Sorkin 2014	53	52.7 (6.9)	9.8 (NR)	36	52.7 (6.9)	9.8 (NR)
Baig 2015	50	51.7 (11.6)	8.7 (8.67)	50	55.7 (11.4)	7.8 (7.14)
Kasteleyn 2015	101	66 (9.3)	7.0 (2.8-16)	100	65.6 (9.4)	8.5 (5-15)
Trief 2016	97	57.8 (10.8)	12.8 (8.5)	78	56.9 (10.4)	12.6 (8.3)
McEwen 2017	NR	NR	NR	NR	NR	NR
Samuel-Hodge 2017	36	55 (NR)	7.3 (NR)	18	53 (NR)	5.4 (NR)
Wichit 2017	70	61.3 (11.6)	6.0 (4.7) 6.0 (4.7)	70	55.5 (10.5)	5.4 (4.3)

Supplemental Table S2. Trial participant baseline characteristics



Supplemental Figure S1. Risk of bias of included trials (Cochrane risk of bias tool)

Assessing confidence in the estimates of effect: GRADE

Quality assessment							№ of patients		Effect	Quality	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Social network interventions	Any comparator	Absolute (95% CI)		
Social Support											
7	randomised trials	serious [1]	serious [2,3]	not serious	serious [4]	strong association	432	397	SMD **0.88 higher** (0.40 higher to 1.36 higher)	Low to moderate	IMPORTANT

CI: Confidence interval; **SMD:** Standardised mean difference

1. unclear blinding of outcome assessors
2. I2=90%
3. non-overlapping CIs
4. confidence interval or estimate effect includes non-important change as well as very important change

Quality assessment							№ of patients		Effect	Quality	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Social network interventions	Any comparator	Absolute (95% CI)		
HbA1c: 3 months											
6	randomised trials	serious [1]	not serious	not serious	not serious	none	471	453	MD **0.23 lower** (0.38 lower to 0.08 lower)	Low to very low	IMPORTANT
HbA1c: 5-7 Months											
8	randomised trials	serious [1]	serious [2]	not serious	not serious	none	694	653	MD **0.27 lower** (0.56 lower to 0.02 higher)	Low to very low	IMPORTANT
HbA1c: 8+ months											

Quality assessment							№ of patients		Effect	Quality	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Social network interventions	Any comparator	Absolute (95% CI)		
3	randomised trials	serious[1]	very serious[2]	not serious	serious[3]	none	355	319	MD **0.1 lower** (0.84 lower to 0.65 higher)	Low to very low	IMPORTANT
HbA1c: Longest follow-up											
13	randomised trials	serious[1]	not serious	not serious	not serious	none	1051	974	MD **0.17 lower** (0.34 lower to 0)	Low to very low	IMPORTANT

CI: Confidence interval; **MD:** Mean difference

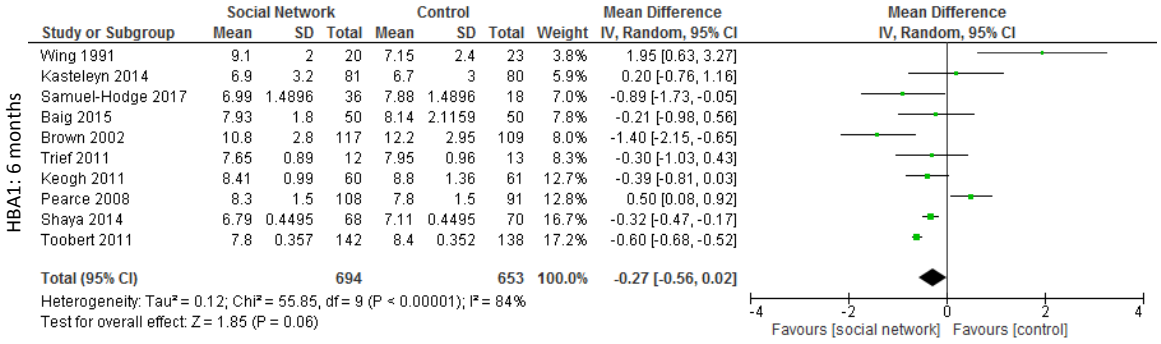
1. unclear allocation concealment
2. high I2
3. large CI

Quality assessment							№ of patients		Effect	Quality	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Social network interventions	Any comparator	Absolute (95% CI)		
Well-being											
2	randomised trials	serious[1]	very serious[2,3]	not serious	very serious[4]	none	141	141	SMD **0.62 higher** (0.13 lower to 1.37 higher)	Low to very low	IMPORTANT
Quality of Life: Physical Component											
3	randomised trials	serious[1]	not serious	not serious	not serious	none	284	240	SMD **0.07 higher** (0.10 lower to 0.24 higher)	Low to very low	IMPORTANT
Quality of Life: Mental Component											
2	randomised trials	serious[1]	not serious	not serious	not serious	none	284	240	SMD **0.01 lower** (0.18 lower to 0.20 higher)	Low to very low	IMPORTANT

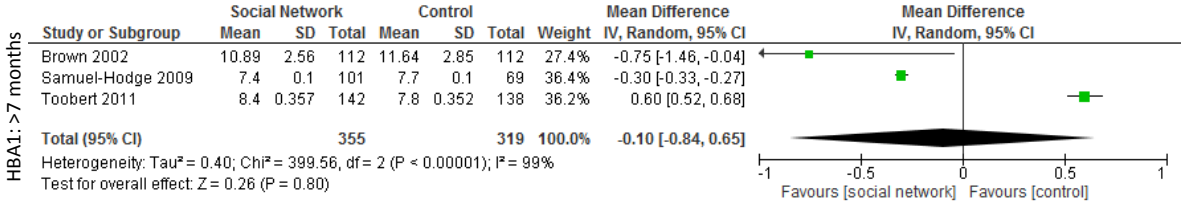
CI: Confidence interval; **SMD:** Standardised mean difference

1. unclear allocation concealment
2. high I2
3. differences in scales used
4. very wide CI

Supplemental Table S3. GRADE assessment



Supplemental Figure S2. Effect of social network intervention on HbA1c at 6 months follow-up



Supplemental Figure S3. Effect of social network intervention on HbA1c at 8+ months follow-up

Subgroup Analyses						
	Hba1c at last follow-up			**Social support at last follow-up**		
	Subgroup *effect size (95% CI); I^2*	**Comparison subgroup** *effect size (95% CI); I^2*	**P-value for interaction**	**Subgroup** *effect size (95% CI); I^2*	**Comparison subgroup** *effect size (95% CI); I^2*	**P-value for interaction**
Patient characteristics						
Mean baseline HbA1c> 8%	-0.08 (-0.42, 0.26); 66%	-0.28 (-0.40, -0.17); 0%	0.28	1.04 (0.46, 1.61); NA	0.49 (-0.50, 1.47); 88%	0.35
Intervention characteristics						
Self-selected social network	-0.22 (-0.46, 0.01); 63%	-0.14 (-0.35, 0.06); 0%	0.64	0.94 (0.38, 1.50); 92%	0.56 (0.13, 1.0); NA	0.30
Household member	-0.08 (-0.31, 0.16); 51%	-0.33 (-0.45, -0.20): 0%	0.07	1.16 (0.44, 1.88); 92%	0.49 (-0.07, 1.06); 79%	0.15
Contact time >585 minutes	-0.18 (-0.46, 0.09); 25%	-0.34 (-0.59, -0.09); 0%	0.40	1.02 (0.42, 1.62); NA	0.82 (0.18, 1.47); 73%	0.66
Underlying framework	-0.25 (-0.37, -0.14); 5%	-0.11 (-0.63, 0.4); 76%	0.6	0.49 (0.10, 0.87); 71%	1.39 (0.32, 2.47); 94%	0.12
Dyadic social network reported	-0.22 (-0.39, -0.04); 13%	-0.07 (-0.46, 0.32); 83%	0.51	1.13 (0.47, 1.79); 89%	0.33 (-0.26, 0.93); 88%	0.08
Trial characteristics						
Low risk of bias	-0.19 (-0.50, 0.11); 69%	-0.26 (-0.39, -0.14); 10%	0.67	0.63 (0.45, 0.80); 0%	1.20 (-0.27, 2.66); 96%	0.45

Supplemental Table S4. Subgroup analyses

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	6
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	6
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6-7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6-7 and supplement
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	supplement
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	7-8
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	9
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	9-10
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	10

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	10
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	10
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	11
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	11-13, table 1
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	14, supp fig s1, supp table s3
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	14-15, fig 4, supp fig s2, supp fig s3
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	14-15
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	14, supp fig s1, supp table s3
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	14-15, sup table s4
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	15-17

PRISMA 2009 Checklist

Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	16
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	17-18
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	19

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: **www.prisma-statement.org**.

Page 2 of 2

BMJ Open

A systematic review and meta-analysis of trials of social network interventions in type 2 diabetes

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-016506.R2
Article Type:	Research
Date Submitted by the Author:	22-Jun-2017
Complete List of Authors:	Spencer-Bonilla, Gabriela ; Mayo Clinic, Ponce, Oscar Rodriguez-Gutierrez, R; Mayo Clinic Alvarez-Villalobos, Neri Erwin, Patricia; Mayo Clinic College of Medicine Larrea-Mantilla, Laura Rogers, Anne; University of Southampton, Faculty of Health Sciences Montori, Victor; Mayo Clinic, Knowledge and Encounter Research Unit
Primary Subject Heading:	Diabetes and endocrinology
Secondary Subject Heading:	Patient-centred medicine, Public health, Nutrition and metabolism
Keywords:	General diabetes < DIABETES & ENDOCRINOLOGY, Diabetes & endocrinology < INTERNAL MEDICINE, PUBLIC HEALTH

Title: A systematic review and meta-analysis of trials of social network interventions in type 2 diabetes

Short title: Social network interventions in type 2 diabetes

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Word count: 3,327

Table and figure count: 5

Supplemental table and figure count: 7

ABSTRACT

Objectives: In the care of patients with type 2 diabetes, self-management is emphasized and studied while theory and observations suggest that patients also benefit from social support. We sought to assess the effect of social network interventions on social support, glycemic control, and quality of life in patients with type 2 diabetes.

Research Design and Methods: We searched Ovid MEDLINE, Ovid EBM Reviews, Cochrane Central Register of Controlled Trials, EMBASE, PsycINFO, and CINAHL through April 2017 for randomized trials (RCTs) of social network interventions in patients with type 2 diabetes. Reviewers working independently and in duplicate assessed eligibility and risk of bias, and extracted data from eligible RCTs. We pooled estimates using inverse variance random-effects meta-analysis.

Results: We found 19 eligible RCTs enrolling 2319 participants. Social network interventions were commonly based on individual behavior change rather than social or interpersonal theories of self-management, were educational, and sought to engage social network members for their knowledge and experience. Interventions improved social support (0.74 standard deviations [95% CI: 0.32, 1.15], I^2=89%, 8 RCTs), and HbA1c at 3 months (-0.5 percentage points [95% CI: -0.40, -0.11], I^2=12%, 9 RCTs), but not quality of life.

Conclusions: Despite a compelling theoretical base, researchers have only minimally studied the value of interventions targeting patients' social networks on diabetes care. Although the body of evidence to date is limited, and based on individual behavior change theories, the results are promising. This review challenges the scientific community to design and test theory-based interventions that go beyond self-management approaches to focus on the largely untapped potential of social networks to improve diabetes care.

PROSPERO registration: CRD42016036117

ARTICLE SUMMARY

Strengths and limitations

- This systematic review and meta-analysis was strengthened by a thorough literature search, author contact, reproducible judgments about the inclusion and appraisal of the evidence, and theory-based discussion of its results.
- The review found and summarized few reports of randomized trials testing interventions with poor theoretical alignment and limited protection against bias, which produced imprecise and inconsistent estimates of effect on markers of social support and short-term diabetes control.
- These limitations notwithstanding, this first meta-analysis of randomized trials of social network interventions identified an important knowledge (and practice) gap in the care of patients with type 2 diabetes, and produced a theoretical model connecting social network interventions with outcomes in these and other patients living with chronic conditions.

1. INTRODUCTION

Patients with type 2 diabetes implement self-management practices – self-testing, diet and activity regimens, medication administration – into their daily routines, along with frequent office visits for examination and laboratory testing to reduce the risk of complications of diabetes and its comorbidities. Patients must have sufficient capacity (resources, time, and energy) to shoulder this workload.[1 2] Without support or sufficient capacity, these delegations can overwhelm patients and contribute to burden of treatment which is associated with decreased adherence to medical recommendations and exhaustion with self-care.[2]

Patients do not enact the work of self-management in isolation. Rather, social relationships are often cited as essential to managing type 2 diabetes. Observational studies have repeatedly found that better social support is associated with effective diabetes self-management and better efficacy of self-management interventions.[3 4] A recent meta-synthesis identified the different mechanisms through which social networks can influence diabetes self-management by; (1) sharing knowledge and (2) facilitating access to resources, but only to the extent that patients can (3) engage and maintain productive relationships with network members (**Figure 1**).[5] Social networks may, therefore, mitigate (or exacerbate when dysfunctional) the workload patients must shoulder and impact diabetes care. Yet, social networks are not usually considered in the design and evaluation of chronic disease management interventions; self-management programs have typically been based on theories *individual* behavior change.[6 7] The impact of interventions based on social theories and aimed at supporting social networks on the care and outcomes of patients with type 2 diabetes remains unknown.

In this review, we summarize the literature evaluating interventions in randomized clinical trials (RCTs) that targeted friends, families, and peers (social networks) of patients with

type 2 diabetes. We describe the interventions, their theoretical underpinnings, how existing social networks are enrolled, and the efficacy of the interventions in terms of social support, quality of life, and glycemic control relative to interventions that did not target patients' social networks.

2. METHODS

2.1 Protocol and Registration

This review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) Statement[8] and has a registered protocol (PROSPERO registration: CRD42016036117).[9]

2.2 Eligibility Criteria

We included RCTs testing interventions for type 2 diabetes management that involved patients' social networks (families, friends, peers and communities) in any capacity. RCTs had to evaluate interventions targeting dyadic (e.g. a spouse or friend) or community (ie. network of networks like neighborhoods, families and churches) networks[10] based on enduring social relationships likely to be involved in the patients' lives over the long periods of time required for self-management.[11] Thus, we excluded RCTs involving social relationships created for the trial, e.g., RCTs testing interventions enrolling and training patients with type 2 diabetes to provide peer support to other participants using online communities.

2.3 Data Sources and Searches

A comprehensive electronic search of Ovid MEDLINE, Ovid EBM Reviews, Cochrane Central Register of Controlled Trials, EMBASE, PsycINFO, and EBSCO CINAHL was performed from inception of each database through the second week of April 2017 to identify published studies and conference abstracts. Working with an experienced medical

librarian (P.J.E), G.S-B. developed a sensitive search strategy to identify eligible RCTs. Previous qualitative studies in the field [5 7 10] were used to identify relevant search terms such as descriptors of the constitution or properties of social networks (e.g. *social*, *couples*, *spouse*, *family* and *church*) and terms related to relationships (e.g. *stigma and support*). The full search strategy is available as **Supplemental Table S1**. There were no restrictions by date of publication or language. Reference lists of included articles, reviews and qualitative syntheses on the topic were hand-searched to identify any potentially eligible studies that may have been missed by our electronic search strategy. An expert in the field (A.R.) reviewed the list of included studies for missed articles.

2.4 Study Selection

Three reviewers (G.S.B, R.R-G. and O.J.P.), working independently, in pairs, and in duplicate, considered the eligibility of titles and abstracts that resulted from the search after calibrating with 20 abstracts. As part of calibration, eligibility criteria were iterated for clarity and consistency while considering examples of pre-existing and made-for-the-trial social networks.

Reviewers, working independently and in duplicate, considered all available full-text reports for eligibility, obtained if at least one reviewer considered the abstract potentially eligible. Before full-text screening, the reviewers calibrated their judgments using 10 eligible reports. Reasons for exclusion were not mutually exclusive, therefore reviewers agreed to prioritize reasons for exclusion as follows: (1) inappropriate population, (2) unsuitable study design, (3) inappropriate intervention, and (4) no outcomes of interest reported. After completion of full-text screening, chance-adjusted agreement was quantified using the kappa statistic,[12] and disagreements resolved by discussion and consensus among the three reviewers. We

subsequently searched MEDLINE with the first and last authors' last names for protocols for other relevant publications (e.g., pilots and results at different follow-up lengths) to obtain additional details about the included RCTs.

2.5 Data Extraction and Quality Assessment

The three reviewers, calibrated using two reports, performed data extraction independently and in duplicate using a standardized form. Extracted data included a full description of study characteristics: design, setting where recruitment took place, participant eligibility criteria, conceptual frameworks justifying the interventions, and of baseline participant characteristics. For each intervention, we sought details about who delivered the intervention, to whom (which members of the social network were involved), dose (duration and frequency of sessions, total contact time), and fidelity (monitoring of fidelity to the protocol and extent of participant attendance and reasons for non-attendance). We planned to extract the following outcomes: quality of life, social support, treatment burden, metabolic control, and diabetes-related morbidity and mortality; no trials however, reported diabetes-related morbidity and mortality as outcomes measures. Eligible trials reporting on at least one of these outcomes were included.

Due to the heterogeneity of included interventions and comparators we used modified versions of previously published frameworks[5 13] to describe the strategies used (e.g. information and education or cognitive strategies). We also classified how the social network was incorporated into the intervention (**Figure 1**); for (1) sharing information, to (2) facilitate accessing and mediating resources, or to (3) support productive relationships. After piloting this procedure with 2 RCTs, two reviewers classified the interventions using line-by-line coding of trial methods. Conflicts were resolved by consensus.

The three reviewers, independently and in duplicate, assessed each RCT's risk of bias using the Cochrane tool,[14] recognizing the impossibility of blinding participants and interventionists (persons delivering the intervention, e.g. physician, nurse educators) to intervention allocation.[15] These could not be disregarded, however, because subjective and patient-reported outcomes were assessed. Publication bias could not be assessed statistically or graphically given the small number and inconsistency of included RCTs.[16] The overall confidence in the results was rated using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach.[17] This approach assesses the confidence merited by the body of evidence based on the risk of bias of the individual studies, inconsistency in the results, indirectness, imprecision, and other considerations.

2.6 Author Contact

For all included RCTs, we asked the corresponding author via email to complete a table of missing data and risk of bias information. Non-responders received a second communication two weeks later. Six of 18 authors responded with complete or partial data; one author reported no longer having access to necessary data.

2.7 Data Synthesis and Analysis

We used Review Manager version 5.3 to conduct meta-analyses.[18] When possible, we generated meta-analytic estimates of treatment effects using the inverse variance random-effects model. When trials had more than one comparator to the intervention of interest, we chose the arm whose procedures most resembled usual care or no intervention, as this was the most common comparator for two-arm trials. Meta-analyses generated either a weighted mean difference expressed in usual units (e.g., HbA1c) or a mean difference expressed in standard-deviation units, a common approach that enables pooling across different scales assessing the

same construct (e.g., quality of life). A standardized mean difference (SDM) of 0.5 standard deviations or greater was considered important.[19]

To determine the impact of interventions on HbA1c, we pooled results at 3 months (represented by studies reporting results from 2 to 4 months of follow-up), 6 months (5-7 months of follow-up) or greater (>7 months of follow up). Otherwise, values at longest follow-up were used for all outcomes. Missing measures of variability were imputed either from data reported at another time-point in the same trial and in the same arm (when available) or as the average standard deviation observed across all RCTs. Inconsistency for each outcome not attributable to chance was assessed visually using forest plots and estimated using the I^2 statistic. $I^2 < 25\%$ reflected low inconsistency; $I^2 > 75\%$ reflected high inconsistency.[20]

2.8 Modifications to the registered protocol

The included trials were heterogeneous in terms of length of follow-up. In addition to performing pooled analyses for HbA1c at 3, 6, and >7 months of follow-up, to increase the power and applicability of our analyses, we also pooled all measures of HbA1c at the longest follow-up reported.

2.9 Subgroup Analyses

To understand inconsistency in results, we planned a few subgroup analyses on social support, HbA1c results and quality of life, but sparse data prevented the latter. We tested treatment interactions with risk of bias (low vs. moderate or high), level of glycemic control at baseline (mean baseline HbA1c>8%), and intervention features. Network subgroups were drawn by whether the target of the intervention was (1) a patient- or an investigator-selected (by protocol, e.g., the patient's spouse) social network member; (2) a member of the patient's household or not as reported in the trial inclusion criteria; (if the social network member

involved was a spouse, they were assumed to be household members); and (3) a dyadic network or a group of more than two people. We also tested subgroups based on whether the intervention was based on a specific underlying framework or not, and on the duration in contact minutes with the interventionist using a median split. For each analysis, we estimated the subgroup effect and conducted a test of interaction. Because most subgroup analyses were underpowered and exploratory, we did not adjust alpha levels for multiple comparisons.

3. RESULTS

3.1 Study Selection

Figure 2 demonstrates the study selection process. We found 1208 records (7 of which were identified through hand-search); 137 were identified as potentially eligible for inclusion after title and abstract screening. We reproducibly (k=.73) included 19 trials; 17 patient-randomized trials [21-30] [31-42] and 2 cluster-randomized trials [43] [44]; overall these trials enrolled 2319 participants.

3.2 Study Characteristics

Table 1 describes these RCTs. Thirteen of the 19 RCTs reported an underlying framework for the intervention either in publication or after author contact.[21] [24] [25] [28] [31] [32] [37-42] [44] While variability in all study characteristics was the norm, most RCTs took place in the community, with the experimental intervention delivering education, information transfer, goal-setting and problem solving (**Figure 3, Table 1**). Social networks -- family members, spouses or partners -- were most commonly employed to share knowledge and experience (**Figure 3**). Overall chance-adjusted agreement for classification of intervention and comparator procedures (**Figure 3**) was good (kappa=.79); comparators used in trials were heterogeneous. **Supplemental Table S2** describes baseline characteristics of RCT participants. One RCT only enrolled patients with

diabetes and a history of an acute coronary event;[31] one required participants to also have uncontrolled hypertension,[45]and another enrolled only patients that were overweight or obese.[34] Two trials only enrolled women.[26 29]

Study	Intervention description	Underlying framework	Support network involved and role	Intervention deliverer(s)	Setting where intervention was delivered	Length (months)	Intervention contact time (minutes)
Wing 1991	Behavioral weight loss program with calorie restriction	Behavioral marital therapy	Spouse; participated in intervention, spouse support for modifying diet and exercise habits	Staff and physicians	NR	5	960
Brown 2002	Instructional and support group emphasizing nutrition, monitoring and self-care	NR	Close family member or close friend; participated in intervention	Clinicians and community health workers	Community	12	120
Pearce 2008	Individualized patient education sessions and newsletters	Health belief model	Relative or friend; joined participant for education session	Nurse practitioner educator	Community and telephone	12	NR
Samuel - Hodge 2009	Individualized counseling, group education sessions and phone contact	Behavior change and adult education	Church community; building community support systems	Church diabetes advisor (CDA) and a health professional	Community and telephone	12	1140-1500
Kang 2010	Individualized counseling, group education sessions and phone contact	NR	Household family member; participate in intervention, dyad also received an education plan based upon their needs	Clinicians and social workers	Hospital and telephone	6	450
Keogh 2011	Individualized sessions to modify diabetes perceptions and develop action plans	Self-regulation of health and illness	Family member; participated in intervention, tailored to dyad	Psychologist	Home	0.75	100
Toobert 2011	Group sessions based on education and problem-solving	NR	Family members; participate in family nights	Group leader	Community	NR	NR
Trief 2011	Diabetes education, goal setting, and collaborative problem solving	Social learning theory	Spouse/partner: participated in couples' calls to promote collaborative problem-solving	Diabetes educator and marriage/family therapist	Telephone	3	NR
Haltiwanger 2012	Diabetes education group sessions	NR	Spouse; participated in intervention	Health educator	NR	2	720

Khosravizade 2014	Individualized education; focus on medication adherence and family support behavior	NR	Household family member; attended small group sessions for family members	Researchers	NR	3	NR
Shaya 2014	Education sessions and team building exercises	Education and medication therapy management	Peers; participated in intervention which included team-building	Nurse practitioner educator	Community	6	NR
Sorkin 2014	Group sessions, home visits, and booster phone calls	Lifestyle changes	Daughter; participated in intervention, dyadic collaboration encouraged	Lifestyle community coach	Community, home and telephone	4	NR
Greene 2015	Diabetes self-management education	NR	Household family member or companion; participated in intervention	Unclear	NR	2	3120
Baig 2015	Group education classes focused on nutrition, physical activity and behavioral problem solving	Social cognitive theory, the transtheoretical model, and self-determination theory	Church community; community based participatory study	Lay leaders	Community	2	720
Kasteleyn 2015	Home visits with individualized education sessions	Self-efficacy	Spouse/partner; attended sessions	Diabetes nurse practitioner	Home	2	155
Trief 2016	Telephone calls with education and behavioral strategies with spouse	Interdependence theory and social learning theory	Spouse/partner; participated in intervention and phone calls based collaborative problem-solving and interdependence	Diabetes educator or counselor	Telephone	3	720
McEwen 2017	Family-based T2DM social support intervention	Family social capital	Family members; participated in intervention	Certified diabetes educator nurse	Community, home and telephone	3	1140
Samuel-Hodge 2017	Group-based sessions focusing on group sharing and problem solving	Social interdependence and social support theories	Family member; participated in intervention	Registered dietitians	University	5	2400
Wichit 2017	Group-based education sessions using workbooks	Self-efficacy theory	Household family member; participated in intervention	Registered nurse	Diabetes clinic	3	360

Table 1. Trial and intervention characteristics

3.3 Risk of bias and confidence in the body of evidence

The overall risk of bias was judged to be moderate for all outcomes (**Supplemental Figure S1, Table S3**). Allocation concealment and blinding of outcome assessor were often unclear; some studies lost up to one third of participants to follow-up. Outcome reporting was deemed complete for most trials. When considering the body of evidence, unexplained inconsistency in results across RCTs further reduced confidence in the overall results, particularly for the social support outcome.

3.4 Meta-analysis

3.4.1 Self-reported outcomes

After pooling the results from the 8 RCTs reporting social support (986 total participants), we found a large increase in self-reported social support, SDM 0.74 (95% CI, 0.32 to 1.15), with high inconsistency in results across trials (I^2=89%) (**Figure 4**). Inconsistency remained unexplained after subgroup analyses (**Supplemental table S4)**.

Both well-being (measured with WHO5[46] and the 12-item well-being scale[47]) and self-rated health (measured with the SF-36[48] and SF-12[49] mental and physical score components) scales assessed quality of life. When pooled, neither well-being scales (2 trials, 282 participants; SMD 0.62 [95% CI, -0.13 to 1.37], I^2=91%) nor the physical (4 trials, 524 participants; SMD 0.06 [95% CI, -0.11 to 0.23], I^2=0%) and mental (4 trials, 524 participants; SMD 0.01 [95% CI, -0.18 to 0.20], I^2=14%) self-rated health measures showed significant improvements (**Figure 4**). One trial assessed the burden of treatment[39] using the 17-item Diabetes Distress scale[50] and found that the intervention group reported lower treatment burden than the csomparator.

3.4.2 Biomedical outcomes

When pooled, the 9 trials reporting HbA1c at 3 months, showed significant lowering (1081 participants; mean difference (MD) -0.25 [95% CI, -0.40 to -0.11]) with minimal inconsistency across trials (I^2=12%). No significant differences in HbA1c were evident at 6 months (141 trials, 1504 participants; MD -0.24 [95% CI, -0.52 to 0.03], I^2=83%) (**Supplemental figure S2)**, >7 months after baseline (3 trials, 674 participants; MD -0.10 [95% CI, -0.84 to 0.64], I^2=99%) (**Supplemental figure S3)**, or when considering the HbA1c available at the point of longest follow-up (17 trials, 2182 participants; MD -0.16 [95% CI, -0.32 to 0.00], I^2=46%) with moderate to high inconsistency across trials at all time-points (**Figure 4**). Subgroup analyses did not reveal important interactions (**Supplemental table S4**).

4. DISCUSSION AND CONCLUSION

4.1 Discussion

4.1.1 Summary of findings

We uncovered a nascent body of evidence, small, sparse, and heterogeneous, at moderate risk of bias, reporting favorable effects on social support and short-term HbA1c and no significant effect on quality of life of social network interventions in patients with type 2 diabetes. Only one trial evaluated treatment burden directly, and its findings are broadly consistent with our logic model (**Figure 1**) suggesting benefit of interventions to promote social network support in patients with type 2 diabetes.

4.1.2 Comparisons with Previous Studies

To our knowledge, we provide the first meta-analysis of the effects of social network interventions in the management of type 2 diabetes. In concordance with the findings of a previous systematic review on social support in diabetes, studies were highly heterogeneous in their intervention components with limited details reported about these interventions.[51] A recent

meta-synthesis of qualitative literature reports that some group-based initiatives use individual rather than social approaches.[7] This is reflected in our findings; seven trials reported the underlying framework for their social network intervention to be based on single-person theories such as self-efficacy and self-regulation. Similarly, only one intervention employed all mechanisms of social network support identified in diabetes management (**Figure 3**).

4.1.3 Strengths and Limitations of this Review

Our search strategy was designed to balance rigor with feasibility; thus, it may have missed reports which did not mention the social support component of the intervention in the title or abstract. We may have overestimated the risk of bias of these RCTs because of their unclear reporting of trial methods.[52] This review reports on an evolving field and its limitations apply almost exclusively to the meta-analytical portion of the systematic review: trial methods and results are heterogeneous and therefore, may limit the usefulness of statistical pooling. We could not assess for publication bias; therefore our results could represent an overly sanguine view of the efficacy of social network interventions.

Conversely, our review has several strengths, including a thorough literature search and reproducible judgments about inclusion, and intervention descriptions. Pooling was followed by a parsimonious set of exploratory pre-specified subgroup analyses to explore inconsistency in results across RCTs. Overall, we are confident this report fairly represents the emerging body of evidence about interventions directed at social networks in support of patients with type 2 diabetes.

4.2 Implications for Research and Practice

Future research should clearly identify and report the explanatory frameworks, mechanisms, and theories for the social network interventions being tested. Ideally, the theory

should be social and explain the proposed impact of social network interventions on care and outcomes.

A recent meta-analysis reported decreased mortality in persons with higher social support.[53] Studies in patients with diabetes[54] and older adults[55] have found social support to be predictive of morbidity and mortality, after adjusting for differences in health behaviors. Emerging literature also highlights network composition (type and number relationships rather than quality of relationships) as important for health and self-management.[55 56]

Proposed mechanisms for the protective effects include modulation of *physiologic stress* responses.[57-59] Social networks can also affect diabetes self-management by impacting the *workload* patients must enact, by providing opportunities to share knowledge, and by facilitating access to resources.[5] In turn, access to these networks requires patients to work to be aware and to deal with network relationships.[5] The effects on *workload* are likely to interact with the theory of *physiological stress* modulation, as access to healthcare and changes in self-efficacy affect psychosocial stress. This is especially pertinent for people with limited access to formal health care; they may be more likely to present to care with higher stress and to depend critically on personal social networks to respond.[5 7] Therefore, the effects of involving social networks in diabetes management on intermediate outcomes such as allostatic load, treatment workload, and treatment burden (assessed in only one included trial) should be tested in future randomized trials along with health outcomes.

Although it may be premature to translate this evidence into practice, the preceding observational and qualitative research and the evolving experimental research summarized here suggest an important but underexploited role for social networks in supporting the work patients do to manage type 2 diabetes. Care approaches enrolling social networks as mediators of

knowledge and access to resources may prove more valuable than interventions supporting self-management alone. Such promise awaits further intervention development and evaluation.

4.3 Conclusion

Despite a compelling theoretical base, researchers have barely studied the value of interventions targeting patient social networks on diabetes care. The body of evidence to date is limited at moderate risk of bias, heterogeneous, with inconsistent results, and based on individualistic theories. The results, however, are promising. This review challenges the scientific community to design and test theory-based interventions that go beyond self-management approaches to focus on the largely untapped potential of social networks to improve diabetes care.

Funding: GS-B was supported by CTSA Grant Number TL1TR000137 from the National Center for Advancing Translational Science (NCATS) and grant number 3R01HL131535-01S1 from the National Heart Lung and Blood Institute (NHLBI). VMM was partially supported by Grant Number UL1TR000135 from the National Center for Advancing Translational Science (NCATS), a component of the National Institutes of Health (NIH). Its contents are solely the responsibility of the author and do not necessarily represent the official view of the NIH. The funder had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Author contributions: GS-B, OJP, PJE, RR-G and VMM designed the protocol. GS-B and PJE searched the literature; GS-B, OJP, and RR-G extracted the data. GS-B, NA-V and VMM analyzed the data. GS-B, OJP, RR-G, NA-V, PJE, LL-M, AR and VMM interpreted the data and critically revised the report.

Conflicts of Interest Disclosure: No competing financial interests exist.

Availability of data and material: Datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

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Tables and Figures

Figure 1. Logic model of social self-management

Figure 2. PRISMA flow chart

Figure 3. Intervention and comparator components

Figure 4. Effect of social network interventions on social support, quality of life (QoL) and HbA1c

Table 1. Trial and intervention characteristics

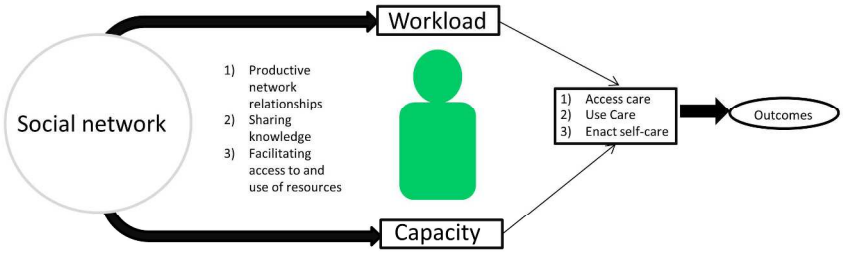


Figure 1. Framework for Social Networks' Influence on Self-management

Caption: This framework is based off the Cumulative Complexity Model[1] and a meta-synthesis identifying the mechanisms by which social networks influence chronic disease self management.[4] *Workload* is composed of patients' *life demands* and healthcare demands with their associated *burden of treatment*. *Capacity* refers to patients' resources and abilities. A balance between workload and capacity should support patients' ability to *access* and a *use care* and *enact self-care* and achieve improved health *outcomes*. Following Foss et al.,[4] social networks can impact (positively and negatively) both workload and capacity by sharing knowledge and experiences, facilitating access to and use of resources. Their efficacy depends on the ability to maintain productive network relationships.

Figure 1. Framework for Social Networks' Influence on Self-management

254x190mm (300 x 300 DPI)

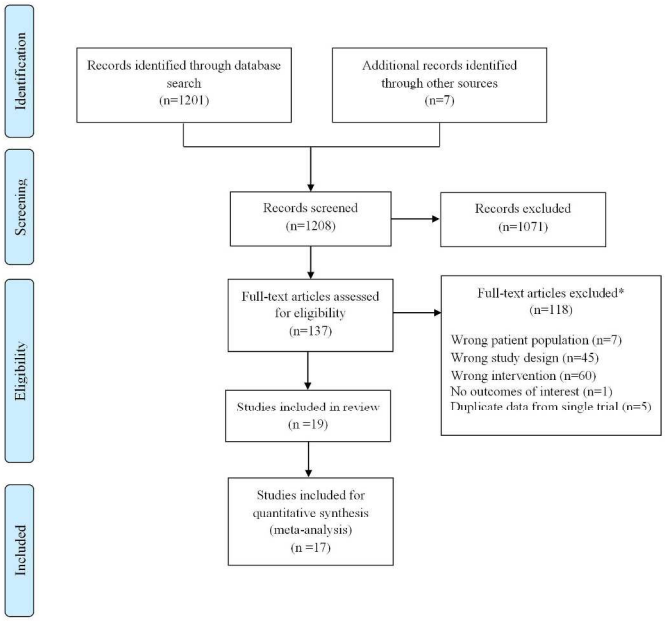


Figure 2. PRISMA flow chart
*reasons not mutually exclusive

Figure 2. PRISMA flow chart

254x190mm (300 x 300 DPI)

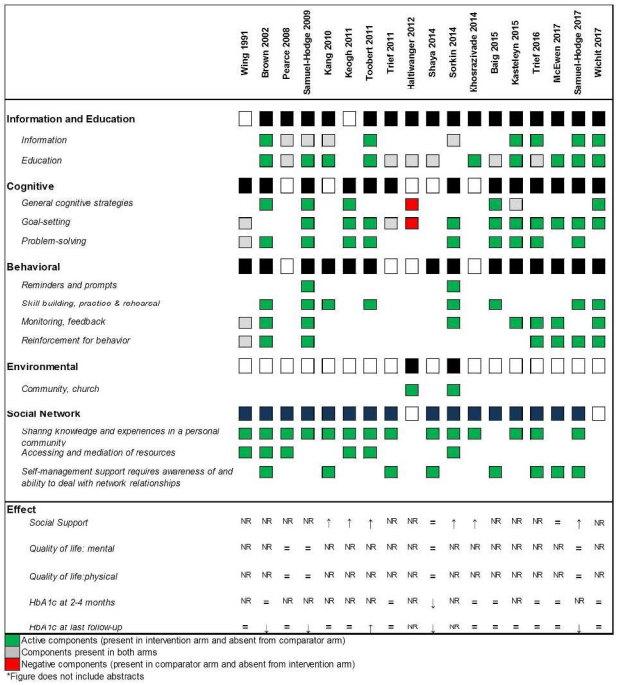


Figure 3. Intervention and comparator components

254x190mm (300 x 300 DPI)

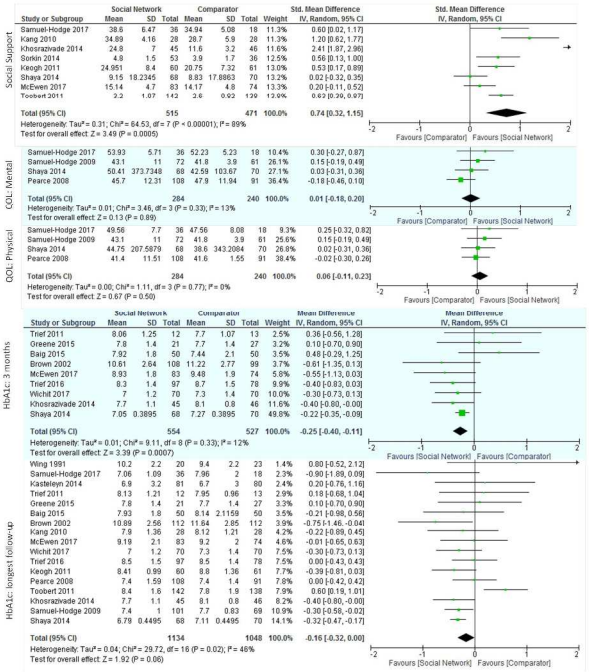


Figure 4. Effect of social network interventions on social support, quality of life (QoL) and HbA1c

Figure 4. Efficacy of social network interventions

254x190mm (300 x 300 DPI)

Supplemental Material

A systematic review of social network interventions in patients with type 2 diabetes

Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) 1946 to Present			
1	*diabetes mellitus, type 2/ or "type 2 diabet*".tw. or niddm.mp. or t2dm.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	114218	Advanced
2	("social network" or "social support").mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	69042	Advanced
3	1 and 2	663	Advanced
4	family relations/ or family conflict/ or intergenerational relations/ or sibling relations/	15431	Advanced
5	family/ or adult children/ or family relations/	73608	Advanced
6	family role/ or family therapy/	7952	Advanced
7	1 and (4 or 5 or 6)	536	Advanced
8	(couple or couples or married or spous* or partner*1 or household or neighbor*1).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	231588	Advanced
9	(church* or religious* or husband* or wife* or relatives or "family based").mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept	110536	Advanced

	word, rare disease supplementary concept word, unique identifier]		
10	1 and 8	749	Advanced
11	1 and 9	1089	Advanced
12	7 or 10 or 11	2151	Advanced
13	limit 12 to randomized controlled trial	87	Advanced
14	12 and intervention*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	290	Advanced
15	12 and (behavior* or behaviour* or adher* or education* or aware* or stigma*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	573	Advanced
16	13 or 14	330	Advanced
17	3 or 7 or 12	2695	Advanced
18	intervention*.mp. and 17 [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	512	Advanced
19	13 or 18	552	Advanced

20	17 and random*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]	338	Advanced
21	19 or 20	676	Advanced
22	remove duplicates from 21	665	

CENTRAL – same strategy – 205

Embase 1988 to 2017 Week 16

#	Searches	Results	Search Type
1	*diabetes mellitus, type 2/ or "type 2 diabet*".tw. or niddm.mp. or t2dm.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	142471	Advanced
2	("social network" or "social support").mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	79400	Advanced
3	1 and 2	645	Advanced
4	family relations/ or family conflict/ or intergenerational relations/ or sibling relations/	69298	Advanced

5	family/ or adult children/ or family relations/	70584	Advanced
6	family role/ or family therapy/	8709	Advanced
7	1 and (4 or 5 or 6)	439	Advanced
8	(couple or couples or married or spous* or partner*1 or household or neighbor*1).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	265365	Advanced
9	(church* or religious* or husband* or wife* or relatives or "family based").mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	109824	Advanced
10	1 and 8	1041	Advanced
11	1 and 9	1305	Advanced
12	7 or 10 or 11	2620	Advanced
13	3 or 12	3134	Advanced
14	13 and intervention*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	653	Advanced
15	randomized controlled trial/	376080	Advanced
16	13 and 15	158	Advanced

17	13 and random*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	410	Advanced
18	14 or 16 or 17	847	Advanced
19	limit 18 to human	796	Advanced
20	non insulin dependent diabetes mellitus/	166150	Advanced
21	19 and 20	665	

PsycINFO 1987 to April Week 2 2017

#	Searches	Results	Search Type
1	diabetes mellitus/	4189	Advanced
2	1 and ("type 2" or noninsulin* or "non insulin" or niddm or t2d or t2dm).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures]	1815	Advanced
3	exp social support/	26965	Advanced
4	social networks/ or exp social groups/ or exp social interaction/ or exp social support/ or exp support groups/	276211	Advanced
5	2 and (3 or 4)	90	Advanced

6	exp Family Therapy/ or family.mp. or exp Family Relations/ or exp Family/ or exp Family Systems Theory/ or exp Family Structure/	282330	Advanced
7	couples/ or cohabitation/ or dyads/ or significant others/ or exp spouses/	25371	Advanced
8	2 and (6 or 7)	195	Advanced
9	5 or 8	258	Advanced
10	limit 9 to ("0830 systematic review" or 1200 meta analysis)	1	Advanced
11	9 and (intervention* or random*).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures]	78	Advanced
12	10 or 11	79	Advanced
13	limit 12 to all journals	55	

CINAHL

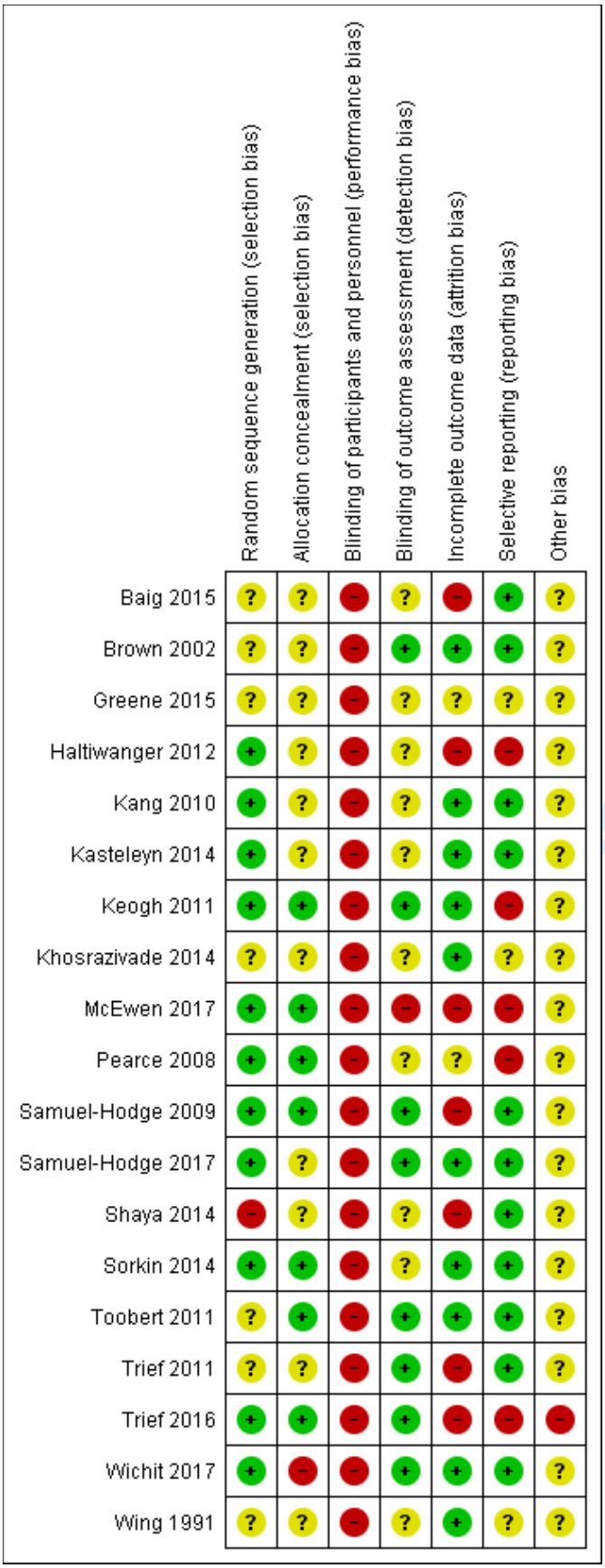
#	Query	Limiters/Expanders	Last Run Via	Results
S12	S8 AND S11	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	9
S11	S5 AND S10	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	78
S10	(MH "Family+") OR (MH "Family Relations+") OR (MH "Patient-Family	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search	123,032

	Relations") OR (MH "Nuclear Family+") OR (MH "Family Attitudes+")		Database - CINAHL with Full Text	
S9	S5 AND S8	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	75
S8	S6 OR S7	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	129,321
S7	(MH "Intervention Trials") OR "intervention"	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	111,076
S6	(MH "Randomized Controlled Trials")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	25,142
S5	S1 AND S4	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	385
S4	S2 OR S3	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	48,947
S3	(MH "Young Adult Social Support Index") OR (MH "Social Support Index") OR (MH "Social Support (Iowa NOC)") OR (MH "Norbeck Social Support Questionnaire")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	289
S2	(MH "Social Networks") OR (MH "Social Network Analysis (Saba CCC)") OR (MH "Support, Psychosocial+")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	48,840
S1	(MH "Diabetes Mellitus, Type 2")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL with Full Text	26,607

Supplement Table S1. Search strategy

Study	Notable inclusion criteria	Intervention			Control		
		N	Mean Age in years (SD)	Mean duration of T2DM in years (SD)	N	Mean Age in years (SD)	Mean duration of T2DM in years (SD)
Wing 1991	>20% above ideal above weight	25	53.6 (7.7)	NR	24	51.2 (7.3)	NR
Brown 2002	None	128	54.7 (8.2)	7.6 (5.8)	128	53.3 (8.3)	8.1 (6.9)
Sammuel - Hodge 2002	A1C>8%	117	57 (9.7)	9 (NR)	84	61.3 (11.9)	11 (NR)
Pearce 2008	No history of ketoacidosis	108	61.2 (10.59)	NR	91	63.1 (8.63)	NR
Kang 2010	At least two of last three A1C reading >=7%; used oral antidiabetic agents only	33	55.3 (7.7)	3.8 (3.2)	34	51.7 (8.5)	4.4 (3)
Toobert 2011	2 out of 3 LAST A1Cs >8%	142	55.6 (9.7)	8.4 (6.5)	138	58.7 (10.3)	10.4 (9.8)
Greene 2015	Latinas	21	NR	NR	27	NR	NR
Keogh 2011	Married for >1 year; A1C>7.3%	60	59.96 (11.67)	9.17 (7.1)	61	57.9 (11.34)	9.65 (6.45)
Trief 2011	>60 years old; Mexican American; documented difficulties with health habits	12	60.33 (8.63)	8.63 (NR)	12	61.08 (9.27)	9.27 (NR)
Haltiwanger 2012	>30 years old; medium or low adherence; low social support	12	NR	NR	36	NR	NR
Khosravizade 2014	A1C>7% or FBS >110mg/dl	45	52.93 (7.62)	9.71 (6.75)	46	54.13 (7.56)	11.39 (5.4)
Shaya 2014	Latina; mother to overweight woman	68	53.9 (NR)	9.2 (8.6)	70	51.9 (NR)	8.8 (8.2)
Sorkin 2014	African American	53	52.7 (6.9)	9.8 (NR)	36	52.7 (6.9)	9.8 (NR)
Baig 2015	Diagnosis of diabetes by a physician	50	51.7 (11.6)	8.7 (8.67)	50	55.7 (11.4)	7.8 (7.14)
Kasteleyn 2015	>35 years old; within 2 weeks from hospital discharge after first acute coronary event	101	66 (9.3)	7.0 (2.8-16)	100	65.6 (9.4)	8.5 (5-15)
Trief 2016	Married or with partner for >1 year; A1C>7.5%	97	57.8 (10.8)	12.8 (8.5)	78	56.9 (10.4)	12.6 (8.3)
McEwen 2017	Mexican American	83	53.64 (9.6)	11.92	74	53.41 (8.4)	11.05
Samuel-Hodge 2017	African American; overweight or obese; A1C ≤11%	36	54.6 (10.55)	7.3 (NR)	18	52.8 (8.56)	5.4 (NR)
Wichit 2017	≥35 years old; T2DM duration of ≥6 months and living in Thachang District, Thailand	70	61.3 (11.6)	6.0 (4.7) 6.0 (4.7)	70	55.5 (10.5)	5.4 (4.3)

Supplemental Table S2. Trial inclusion criteria and participant baseline characteristics



Supplemental Figure S1. Risk of bias of included trials (Cochrane risk of bias tool)

Assessing confidence in the estimates of effect:
GRADE

Quality assessment							№ of patients		Effect	Quality	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Social network interventions	Any comparator	Absolute (95% CI)		
Social Support											
8	randomised trials	serious [1]	serious [2,3]	not serious	serious [4]	strong association	515	471	SMD **0.74 higher** (0.32 higher to 1.15 higher)	Low to moderate	IMPORTANT

CI: Confidence interval; **SMD:** Standardised mean difference

1. unclear blinding of outcome assessors
2. I2=90%
3. non-overlapping CIs
4. confidence interval or estimate effect includes non-important change as well as very important change

Quality assessment							№ of patients		Effect	Quality	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Social network interventions	Any comparator	Absolute (95% CI)		
HbA1c: 3 months											
9	randomised trials	serious [1]	not serious	not serious	not serious	none	554	527	MD **0.25 lower** (0.40 lower to 0.11 lower)	Low to very low	IMPORTANT
HbA1c: 5-7 Months											
11	randomised trials	serious [1]	serious [2]	not serious	not serious	none	777	727	MD **0.24 lower** (0.52 lower to 0.03 higher)	Low to very low	IMPORTANT

Quality assessment							№ of patients		Effect	Quality	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Social network interventions	Any comparator	Absolute (95% CI)		
HbA1c: 8+ months											
3	randomised trials	serious[1]	very serious[2]	not serious	serious[3]	none	355	319	MD **0.1 lower** (0.84 lower to 0.65 higher)	Low to very low	IMPORTANT
HbA1c: Longest follow-up											
17	randomised trials	serious[1]	not serious	not serious	not serious	none	1134	1048	MD **0.16 lower** (0.32 lower to 0)	Low to very low	IMPORTANT

CI: Confidence interval; **MD:** Mean difference

1. unclear allocation concealment
2. high I2
3. large CI

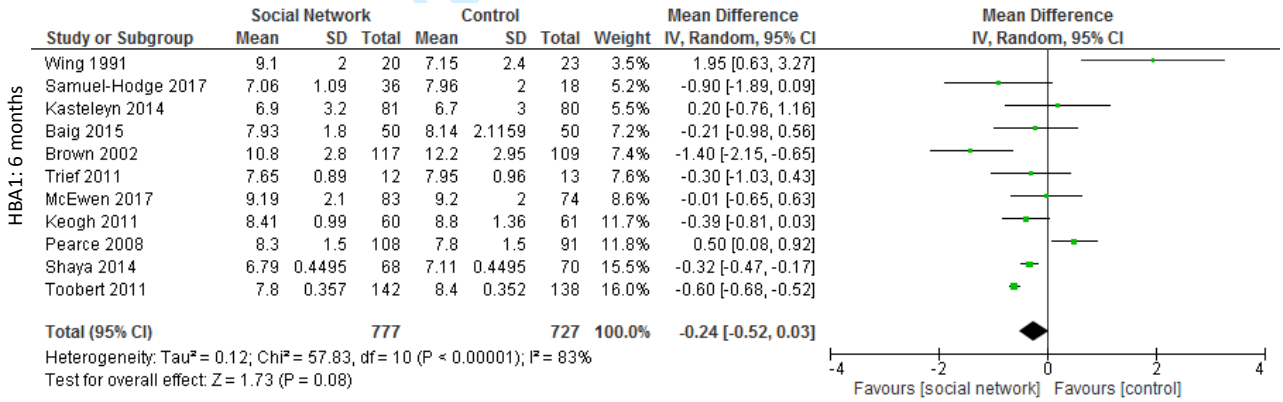
Quality assessment							№ of patients		Effect	Quality	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Social network interventions	Any comparator	Absolute (95% CI)		
Well-being											
2	randomised trials	serious[1]	very serious[2,3]	not serious	very serious[4]	none	141	141	SMD **0.62 higher** (0.13 lower to 1.37 higher)	Low to very low	IMPORTANT
Quality of Life: Physical Component											
4	randomised trials	serious[1]	not serious	not serious	not serious	none	284	240	SMD **0.06 higher** (0.11 lower to 0.23 higher)	Low to very low	IMPORTANT
Quality of Life: Mental Component											

Quality assessment							№ of patients		Effect	Quality	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Social network interventions	Any comparator	Absolute (95% CI)		
4	randomised trials	serious[1]	not serious	not serious	not serious	none	284	240	SMD **0.01 lower** (0.18 lower to 0.20 higher)	Low to very low	IMPORTANT

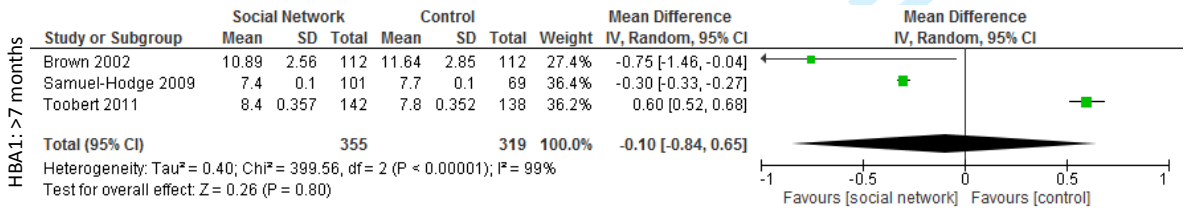
CI: Confidence interval; **SMD:** Standardised mean difference

1. unclear allocation concealment
2. high I2
3. differences in scales used
4. very wide CI

Supplemental Table S3. GRADE assessment



Supplemental Figure S2. Effect of social network intervention on HbA1c at 6 months follow-up



Supplemental Figure S3. Effect of social network intervention on HbA1c at 8+ months follow-up

Subgroup Analyses						
	Hba1c at last follow-up			**Social support at last follow-up**		
	Subgroup *effect size (95% CI); I^2*	**Comparison subgroup** *effect size (95% CI); I^2*	**P-value for interaction**	**Subgroup** *effect size (95% CI); I^2*	**Comparison subgroup** *effect size (95% CI); I^2*	**P-value for interaction**
Patient characteristics						
Mean baseline HbA1c> 8%	-0.08 (-0.38, 0.23); 62%	-0.28 (-0.40, -0.16); 0%	0.22	0.89 (0..39, 1.38); 90%	0.26 (-0.30, 0.82); 65%	0.10
Intervention characteristics						
Self-selected social network	-0.20 (-0.41, 0.02); 59%	-0.14 (-0.35, 0.06); 0%	0.73	0.77 (0.29, 1.24); 91%	0.56 (0.13, 1.0); NA	0.54
Household member	-0.07 (-0.29, 0.0.14); 47%	-0.32 (-0.45, -0.19): 0%	0.05	0.96 (0.36, 1.55); 92%	0.35 (-0.05, 0.76); 63%	0.10
Contact time >585 minutes	-0.17 (-0..38, 0.04); 5%	-0.34 (-0.59, -0.09); 0%	0.30	0.32 (-0.03, 0.68); 27%	0.82 (0.18, 1.47); 73%	0.18
Underlying framework	-0.25 (-0.36, -0.15); 1%	-0.11 (-0.63, 0.4); 76%	0.60	0..34 (0.11, 0.57); 43%	1.39 (0.32, 2.47); 94%	0.06
Dyadic social network reported	-0.21 (-0.38, -0.04); 9%	-0.07 (-0.41, 0.27); 77%	0.46	1.05 (0.38, 1.72); 89%	0.30 (-0.08, 0.67); 79%	0.05
Trial characteristics						
Low risk of bias	-0.18 (-0.49, 0.12); 67%	-0.25 (-0.38, -0.13); 0%	0.66	0.59 (0.42, 0.76); 0%	0.94 (-0.03, 1.90); 95%	0.49

Supplemental Table S4. Subgroup analyses

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	6
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	6
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6-7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6-7 and supplement
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	supplement
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	7-8
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	9
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	9-10
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	10

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	10
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	10
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	11
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	11-13, table 1
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	14, supp fig s1, supp table s3
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	14-15, fig 4, supp fig s2, supp fig s3
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	14-15
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	14, supp fig s1, supp table s3
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	14-15, sup table s4
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	15-17

PRISMA 2009 Checklist

Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	16
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	17-18
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	19

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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