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The effectiveness of psychological interventions on mental health and quality-of-life in people living with type 1 diabetes: A systematic review and meta-analysis

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Introduction

Living with type 1 diabetes can be associated with significant psychological morbidity, leading to poor metabolic control, high burden of microvascular complications and significant morbidity [1][2]. Depression, anxiety, diabetes-related distress and impaired quality of life (QoL) are commonly reported amongst adolescents and young adults with type 1 diabetes [3][4].

Although some studies have shown promising effects of psychological interventions on psychological outcomes in people living with type 1 diabetes [5][6][7], others have failed to demonstrate a significant effect [8][9][10]. In addition, there is inconsistent evidence regarding the effectiveness of psychological interventions in improving glycaemic control in children and adults with type 1 diabetes[11][12]. However, when people living type 2 diabetes were studied, psychological interventions demonstrated significant effects on depression, no reduction in diabetes-related distress and limited effectiveness in glycaemic control improvement [13][14][15].

Despite the presence of inconsistent evidence, the Current National Institute for Health and Care Excellence (NICE) guidelines recommend timely referral to relevant specialist services for people with type 1 diabetes when psychological comorbidities interfere with diabetes self-management and well-being [16]. There is a need therefore to investigate the effects of psychological interventions on mental health and glycaemic control in people living with type 1 diabetes. The aim of this systematic review is to synthesise the evidence regarding the clinical effectiveness of psychological interventions in reducing the comorbid depression, anxiety and diabetes-related distress symptoms and improving quality of life and glycaemic-control in people living with type 1 diabetes.

Methods

The protocol of this systematic review and meta-analysis was registered with PROSPERO (CRD**********). This systematic review and meta-analysis conforms to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines[17]. The primary outcomes of this study were: i) depression symptoms as these were assessed by validated scales, such as [Center for Epidemiologic Studies Depression Scale (CES-D), Children's Depression Inventory (CDI), Beck Depression Inventory (BDI)]; ii) anxiety symptoms as these were assessed by validated scales, such as [(Perceived Stress Scale (PSS), State-Trait Anxiety Inventory (STAI), Beck Anxiety Inventory)]. The secondary outcomes of this study were: i) diabetes-related distress as it was assessed by validated

scales [(Problem Areas in Diabetes scale (PAID), Type 1 Diabetes Distress Scale (T1DD), Diabetes Stress Inventory)]; ii) QoL as it was assessed by validated skills [(Paediatric Quality of Life (PedsQL), Diabetes Quality of Life Measure for Youths (DQoLY), Child Health Questionnaire-Child Form 87 items (CHQ-CF87)- Mental Health)]; iii) glycaemic control as it was assessed by glycated haemoglobin (HbA1c).

All published randomised controlled trials (RCTs) and cluster-RCTs, testing the effectiveness of psychological interventions [e.g., cognitive behaviour therapy (CBT)-based, emotional, motivational, mindful-based interventions, education and counselling programs, coping skills training and resilience interventions] targeting depression, diabetes related distress, QoL, glycaemic control (HbA1c), compared with any type of control condition (no intervention, routine diabetes care, diabetes education, support visits), were eligible for inclusion. Cross-over trials were not considered eligible for inclusion.

People living with type 1 diabetes, were eligible for inclusion in this review. Studies that included participants with type 1 and other types of diabetes, were included only if data for type 1 diabetes participants could be separately extracted. Psychological interventions, such as CBT-based, emotional, motivational, mindful-based interventions, education and counselling programs, coping skills training and resilience interventions, were eligible for inclusion regardless of their administration format (e.g., groups, individual), type (face-to-face, group), and intensity. Studies that targeted participants with type 2 diabetes, drug-induced diabetes, type 3c diabetes, gestational diabetes, monogenic or other rare forms of diabetes were excluded.

Electronic databases, which were searched from inception to March 25 & 26, 2021, were: MEDLINE (including PubMed), EMBASE (Excerpta Medica), Cochrane Central Register of Controlled Trials (CENTRAL), Cumulative Index to Nursing and Allied Health Literature (CINAHL), PsycINFO, Scopus, Science Citation Index and Conference Proceedings (Web of Science), ClinicalTrials.gov, International clinical trials registry platform (ICTRP), OpenGrey and ProQuest Dissertations & Theses (PQDT). No publication type filters and language restrictions were applied. A detailed search strategy for Medline is presented in supplementary table 1.

Two reviewers (** and **) independently performed title and abstract screening, full text screening (cohen’s kappa= 0.96) and then abstracted information regarding study design, demographics, population characteristics, interventions, comparators and measurement scales. Any discrepancies were

resolved after discussion between the two reviewers and involvement of the third reviewer to resolve differences was not required at any point. Additionally, the two investigators abstracted information concerning the measurement scales of depression, anxiety, diabetes related distress and QoL in each study, as well as the pre and post intervention values for depression, anxiety, diabetes-related distress and HbA1c. Disagreements were resolved by discussion between the two reviewers.

The quality of included studies was assessed using the Cochrane Collaboration tool for assessing risk of bias[18]; a new adaptation of the tool specifically designed for cluster-RCTs was used for quality assessment of cluster-RCTs [18]. Two reviewers (**, **) independently assessed the risk of bias in the included studies (cohen's kappa=0.84). Within each specified domain, adequate reporting resulted in a rating of "low risk" of bias, whereas inadequate reporting resulted in a rating of "high risk" of bias. A third reviewer (**) was available as a final arbiter however this process was not needed at any point in our study. The Grading of Recommendations Assessment and Development and Evaluation (GRADE) system was used to assess confidence in the quality of evidence of individual outcomes and the strength of recommendations [19].

Data analysis was performed using RevMan Version 5.4.1 and Stata Version SE 16 [20][21]. Standardised mean differences (SMD) were computed for depression, diabetes-related distress and QoL. Studies that reported total QoL scores were included in a quantitative analysis using standardised mean differences. Mean differences (MD) were calculated for HbA1c. Post-intervention effect sizes were computed, comparing the intervention to control arms. Given the heterogeneity of methodologically diverse studies, a random effects model was implemented. The following subgroup analyses were to be performed: adolescents vs young adults with type 1 diabetes and 2) CBT-based interventions vs other interventions.

Four authors were contacted when there was insufficient information regarding the implemented interventions and/or lack of data; yet there was no reply back from any of the authors. Analyses of cluster-RCTs were conducted, conforming to Cochrane guidelines for analysing and reporting cluster-RCTs[22] . In case RCTs with multiple intervention groups were eligible for inclusion, intervention arms were combined in order to obtain a single-pairwise comparison, conforming to Cochrane guidelines for analysing and reporting RCTs with multiple intervention groups[22].

Results

The search yielded 7616 abstracts following the removal of duplicates. Screening of title and abstracts resulted in 45 full text articles undergoing eligibility assessment, of which 20 were included in the systematic review and 16 in the meta-analysis. Figure 1 presents a PRISMA Flow Chart illustrating study selection.

Supplementary table 2 presents a summary of study characteristics included in the qualitative synthesis. Seven studies were conducted in the United States [9][23][24][25][26], four in the United Kingdom [6][27][28][29], three in the Netherlands [8][30][31], one in Australia[10], one in Sweden [5], one in Germany [32], one in Iran [33], one in Norway [34] and one in China[35]. Eleven studies targeted depression symptoms [5][6] [7][8][9] [23][25][30][31][32][33], four studies targeted anxiety [5][6][26][33] and two reported generalised perceived-stress [9][10], six targeted diabetes-related distress [5][8][23][24][26][30], 11 studies targeted QoL [6][7][10] [25][28][29] [31][32][34][35][36] and 20 studies targeted HbA1c [5][6][7][8][9][10][23][24][25][26] [27][28][29][30][31][32][33][34][35][36]. A summary of measurement scales of the selected outcomes is reported in supplementary tables 3,4 and 5.A RCT design was used in 14 studies included in the quantitative synthesis and a cluster-RCT design was used in two studies [29][31]. Two studies included two intervention arms alongside a control arm [9][27]. Average follow up of the nine studies that looked at depression symptoms and included in the meta-analysis ranged from three to 24 months and average follow up of the of the four trials that studied anxiety ranged from three to 24 months. Average follow up of the four studies that looked at diabetes-related distress and included in the meta-analysis ranged from three to 16 months, average follow up of the five studies that looked at QoL and included in the meta-analysis ranged from six to 18 months and average follow up of the 16 studies that looked at glycaemic control and included in the meta-analysis ranged from three to 18 months.

Six studies included adults with type 1 diabetes [5][8][24][27][30][32] with average age ranging from 36 to 47.3 years. The rest of studies included children and adolescents [6][7][9][10][23] [25][26][28][29][33][34][35][36] with an average age ranging between 13.6-18 years. In studies that included children and adolescents, average duration of diabetes ranged from 5.6- 9.2 years and average HbA1c ranged from 8.5-12.7%. In studies that included adults, the average duration of diabetes ranged from 17-26 years and the average HbA1c ranged from 8.5 to 9.7%.

Interventions including CBT-based elements were found in studies targeting depressive symptoms [7][8][9][23][25]. The Center for Epidemiologic Studies Depression Scale (CES-D) in was used in four studies [7][8][9][31], the Children's Depression Inventory (CDI) was used in two studies [23][25], while the ZERSSEN depression score [32], the Beck Depression Inventory (BDI) [33] and the Well-Being Questionnaire (WBQ) were used only once [6].

Summary of risk of bias is reported in Figure 2. Overall, eight studies were judged as low risk of bias [7][23] [25][27][28][29][35][36] and nine as high risk of bias [5][10][24][26][30] [31][32] [33][34]. Reasons for downgrading in risk of bias were: lack of intention to treat analysis, significant involvement of key authors in the delivery of interventions and outcome measurements which could have led to deviations from the intended interventions, unclear timings of HbA1c measurements, bias due to missing data and unclear reporting of reasons for missing data.

Baseline depression scores were reported in eleven studies [5][7][8][9][23] [25][27][30][31][32][33] and anxiety scores were reported in five studies [5][9][10][26] [33] (see supplementary table 3). Participants with mild depressive symptoms were included in eight studies [5][7][8][9][30][31][33][36], moderate depressive symptoms in four studies [23][25][32][33] and severe depressive symptoms in two studies [27][33]. Baseline depressive symptoms were not clearly described in eight studies [6][10][24][26][28][29] [34][35]. Patients with severe mental health disease, or requiring referral to mental health services, (e.g., psychosis, though disorders, severe depression, suicidal thoughts, bipolar disorder) were clearly excluded in seven studies [5][9][10][24][29][33][36]. A non-significant SMD was found for depression symptoms (see table 1 and supplementary figure 1), favouring the intervention condition (SMD = −0.17, 95% CI = [−0.41, 0.07], p = 0.16). Heterogeneity was substantial (I^2 = 68%, Tau2 = 0.08, df = 8, p < 0.002).

Of the studies that investigated anxiety, three included CBT elements[9][10][23][26]. Due to the heterogeneity of the scales used to measure and report anxiety a meta-analysis was not considered appropriate. A significant improvement in anxiety scores post intervention was reported in four studies [5][6][26][33]. Two studies reported significant improvement in self-reported stress [5][9], while one did not show any effect on perceived stress post intervention [10].

Of these studies that investigated diabetes-related distress, all four studies included in the meta-analysis included CBT elements [8][23][24][26]. A non-significant SMD was found for diabetes related distress

(see table 1 and supplementary figure 2), favouring the intervention condition (SMD = −0.12, 95% CI = [−0.27, 0.04], p= 0.13). Heterogeneity was not important (I^2 = 0%, Tau2 = 0.00, df = 3, p= 0.75).

A significant SMD was found for QoL (see table 1 and supplementary figure 3), favouring the intervention condition (SMD = 0.27, 95% CI = [0.11, 0.42], p= 0.0007). Heterogeneity was not important (I^2 = 0%, Tau2 = 0.00, df = 4, p= 0.94). An improvement in ‘’impact’’ and ‘’worry’’ related with diabetes, as well as satisfaction with life experienced by people living with diabetes was noted in several studies [6][25][34][35]. No significant improvement in quality of life was noted in two studies [28][29].

Twenty studies assessed the effects of psychological interventions on glycaemic control of which 16 included in the meta-analysis. A significant mean difference (MD) was found for HbA1c (see table 1 and supplementary figure 4A), favouring the intervention condition (MD = -0.26, 95% CI = [-0.51, -0.01], p= 0.04). However, heterogeneity was substantial (I^2 =72%, Tau2 = 0.16, df = 15, p< 0.00001).

Subgroup and sensitivity analysis

Sources of heterogeneity were explored by undertaking a subgroup analysis of CBT-based component versus other intervention (see figure 3). Interventions that included a CBT-based component showed a significant mean difference (MD) for HbA1c (see table 1 and figure 3), favouring the intervention condition (MD = -0.23, 95% CI = [-0.44, -0.02], p= 0.03), while heterogeneity was not important anymore (I^2 =1%, Tau2 = 0.00, df = 6, p= 0.42). The other interventions subgroup showed a non-significant mean difference (MD) for HbA1c, favouring the intervention condition (MD = -0.32, 95% CI = [-0.70, 0.06], p= 0.09), while heterogeneity remained substantial (I^2 =83%, Tau2 = 0.24, df = 8, p< 0.00001).

Sensitivity analysis for the studies that received a rating of low risk of bias was performed. Sensitivity analysis showed a non-significant effect on HbA1c (MD = -0.10, 95% CI = [-0.31, 0.12], p= 0.38) (supplementary figure 4A).

Risk of bias assessment and credibility of findings

The quality of evidence was assessed using the GRADE approach (supplementary tables 6-9). The quality of evidence for depression was very low, as it was downgraded three levels (i.e., one for risk of

bias, inconsistency and imprecision, respectively). The quality of evidence for diabetes-related distress was low as it was downgraded one level for risk of bias and imprecision, respectively. The quality of evidence for QoL was moderate as it was downgraded one level for risk of bias. The quality of evidence for glycaemic control was moderate as it was downgraded one level for risk of bias. Heterogeneity of glycaemic control outcome could be explained by subgroup analysis as the heterogeneity was absent for CBT-based interventions.

Inspection of the funnel plot for glycaemic control revealed potential asymmetry (see supplementary figure 4B). An Egger's test was performed for testing the funnel plot's asymmetry, indicating no statistical significance for small study effects ($\beta = -1.1$, 95% CI = [−3.0, 0.78], $p = 0.25$).

Discussion

To the best of our knowledge, this is the first meta-analysis that investigated the effects of psychological interventions on depression, diabetes-related distress symptoms, QoL and glycaemic control in children, adolescents and adults with type1 diabetes. Although this meta-analysis showed that psychological interventions may confer some benefits on depression and diabetes-related distress in people living with type 1 diabetes, these effects were not statistically significant. Nevertheless, psychological interventions were found effective in improving QoL with CBT-based psychological interventions being effective in reducing HbA1c.

Sensitivity analysis showed that the reduction in HbA1c was no longer statistically significant when only studies with low risk of bias were meta-analysed. As only seven out of sixteen studies were included in the sensitivity analysis, the number of participants was reduced by 30%. Thus, the sensitivity analysis might have been underpowered to capture a statistically significant effect. Given the need to highlight the mechanisms underpinning the effects of psychological interventions on people with type 1 diabetes, more high-quality trials, which will target psychological outcomes and diabetes-related health behaviours (e.g., glycaemic control) in people with type 1 diabetes, are needed.

Substantial heterogeneity was detected when meta-analysing studies for depression and HbA1c outcomes; I^2=68% and I^2=72%, respectively. Several factors likely contributed to the clinical and methodological diversity between meta-analysed studies (see supplementary table 2). The RCTs included children, adolescents and adults of multiple different ethnicities in various geographical

locations with variable glycaemic control at baseline and a wide range of diabetes duration (1-50 years). The type, method of delivery (face to face vs group), length and intensity of intervention also varied considerably. For example, psychotherapeutic interventions, CBT-based interventions and coping skills training tented to be lengthier compared with structured educational interventions or motivational interviewing. Intensity of interventions (number and frequency of sessions) tented to be variable even amongst similar types of intervention. Delivery of intervention and measurement of outcome were undertaken by a variety of healthcare professionals (specialist nurses, psychologists, doctors) with varying levels of training in each study. Outcome measurement scales and risk of bias also differed between studies. Meta-regression for these characteristics was not feasible in view of the small number of studies for each covariate[37].

However, a prespecified subgroup analysis for CBT-based interventions vs other interventions was conducted to explore heterogeneity. CBT-based interventions have been extensively studied and implemented in clinical practice and are considered the gold-standard of psychotherapy[38]. CBT-based interventions aim to alter maladaptive cognitive processes that drive emotional distress and problematic behaviours[39]. This is especially relevant in people with diabetes. These patients can easily become overwhelmed by the impact of diabetes in their life. Body-image perception related to weight gain and insulin therapy are only some of the factors leading to depression, diabetes-related distress, poor compliance with treatment, low self-efficacy and overall poor glycaemic control. CBT-based interventions aim to change negative patterns by breaking down overwhelming problems into smaller parts and break the vicious cycle of negative thoughts and feelings[39]. This strategy is different compared with structured education interventions, motivational interviewing, mindfulness or emotional based interventions where the vicious cycle between cognition and emotion does not necessarily being addressed at its core. Compared to other interventions, CBT-based interventions showed a statistically significant reduction in HbA1c and heterogeneity for this group was not significant (I^2=1%).

In contrast to our findings, a meta-analysis has demonstrated evidence that psychosocial interventions can be very effective in treating depression in people living with type 2 diabetes [13]. Duration of diabetes was highly variable as in our study. The average baseline HbA1c values were comparable, too. However, there are a few key differences that merit attention. First, our study mainly included

children, adolescents and predominantly young adults with type 1 diabetes. The meta-analysis by Xie J et al. focused on older participants (40-70 years old). Participant age itself could affect peoples' attitudes and behaviour towards their diabetes, psychological interventions and engagement or adherence to treatment. Thus, participant age could significantly affect the effectiveness of psychological interventions on depression.

Second, treatment modalities such as interventional interviewing, motivations enhancement therapy, coping skills training and mindfulness-based interventions were underrepresented in our meta-analysis, yet have shown promising results in people with type 2 diabetes. Further research to explore the effects of these modalities in improving mental health comorbidities and glycaemic control in people living with type 1 diabetes is warranted. Tthird, the underlying drivers of depression could differ between people with type 1 and type 2 diabetes. Phenotypic differences such as body mass index, perception of body image, frequency of insulin injection treatment and the presence of eating disorders could significantly confound the effectiveness of psychological intervention and account for differences in outcomes between different types of diabetes. Furthermore, a meta-analysis that included 30 randomised controlled trials has failed to provide evidence that psychological interventions could improve diabetes-related distress more than usual care in people with type 2 diabetes. This is consistent with our findings.

Psychological interventions have been shown to improve glycaemic control for adults with type 2 diabetes [14]. A recent meta-analysis has demonstrated that psychological interventions can reduce HbA1c in people with type 2 diabetes (SMD −0.19, 95% CI −0.25 to −0.12, $p<0.001$). This reduction is mild and comparable to our findings [14]. This finding is promising and psychological interventions seem to offer an HbA1c reduction in both these diabetes phenotypes.

Mental health comorbidities in the context of diabetes are associated with poor self-care, impaired glycaemic control and in turn more microvascular complications and increased healthcare expenditures [40]. This study shows promising results regarding the effects of psychological interventions on QoL and glycaemic control, especially for CBT-based interventions. Screening patients with type 1 diabetes for mental health comorbidities and referring to mental health specialist in the context of a multidisciplinary approach should be a priority.

Strengths and limitations

This systematic review has a number of strengths. First, this study has a prospectively registered protocol. Second, this review followed gold-standard methods in analysing, reporting and rating the quality of evidence. Third, to the best of our knowledge this is the first review to focus on the effects of psychological interventions on psychological outcomes and glycaemic control in people with type 1 diabetes.

Inevitably, this review has also some limitations. First, scarcity of data in anxiety, diabetes related distress and quality of life may limit the generalizability of our findings regarding the effects of psychological interventions on those outcomes. Second, due to the low number of studies included in the meta-analysis for depression, a subgroup analysis or meta-regression was not performed to explore heterogeneity.

Third, the non-statistically significant result for Egger's test does not rule out small study effects . Egger's test caries inherently low power to detect such effects, especially in meta-analyses with low number of RCTs. Funnel plot asymmetry should be interpreted with caution and could arise due to publication bias, spuriously inflated effects in smaller studies, true heterogeneity or sampling variation or simply be due to chance.

The study by Rostami et al. is an outlier in the funnel plot (supplementary figure 4B). HbA1c post intervention reduced substantially from 11% to 7.9% post intervention. Both the average HbA1c at baseline and HbA1c reduction post intervention is higher in the study by Rostami et al. compared with the majority of the other RCTs. High percentage of participants with severe depression and anxiety at baseline (19.0% and 24.3% respectively) and poorer glycaemic control at baseline could have led to greater benefits in these patients post intervention, such as improved compliance with insulin therapy. The intensity of intervention could also have played a role, yet this has not been reported in great detail by the authors. The study size is comparable to the other RCTs and such an inflation effect for study size does not seem likely. It is more likely that true heterogeneity or chance could have led to this study being an outlier.

Finally, significant variability of diabetes duration and lack of outcome reporting classified by diabetes duration in the primary RCTs was noted. This precluded calculation of effect sizes for different

phenotypes based on diabetes duration in our study. Meta-regression based on diabetes duration was not possible due to the low number of studies in the meta-analysis [37]. In clinical practice, peoples' attitudes and behaviours towards their diabetes and psychological interventions can vary depending on diabetes duration and this should be taken into account by clinicians when prescribing psychological interventions.

Conclusions

Although psychological interventions were not found to considerably improve depressive symptoms in people with type 1 diabetes, they were found to improve quality of life and glycaemic control. More high quality RCTs are needed to further explore the effects of psychological interventions on psychological outcomes in people with type 1 diabetes. Brief CBT based psychological interventions might confer benefits on quality of life and glycaemic control in people with type 1 diabetes and comorbid psychological morbidity.

Compliance with Ethical Standards:

Conflicts of interest: None

Research involving Human Participants or Animals: Non applicable as this study is a systematic literature review and meta-analysis

Informed consent: Non applicable

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Figure legends

Fig.1 PRISMA Flow Diagram

Fig.2 Risk of bias assessment for all Randomised Controlled trials (RCTs) (panel A) and Cluster-RCTs (Panel B)
Fig.3 Subgroup analysis of interventions that included a cognitive behaviour-based component vs other intervention

Supplementary figure legends

Fig.1 Forest plot, effect size estimates and funnel plot for the effectiveness of psychological interventions in reducing depression symptoms

Fig.2 Forest plot, effect size estimates and funnel plot for the effectiveness of psychological interventions in reducing diabetes related distress

Fig.3 Forest plot and effect size estimates for the effectiveness of psychological interventions in improving quality of life

Fig.4. 4A. Forest plot and effect size estimates for studies with low risk of bias and studies with some concerns and high risk of bias
4B. Funnel plot for the effectiveness of psychological interventions in reducing HbA1c

Abstract

Background:

Living with type 1 diabetes can be associated with significant psychological morbidity, poor glycaemic control and increased risk for microvascular complications. This systematic review sought to investigate the effects of psychological interventions on depression, anxiety, diabetes-related distress, quality of life and glycaemic control in people with type 1 diabetes.

Methods:

Eight electronic databases were searched for published and unpublished randomised-controlled trials. Screening, data extraction and risk of bias assessment (using the Cochrane Collaboration tool for assessing risk of bias 2.0) were independently undertaken by two study authors. The results of the studies were meta-analysed, implementing a random-effects model. The Grading of Recommendations Assessment and Development and Evaluation (GRADE) system was used to determine the confidence in the effect estimates.

Results

Twenty studies were identified. Non-significant standardised mean differences (SMD) were found for depression symptoms (SMD= −0.17, 95% CI [−0.41, 0.07], p= 0.16) and diabetes-related distress (SMD= −0.12, 95% CI [−0.27, 0.04], p= 0.13). Significant SMD was found for quality of life (SMD= 0.27, 95% CI [0.11, 0.42], p= 0.0007). Significant mean difference (MD) was found for HbA1c (MD= -0.26, 95% CI [-0.51, -0.01], p= 0.04). Prespecified subgroup

analysis for cognitive behaviour-based interventions showed significant improvement for HbA1c (MD= -0.23, 95% CI [-0.44, -0.02], p= 0.03).

Conclusions:

Psychological interventions were found to significantly increase quality of life and promote glucose control in people with type 1 diabetes. Depending on their cost-effectiveness, psychological interventions could be incorporated in routine clinical practice for people with type 1 diabetes and concomitant psychological morbidity.

Keywords

Type 1 diabetes, depression, anxiety, diabetes-related distress, glycaemic control

Table 1. Summary of meta-analysis results

Outcome	k	n	Effect size (95% CI)	Heterogeneity (% I^2)
Depression				
Follow up	9	988	SMD = −0.17 (−0.41 to 0.07)	68
Diabetes related distress				
Follow up	4	668	SMD = −0.12 (−0.27 to 0.04)	0
Quality of life				
Follow up	5	650	SMD = 0.27 (0.11 to 0.42)	0
HbA1c				
Follow up	16	2945	MD = -0.26 (-0.51 to -0.01)	72
Sensitivity analysis	7	2081	MD = -0.10 (-0.32 to 0.12)	49
Subgroup analysis for HbA1c				
CBT Based interventions	7	950	MD = -0.23 (-0.44 to -0.02)	1
Other interventions	9	1995	MD = -0.32 (-0.70 to 0.06)	83

CBT: Cognitive Behaviour Treatment, HbA1c: Glycated Haemoglobin, CI: confidence interval, k: number of studies, n: number of participants, SMD: Standardised mean differences, MD: Mean differences

Supplementary Table 1. Search strategy for MEDLINE

Keyword	Diabetes mellitus		Psychological therapies		Clinical trials		Outcome
1	exp Diabetes Mellitus/	7	exp Psychotherapy/	23	Randomized Controlled Trials as Topic/	43	exp Mood disorders/
2	diabet$.ab,ti.	8	exp Counseling/	24	randomized trial.ab,ti	44	exp Depression/
3	(("typ$ 1" or typ$ I) adj6 DM).ti,ab.	9	psycho$.mp	25	Random adj3 Allocation. ab,ti	45	depression.mp
4	insulin$ secret$ dysfunc$.ti,ab.	10	counsel$.mp	26	Double Blind	46	depressive.mp
5	(insulin$ defic$ adj6 (absolut$ or relativ$)).ti,ab.	11	(interpersonal adj5 therap$).mp	27	Single Blind	47	exp Anxiety Disorders
6	1 OR 2 OR 3 OR 4 OR 5	12	family adj3 (intervention or treatment or counsel* or therap*).mp	28	clinical trial/	48	Anxiety.mp
		13	behavio?r adj5 (intervention or therap* or modific*).mp	29	Phase I.mp	49	exp Quality of life
		14	cognitive adj5 (therap* or intervention or program* or train* or theory).mp	30	Phase II.mp	50	Quality adj10 life.mp
		15	exp Mindfulness/	31	Phase III.mp	51	QoL.mp
		16	motivation* adj2 (interview* or therap*).mp	32	Phase IV.mp	52	43 OR 44 OR 45 OR 46 OR 47 OR 48 OR 49 OR 50 OR 51
		17	multisystemic therapy.mp	33	multicenter.mp	53	5 AND 22 AND 42 AND 52
		18	CBT OR cbt OR motivation$3 adg5 interview*.mp	34	clinical trial.pt		
		19	Psychoeducation.mp	35	exp Clinical Trials as topic/		
		20	Resilience.mp	36	(clinical adj5 trial$).tw		
		21	Resistance.mp	37	((singl$ or doubl$ or treb$ or tripl$) adj25 (blind$3 or mask$3)).tw		
		22	7 OR 8 OR 9 OR 10 OR 11 OR 12 OR 13 OR 14 OR 15 OR 16 OR 17 OR 18 OR 19 OR 20 OR 21	38	PLACEBOS/		
				39	placebo$.tw		
				40	randomly allocated.ab		
				41	(allocated adj2 random$).tw		
				42	23 OR 24 OR 25 OR 26 OR 27 OR 28 OR 29 OR 30 OR 31 OR 32 OR 33 OR 34 OR 35 OR 36 0R 37 OR 38 OR 39 OR 40 OR 41		

Study	Study design	N	Age in years mean (SD; range)	Gender Male/ Female	Duration of diabetes in years (SD; range)	Baseline HbA1c (%) mean (SD; range)	Intervention	Intervention's format/administrators/mode of administration/intensity	Control	Follow up (average months)	HbA1c post intervention (%) mean (SD)
Amsberg et al.2009	RCT	T:74 I:36 C:38	T: 41.2 (12.3; 19–65) I: 41.1 (11.7; 23–65) C: 41.4 (12.9; 19–64)	T:36/38 I:20/16 C:16/22	T:21.6 (10.8; 5–48) I:19.9 (9.4; 5–44) C:23.2 (11.8; 5–48)	T: 8.5 (0.8; 7.1–11.4) I: 8.5 (0.9; 7.5–11.4) C:8.5 (0.8; 7.1–11.2)	CBT- based intervention	Basic intervention program: -Face to face/ Specialist nurse and psychologist trained in CBT/ Group sessions except week 7/ 8 weekly 2-hour sessions (weeks 0-8 weeks) Maintenance program: -Face to face/ Specialist nurse and psychologist trained in CBT/ 2 individual sessions (weeks 12-24) and 5 phone calls (weeks 10–42)	Free discussion	4	I:7.72 C:8.21
Channon et al. 2007	RCT	T:66 I: 38 C: 28	I: 15.3 (0.97) C: 15.4 (1.19)	T:31/35 I:17/21 C:14/14	I: 9.2 (2.0) C: 9.1 (1.5)	8.8-10.3	Motivational interviewing	Face to face/ Assessors with nursing background- health psychologist/ Individual home visits/ Mean 4 visits in 12 months (20-60 minutes)	Support visits	24	I:8.7 (1.88) C:9.1 (1.51)
De Wit et al. 2008	Cluster-RCT	T:81 I:41 C:40	I: 14.8 (1.1) C: 14.9 (1.0)	T:38/43 I:19/22 C:19/21	I: 7.2 (4.3) C: 6.2 (4.3)	I:8.6 (1.4) C: .8 (1.3)	HRQoL	Face to face/ Paediatrician/ One-to-one sessions/ During clinic appointments	Baseline generic lifestyle questionnaire	12	I:8.4 (1.6) C:8.3 (1.3)
Didjurgeit 2002	RCT	T:44 I:23 C:21	I:36 (9) C:41 (10)	T:17/27 I:9/14 C:8/13	I: 23 (9) C: 25 (10)	I:9.0 (2.0) C:8.7 (1.7)	Psychotherapeutic intervention: brief problem-orientated therapy	Face to face/ Therapist (author) under the supervision of an external consultant (author) in psychotherapeutic medicine/ One-to-one basis/ Maximum 14 sessions a week (55 minutes)	Routine diabetes care	6	I:8.5 (1.6) C:8.8 (1.9)
Ellis et al. 2019	RCT	T:48 MBSR:16 CBT:16 DS:16	MBSR: 18.0 (1.5) CBT: 18.1 (1.3) DS: 18.5 (1.6)	T:24/24 MBSR:6/10 CB5T:11/5 DS:7/9	MBSR: 8.8 (5.2) CBT: 8.2 (4.0) DS: 7.3 (4.7)	MBSR:11.7 (2.0) CBT:12.3 (2.5) DS:12.7(2.5)	MBSR CBT stress management	MBSR: -Face to face/ Trained therapist/ Group sessions/ 9 weekly sessions (mean 5.3), (90-120 minutes) CBT: -Face to face/ Trained therapist/ Group sessions/ 9 weekly sessions (mean 4.0), (90-120 minutes)	DS group	6	MBSR:11.9 (1.7) CBT:12.0 (2.1) DS:12.2 (2.0)
Fisher et al. 2018	RCT	T:301 OnTrack:152 Knowlt:149	OnTrack: 42.8 (15.1) Knowlt: 47.3 (14.5)	T:93/208 OnTrack:49/103 Knowlt:44/105	OnTrack: 23.2(13.3) Knowlt: 26.1 (14.0)	OnTrack:8.83 (1.11) Knowlt:8.77 (1.13)	OnTrack: Emotion based intervention	Face to face + Online video meetings / Trained group leader (a Certified Diabetes Educator for Knowlt and a psychologist with diabetes experience for OnTrack)/ Group workshop/ 1-day face to face workshop + four 1- hour video meetings	Knowlt: Educational, behavioural intervention	9	OnTrack:8.65 (1.19) Knowlt:8.59 (1.25)
Graue et al. 2005	RCT	T:101 I:55 C:46	I: 14.5 (1.6) C: 14.3 (1.6)	T:54/47 I:31/24 C:23/23	I: 6.7 (3.3) C: 6.9 (4.3)	I:9.6 (1.3; 6.9–13.3) C:9.4 (1.7;6.1–14)	Structured educational and counselling programme	Face to face visits + Computer assisted consultations/ Physician, diabetes nurse specialist, clinical psychologist, dietician, and social worker/ Group visits + Individual computer-assisted consultations/ Three 3-hour group visits + Three 45-minutes individual computer-assisted consultations at 3 month-intervals	Traditional care	15	I:-0.35 (1.59)* C:0.09 (1.19)
Grey et al 1998	RCT	T:65 I:34 C:31	I: 15.8 ±2.1 C: 15.0 ±2.3	T:28/37 I:15/19 C:13/18	I: 7.6 (3.9) C: 8.6 (3.6)	I:8.9 ±1.8 C:9.0 ±1.6	Intensive diabetes management with CST	Face to face/ Master's-prepared nurse practitioner/ Group sessions/ 4-8 weekly sessions (1-1.5 hours)	Intensive diabetes management without CST	3	I:7.6 (1.3) C:8.1 (1.3)
Guo et al. 2020	RCT	T:100 I:50 C:50	13.6 (8-20) I: - C: -	T:45/57 I:20/30 C:24/26	T:3.9 (3.1) I: - C: -	T:8.47 I: - C: -	CST	Face to face/ Four trained nurses/ Camp sessions/ Seven 2-day sessions in 4 months (60-90 minutes) Phone calls/ Program trained research assistant/ One-to-one phone calls/ Five monthly calls	Standard care	12	**
Hains et al 2000	RCT	T:15 I: 8 C: 7	T: 12-15	T:7/8 I:3/5 C:4/3	-	I:10.1 (1.1) C:9.9 (1.4)	Cognitive behavioural training	Face to face/ Doctorate-level psychologist (author) and a doctoral student in counselling psychology/ Group sessions/ Six weekly 1-hour sessions	Waiting-list group	2.5	I:9.9 (1.5) C:9.4 (1.4)
Hood et al 2018	RCT	T:264 I:133 C:131	T: 15.7 (1.1; 14-18)	T:106/158	T:6.9 (4)	T:9.1 (1.9)	PRP T1D	Face to face/ Masters-level clinicians/ Group sessions/ Nine biweekly sessions in 4.5 months (90-120 minutes)	Advanced diabetes education	16	I:9.3 (1.9) C:9.1 (1.9)

Ismail et al 2010	RCT	T:344 Usual care: 121 MET:117 MET+CBT:106	Usual care:36.4 (11.3) MET:35.6 (9.6) MET+CBD:37.2 (9.9)	T:136/208 Usual care: 55/66 MET:41/76 MET+CBD: 40/66	Usual care:19.5 (10.4) MET:17.3 (9.6) MET+CBD:18.7 (9.2)	Usual care:9.7 (1.2) MET:9.6 (1.0) MET+CBD:9.6 (1.3)	MET + CBT	MET: -Face to face / Trained nurses/ Individual sessions/ 4 sessions in 2 months (50 minutes) MET+CBT: - Face to face/ Trained nurses/ Individual sessions/ 4 MET sessions in 2 months + 8 CBT sessions in 4 months	Usual care	12	Usual care:9.54 (1.52) MET:9.30 (1.61) MET+CBD:9.11 (1.38)
Jaser et al 2018	RCT	T:120 I:60 C:60	T: 14.83 (1.44) I: 14.78 (1.47) C: 14.88 (1.42)	T:57/63 I:32/28 C:25/35	T:5.8 (3.6) I:5.5 (3.7) C:6.2 (3.6)	T:9.16 (0.90) I:9.15 (0.96) C:9.17 (0.84)	Positive affect Intervention	Mail (education materials) + Positive affect texts or Positive affect Phone calls/ Trained research assistant/ One-to-one/ 2 weekly mail for 8 weeks + Weekly texts for 8 weeks or Weekly phone call for 8 weeks	Education intervention	6	I:9.0 (1.2) C:9.2 (1.4)
Mayer-Davis et al 2018	RCT	T:258 I:130 C:128	I:14.8 (1.1) C:14.9 (1.1)	T:130/128 I:71/59 C:59/69	T:6.4 (3.8) I:6.5(3.8) C:6.4 (3.7)	I:9.7 (3.3) mmol/mol C:9.5 (3.4) mmol/mol	FLEX	Flex basic: -Face to face/ Members of type 1 diabetes care team/ Individual sessions/ 4 sessions in 12 weeks (40-60 minutes) FLEX Regular: -Face to face/ Members of type 1 diabetes care team/ Individual sessions/ 3-4 sessions in six months (40-60 minutes) FLEX Check-In: Phone call/ Members of type 1 diabetes care team/ Individual sessions/ One phone call per month (10-15 minutes)	Usual care	18	I:9.8 (3.9) mmol/mol C: 9.7 (3.7) mmol/mol
Murphy et al 2012	RCT	T:305 I:158 C:147	T:13.1 (1.9) I:13.1 (1.9) C:13.2 (2.0)	T:146/159 I:74/84 C:72/75	T:5.6 (3.3) I:5.5 (3.1) C:5.6 (3.4)	T: 9.3 (1.9) I: 9.2 (1.7) C: 9.4 (2.1)	FACTS diabetes education programme	Face to face/ Trained healthcare professionals/ Group sessions/ Six monthly sessions (90 minutes)	Conventional care	12	I:9.3 (1.5) C:9.5 (1.6)
Robling et al 2012	Cluster-RCT	T:689 I:356 C:333	T:10.6 (2.8) I: 10.4 (2.8) C:10.7 (2.8)	T:342/347 I:187/169 C:155/178	T:5.1 (2.7) I:5.2 (2.8) C:5.0 (2.7)	T:9.3 (1.8) I:9.4 (1.7) C:9.2 (1.8)	Talking Diabetes programme	Web-based + Face to face/ Trained Practitioners/ Group sessions/ 1.5 hours of web-based training + Two team-based day workshops Training program of practitioners who delivered the "Talking Diabetes consulting skills" sessions.	Standard care	12	I:9.7 (1.7) C:9.5 (1.7)
Rostami et al 2016	RCT	T:74 I:37 C:37	T:11-21	T:30/44 I:13/24 C:17/20	T:1-7	I:10.7 (2.2) C:10.2 (2.1)	Group training intervention	Face to face/ Researchers, one paediatric nurse and psychiatric nurse and a graduate student/ Group sessions/ Weekly 2-hour sessions for 8 weeks	No intervention	3	I:7.9 (2.0) C:11.0 (2.3)
Serlachius et al 2016	RCT	T:147 I:73 C:74	I:14.36 (1.07) C:14.31 (1.12)	T:68/79 I:31/42 C:37/37	I:5.63 (3.33) C:6.12 (3.80)	I:8.5 (1.5) C:8.6 (1.4)	BOC	Face to face/ Health psychologist (author)/ Group sessions/ Five weekly 2-hour sessions	Standard care	12	I:8.4 (1.7) C:8.8 (1.6)
Snoek et al 2008	RCT	T:86 I:45 C:41	I:38.1 (9.7) C:37.4 (11.1)	T:36/50 I:22/23 C:14/27	I:17.8 (10.1) C:18.8 (10.9)	I:8.8 (1.3) C:9.1 (1.1)	CBT	Face to face/ psychologist and diabetes nurse educator/Group sessions/ Six weekly sessions	BGAT	12	I:8.8 C:9.4
van der Ven et al 2005	RCT	T:88 I:45 C:43	T:37.8 (10.6; 20–60)	T:36/52	T:18.0 (10.4; 1–50)	T:8.9 (1.19; 6.7–12.9) I:8.9 (1.14) C:8.9 (0.92)	CBGT	Face to face/ Diabetes specialist nurse and psychologist/ Group sessions/ Six weekly 2-hour sessions	BGAT	3	I:8.7 (1.24) C:9.2 (1.10)
BGAT: Blood Glucose Awareness Training, BOC: The Best of Coping Programme, CBGT: Cognitive behavioural based group training, CBT: Cognitive Behaviour Training, CST: Coping skills training, DS: Diabetes Support, FACTS: Families and Adolescents Communication and Teamwork Study, FLEX: Flexible Lifestyles Empowering Change, HRQoL: Health-Related Quality of Life discussion and monitoring, MBSR: Mindfulness-based stress reduction, MET: Motivational Enhancement Therapy, PRP T1D: Penn Resilience Program for Type 1 diabetes											

Supplementary Table 2. Summary of study characteristics

*Post intervention difference from baseline

**Estimated group effects expressed as B effect (Standard error) by generalised estimation equation: For school aged children 8-12 years old B= -0.33 (0.47) and for adolescents 13 – 20 years old B= 0.61 (0.46)

N: Number of patients, SD: Standard Deviation, T: Total, I: Intervention, C: Control, HbA1C: Glycated Haemoglobin

Study	Depression scale	Depression score baseline I mean (SD) /C mean (SD)	Depression score post intervention I mean (SD) /C mean (SD)	Anxiety scale	Anxiety score baseline I mean (SD) / C mean (SD)	Anxiety score post intervention I mean (SD) / C mean (SD)
Amsberg et al.2009	HAD	4.50 (3.70) / 4.30 (4.20)	1.7 3.51 / 5.09 SD not given *-1.59 (-2.98 - -0.18)	HAD	6.7 (5.1) / 6.3 (4.6)	5.07 / 6.32 SD not given *-1.25 (-2.49 - -0.01)
Channon et al. 2007	WBQ	Not given	10.08 (2.25) / 11.85(1.81)	WBQ	Not given	6.03 (2.23) / 11.55 (3.69)
De Wit et al. 2008	CES-D	8.37 (6.12) / 7.01 (5.19)	6.88 (5.73) / 5.84 (4.80)	-	-	-
Didjurgeit 2002	ZERSSEN depression score	16.30 (9.60) / 13.80 (8.90)	11.80 (10.90) / 11.70 (9.80)	-	-	-
Ellis et al. 2019	CES-D	MBSR: 1.52 (0.46) CBT: 1.71 (0.59) DS: 1.97 (0.55)	MBSR: 1.56 (0.56) CBT: 1.6 (0.54) DS: 1.63 (0.38)	PSS	MBSR 2.82 (0.44) CBT 2.88 (0.75) DS 3.01 (0.91)	MBSR: 2.47 (0.64) CBT: 2.81 (0.53) DS: 2.56 (0.88)
Grey et al 1998	CDI	7.90 (1.30) / 6.6 (1.80)	6.3 (1.30) / 6.0 (1.20)	-	-	-
Hains et al 2000	-	-	-	STAI	41.25 (7.11) / 43.83 (12.11)	36.14 (6.74) / 42.80 (5.89)22.50.
Hood et al 2018	CDI	7.60 (6.10) / 7.90 (6.30)	8.50 (8.50) / 8.50 (8.00)	-	-	-
Ismail et al 2010	PHQ	MET:34 (29.1)/ MET+CBD:29 (27.4)/ Usual care:34 (28.1)	*			
Mayer-Davis et al 2018	CES-D	9.3 (8.9) / (9.2 (7.7)	6.60 (7.10) / 8.50 (7.10)	-	-	-
Rostami et al 2016	BDI	16.1 (10.8) / 20.0 (10.7)	13.00 (8.50) / 21.30 (9.90)	BAI	16.8 (10.5) /18.3 (10.4)	12.5 (8.2) / 19.0 (10.2)
Serlachius et al 2016	-	-	-	DSQ	106.8 (24.5) / 112.4 (26.7) At 3 months	105.7 (26.9) / 110.8 (31.6) At 12 months
Snoek et al 2008	CES-D	16.00 (12.70) / 16.30 (9.40)	15.40 / 15.50 SD not given	-	-	-
van der Ven et al 2005	CES-D	16.90 (12.77) / 15.50 (10.05)	13.50 (12.62) / 13.20 (7.38)	-	-	-

BAI: Beck Anxiety Inventory, BDI: Beck Depression Inventory, CBT: Cognitive Behaviour Therapy, CES-D: Centre for Epidemiological Studies scale for Depression, CDI: The Children's Depression Inventory, DS: Diabetes Support, DSQ: Diabetes Stress Questionnaire for Youths, HAD: Swedish Hospital Anxiety and Depression Scale, MBSR: Mindfulness-based stress reduction, PHQ: Patient HealthCare Questionnaire, PSS: Perceived Stress Scale, STAI: State-Trait Anxiety Inventory, WBQ: Well-Being Questionnaire

Supplementary Table 3. Depression and anxiety measurement scales and study data

CBT: Cognitive Behavioural Therapy, MET: Motivational Enhancement Therapy SD: Standard Deviation

* 12-month score 1.10 (95% CI –0.34 to 2.54) higher in the MET + CBT group and 0.02 (95% CI –1.18 to 1.21) higher in the MET group than usual care

Study	Diabetes related distress scale	Diabetes related distress score baseline I mean (SD) /C mean (SD)	Diabetes related distress score post intervention I mean (SD) /C mean (SD)
Amsberg et al.2009	Swe-PAID-20	31.1 (20.4) / 33.4 (17.3)	22.92 / 29.80 SD not given
Fisher et al. 2018	T1-DD	2.90 (0.60) / 2.87 (0.63)	2.15 (0.52) / 2.18 (0.65)
Hains et al 2000	DSI	81.00 (36.01) / 78.83 (17.61)	71.00 (33.68) / 76.67 (20.02)
Hood et al 2018	PAID-T	72.1 (28.3) / 74.2 (25.0)	62.8 (26.5) / 68.7 (27.6)
Snoek et al 2008	PAID	44.4 (22.4) / 49.0 (17.2)	38.3 / 45.4 SD not given
van der Ven et al 2005	PAID	47.0 (21.60) / 46.6 (18.02)	42.6 (20.83) / 43.1 (17.59)
DSI: Diabetes Stress Inventory, PAID: Problem Areas in Diabetes scale, PAID-T: Problem Areas in Diabetes–Teen, Swe-PAID-20: Swedish version of the 20-item Problem Areas in Diabetes Scale, T1-DD: Type 1 Diabetes Distress Scale			

Supplementary Table 4. Diabetes related distress measurement scales and study data

SD: Standard Deviation

Study	QoL scale	QoL score baseline I mean (SD) /C mean (SD)	QoL score post intervention I mean (SD) /C mean (SD)
Channon et al. 2007	DQoLY: Impact**: Satisfaction: Worry**:	 - - -	 50.49 (12.05)/ 61.05 (18.48) 33.28 (9.88) / 45.55 (10.79) 17.71 (7.15)/ 30.23 (11.59)
De Wit et al. 2008	CHQ-CF87 Mental Health Mental health Domain: Psychosocial health summary score:	 76.65 (11.01) / 78.42 (11.12) 83.70 (8.70) / 85.82 (7.47)	 80.38 (11.26) / 80.53 (10.14) 88.01 (6.10)/ 85.18 (8.19)
Didjurgeit 2002	Non-diabetes-specific IRES questionnaire	4.0 (2.2) / 4.7 (2.0)	4.4 (1.7) / 4.3 (1.6)
Grey et al. 1998	DQoLY Impact**: Satisfaction: Worry**:	 50.8 (11.5) / 47.3 (9.0) 64.0 (13.4) / 66.3 (11.5) 21.8 (7.5) / 19.8 (5.0)	 46.1 (11.0) / 43.6 (11.2) 67.8 (11.3) / 67.0 (13.5) 20.7 (6.7) / 19.5 (7.4)
Graue et al. 2005	DQOL Impact**: Satisfaction: Worry**:	 - - -	Differences in scores from baseline: 2.8 (11.0) / -1.5 (8.2) - 1.9 (11.5) / -2.9 (12.2) -1.0 (10.8) / -1.0 (10.4)
Guo et al. 2020	QLS	*	*
Jaser et al 2019	PedsQL	71.3 (11.9) / 70.2 (11.9)	76.0 (11.8) / 72.4 (13.4)
Mayer-Davis et al 2018	PedsQL	80.7 (13.1) / 81.1 (11.7)	85.2 (11.4) / 82.2 (12.6)
Murphy et al 2012	DQoLY Impact**: Worry**: Parental involvement:	 15.8 (4.6) / 17. 1 (5.3) 12.8 (5.5) / 14.6 (5.7) 8.3 (3.1) / 8.8 (3.4)	 18.6 (21.9) / 17.9 (11.5) 13.5 (10.4) / 16.5 (11.9) 8.3 (3.1) / 8.6 (3.5)
Robling et al 2012	QoL Barriers: Symptoms: Adherence: Worry**: Communication:	 66.8 (22.0) / 69.3 (19.6) 54.4 (15.0) / 56.5 (13.6) 76.4 (17.2) / 77.9 (15.1) 68.8 (23.8) / 67.3 (22.0) 63.3 (26.9) / 66.0 (23.8)	 67.5 (21.2) / 73.3 (18.2) 55.3 (15.3) / 57.2 (14.3) 76.8 (17.4) / 80.6 (15.4) 67.2 (23.2) / 69.8 (20.2) 62.3 (26.9) / 69.1158 (22.2)
Serlachius et al 2016	DQOL	88.7 (13.1) / 84.3 (14.0) At 3 months	88.7 (12.6) / 84.9 (14.0) At 12 months
CHQ-CF87: Child Health Questionnaire-Child Form 87 items, DQOL: Diabetes-related quality of life scale, DQoLY: Diabetes Quality of Life Measure for Youths, IRES: Indicators of the Rehabilitation Status, PedsQL: Paediatric Quality of Life, QLS: Quality of Life Scale for Children and Adolescents, QoL: Quality of Life			

Supplementary Table 5. Quality of life measurement scales and study data

*Estimated group effects expressed as B effect (Standard error) by generalised estimation equation: For school aged children 8-12 years old: 2.27 (0.94) and for adolescents 13 – 20 years old 0.46 (0.73)

** Lower scores indicate higher quality of life

SD: Standard Deviation

Supplementary Table 6. GRADE table for assessing the quality of evidence for depression

Certainty assessment							Summary of findings			
Number of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Number of patients		Effect SMD (95% CI)	Certainty
							Intervention	Control		
9	RCT	Serious	Serious	Not serious	Serious	None	513	475	-0.17 (-0.41, 0.07)	Very low

Supplementary Table 7. GRADE table for assessing the quality of evidence for diabetes related distress

Certainty assessment							Summary of findings			
Number of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Number of patients		Effect SMD (95% CI)	Certainty
							Intervention	Control		
4	RCT	Serious	None	Not serious	Serious	None	338	330	-0.12 (-0.27, 0.04)	Low

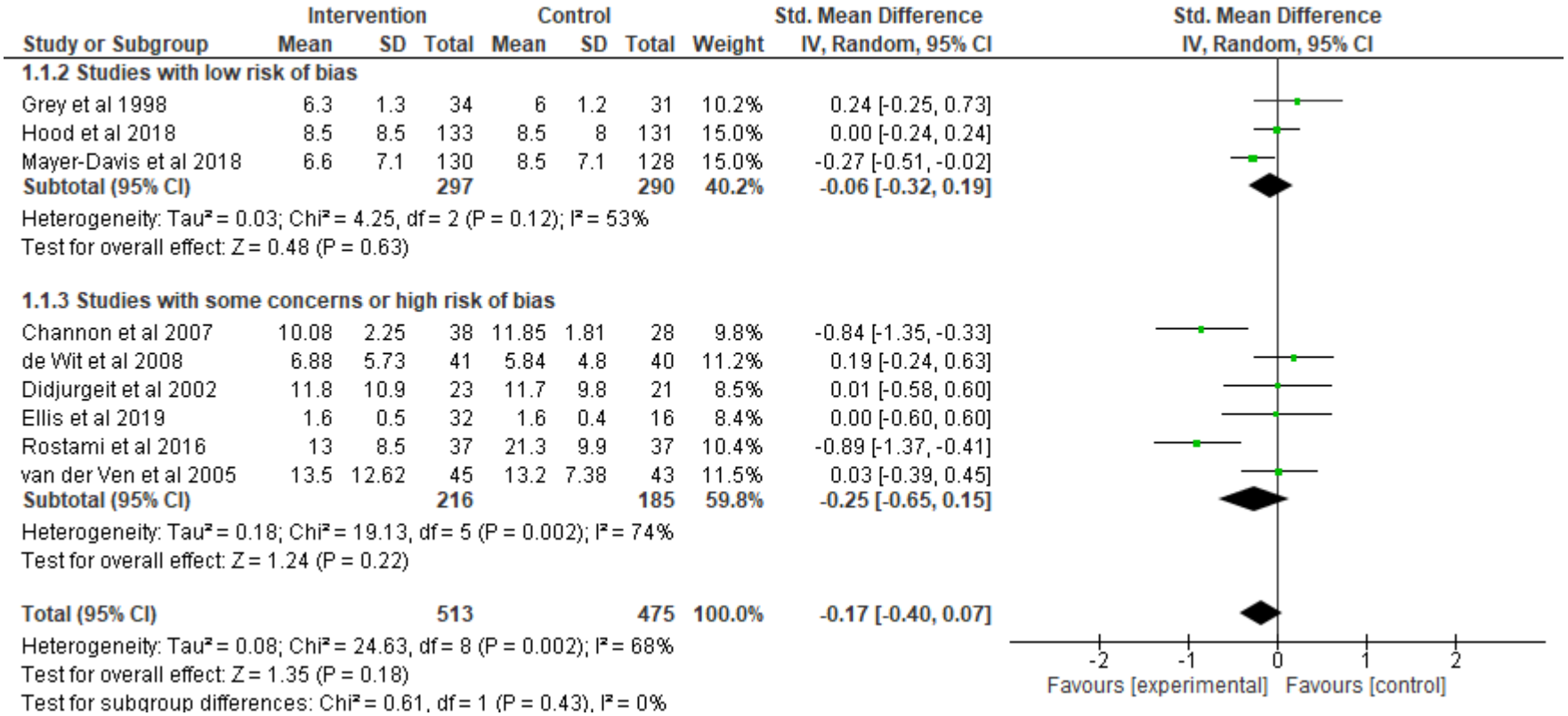
Supplementary Table 8. GRADE table for assessing the quality of evidence for quality of life

Certainty assessment							Summary of findings			
Number of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Number of patients		Effect SMD (95% CI)	Certainty
							Intervention	Control		
4	RCT	Serious	None	Not serious	Not serious	None	327	323	0.27 (0.11-0.42)	Moderate

Supplementary Table 9. GRADE table for assessing the quality of evidence for glycaemic control (HbAIc)

Certainty assessment							Summary of findings			
Number of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Number of patients		Effect SMD (95% CI)	Certainty
							Intervention	Control		
16	RCT	Serious	Not Serious	Not serious	Not serious	None	1564	1381	-0.26 (-0.51, -0.01)	Moderate

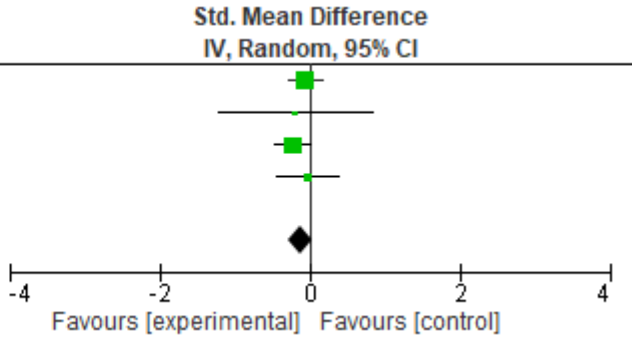
Supplementary figure 1. Forest plot, effect size estimates and funnel plot for the effectiveness of psychological interventions in reducing depression symptoms



Supplementary figure 2. Forest plot, effect size estimates and funnel plot for the effectiveness of psychological interventions in reducing diabetes-related distress

Study or Subgroup	Intervention Mean	SD	Total	Control Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Fisher et al 2018	2.15	0.52	152	2.18	0.65	149	45.2%	-0.05 [-0.28, 0.18]
Hains et al 2000	71	33.68	8	76.67	20.02	7	2.2%	-0.19 [-1.21, 0.83]
Hood et al 2018	62.8	26.5	133	68.7	27.6	131	39.4%	-0.22 [-0.46, 0.02]
van der Ven et al 2005	42.6	20.83	45	43.1	17.59	43	13.2%	-0.03 [-0.44, 0.39]
Total (95% CI)			**338**			**330**	**100.0%**	**-0.12 [-0.27, 0.04]**

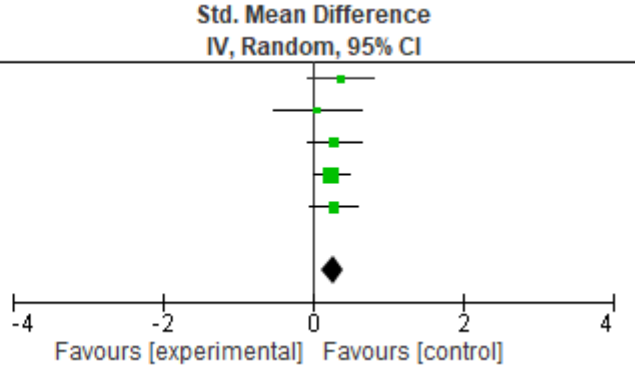
Heterogeneity: Tau² = 0.00; Chi² = 1.19, df = 3 (P = 0.75); I² = 0%
Test for overall effect: Z = 1.50 (P = 0.13)



Supplementary figure 3. Forest plot and effect size estimates for the effectiveness of psychological interventions in improving quality of life

Study or Subgroup	Intervention Mean	SD	Total	Control Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
de Wit et al 2008	88	6.1	41	85.2	8.2	40	12.3%	0.38 [-0.06, 0.82]
Didjurgeit et al 2002	4.4	1.7	23	4.3	1.6	21	6.8%	0.06 [-0.53, 0.65]
Jaser et al 2019	76	11.8	60	72.4	13.4	60	18.5%	0.28 [-0.08, 0.64]
Mayer-Davis et al 2018	85.2	11.4	130	82.2	12.6	128	39.8%	0.25 [0.00, 0.49]
Serlachius et al 2016	88.7	12.6	73	84.9	14	74	22.6%	0.28 [-0.04, 0.61]
Total (95% CI)			**327**			**323**	**100.0%**	**0.27 [0.11, 0.42]**

Heterogeneity: Tau² = 0.00; Chi² = 0.79, df = 4 (P = 0.94); I² = 0%
Test for overall effect: Z = 3.39 (P = 0.0007)

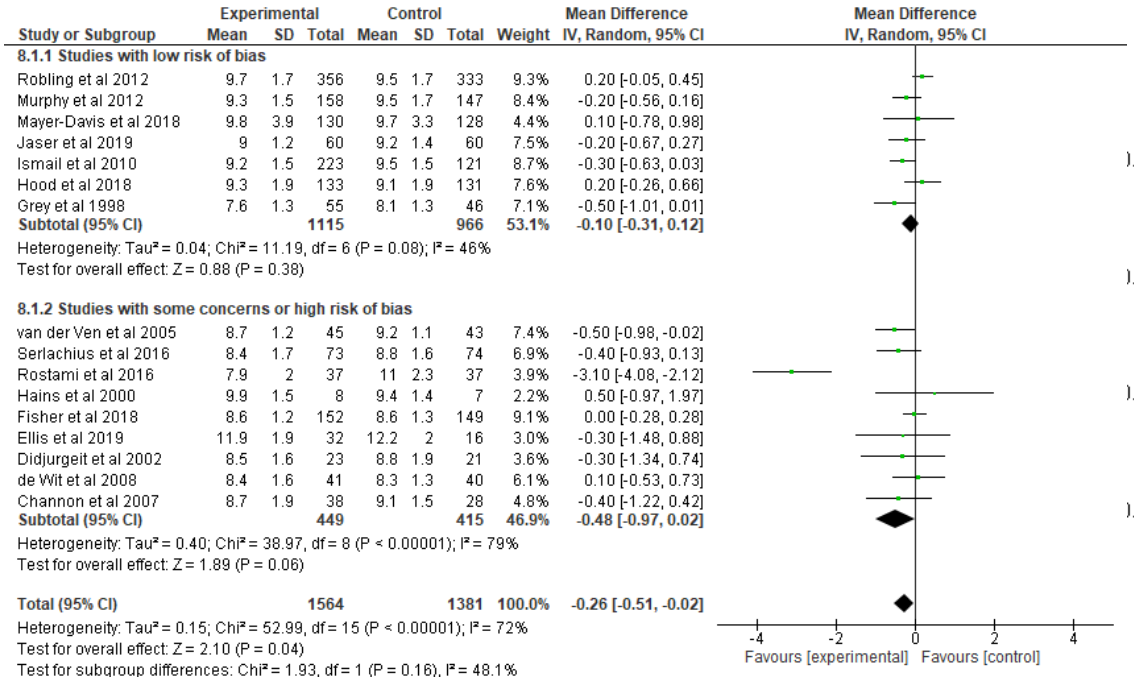


Supplementary figure 4.

4A. Forest plot and effect size estimates for the effectiveness of psychological interventions in reducing HbA1c

4B. Funnel plot for the effectiveness of psychological interventions in reducing HbA1c

4A



4B