International Diabetes Nursing, Vol. 12, 2015, 93–107

High rates of elevated diabetes distress in research populations: A systematic review and meta-analysis

Kathryn Dennick[1†], Jackie Sturt[1], Danielle Hessler[2], Edward Purssell[1], Benjamin Hunter[1], Jennifer Oliver[1] and Lawrence Fisher[2]

[1]Florence Nightingale Faculty of Nursing and Midwifery, Kings College London, UK; [2]Department of Family and Community Medicine, University of California San Francisco, USA

Diabetes distress has implications for diabetes end-points, hence targeted interventions are indicated; yet, preliminary work quantifying and characterising the problem is required. We sought to identify the potential magnitude and determinants of elevated diabetes distress across study populations. Databases such as Medline, PsycINFO and Embase were searched for studies ($n \geq 50$) administering the problem areas in Diabetes scale or Diabetes Distress scale, in adults with Type 1 or 2 diabetes. Random effects meta-analysis and meta-regression estimated the average rate of elevated diabetes distress and prognostic contribution of age, gender, HbA1c, and health-care context. Of the 16,627 citations identified, adequate data were available for 58 studies. On average, 22% of participants reported elevated diabetes distress. Only female gender and secondary care predicted a higher rate of elevated diabetes distress. A quarter of people with diabetes have a level of distress likely to impact outcomes. Secondary-care practitioners should be vigilant of women with diabetes.

Key words: Diabetes, Diabetes distress, Prevalence, Systematic review, Meta-analysis, Meta-regression

Received 26 March 2016; accepted 30 May 2016

Introduction

Diabetes distress (DD) is characterised by a range of different negative emotional reactions, for example worry, fear, anger and feeling overwhelmed, etc., to adverse aspects of living with and managing diabetes.[1] DD is independently associated with HbA1c.[2–7] Fluctuations in each are related over time reflecting the ongoing negative experience of DD and its implications for outcomes and vice versa.[4,5] Adults who experience intervention related improvements in DD also evidence clinically relevant improvements in HbA1c,[8–10] and a 10 point change in Problem Areas in Diabetes (PAID) scale scores is associated with a change of 0.2% in HbA1c.[6,9] DD also impacts certain self-management behaviours (SMBs).[2,3,5,11,12]

Individuals with elevated, or 'clinically relevant', DD additionally participate less in educational and self-management interventions comprising no psychological component[8] and exhibit less improvement in HbA1c.[10] Conversely where interventions target DD those with elevated DD, but not depression, engage to a greater degree and evidence improvement in SMBs.[13] Ameliorating DD is therefore a priority and interventions must move towards targeting elevated DD to improve well-being, SMBs and clinical end-points.[13,14] Such endeavours must begin at the ground level with systematic consideration of the presence, magnitude and determinants of elevated DD, serving to identify the potential size of the problem and isolate candidate populations with the greatest need for intervention.

There is emerging evidence of the rate of elevated DD in study samples. In UK primary care, 21% of adults report elevated DD.[15] In the Netherlands, 4% and 19% of primary and secondary care patients, respectively, experience elevated DD.[16] In Australia, elevated DD affects 28%, 22% and 17% of adults with Type 1 and Type 2 diabetes, using and not using insulin, respectively.[17] The USA community point prevalence of elevated DD is 18%, which increases to 48% over an 18 months period.[18] The prevalence and determinants of depression in diabetes has been reviewed extensively.[19,20] Equivalent evidence on DD has thus far not received the same attention. A question therefore remains; what is the average rate of elevated DD in research populations and what individual and contextual characteristics determine this rate?

Objectives

To identify the average rate and determinants of elevated DD across study populations of adults with diabetes.

Method

A systematic review was undertaken according to the MOOSE (Meta-analysis Of Observational Studies in Epidemiology) Group guidance.[21]

Correspondence to: Kathryn Dennick, Florence Nightingale Faculty of Nursing and Midwifery, King's College London, James Clerk Maxwell Building, 57 Waterloo Road, London SE1 8WA, UK. Email: kathryn.dennick@kcl.ac.uk

[†]Current address: Kathryn Dennick, Research Department of Clinical, Educational and Health Psychology, University College London, 1–19 Torrington Place, London, WC1E 7HB, UK. Email: k.dennick@ucl.ac.uk

DOI 10.1080/20573316.2016.1202497

Identification of studies

Medline, Psychinfo and Embase were searched without language restrictions (1995–2013). In an initial scoping search, we found all of the relevant evidence in psychology or medically led, rather than nursing led, studies hence it made sense to search these databases. The objective of the review was to bring DD to the attention of diabetes nurses and influence nursing practice around identifying and managing DD which we believe to be core diabetes nursing practice.

Included were studies assessing DD using the PAID scale[22] or Diabetes Distress Scale (DDS)[23] in any adult (≥18 years of age) population with diagnosed Type 1 or 2 diabetes. Studies using anything other than the full versions of the widely adopted PAID or DDS were excluded to encourage homogeneity in outcome assessment. We included a heterogeneous range of study populations as the objective of the review was to derive a preliminary indication of the average size of the problem and explore this clinical and methodological heterogeneity as potential sources of anticipated variation in rates of elevated DD. A broad, two pronged search strategy (available from the authors) captured terms historically used to describe the experience of DD, and the above measures, and terms that identify the types of studies known to include measures of DD as indicated by the initial scoping search; (a) '*diabetes distress*' text words (all known variants and terms describing measures of DD), and (b) index terms and text words relating to 'diabetes' AND, for example, '*distress*', '*mood*', '*emotion*', '*depression*', '*quality of life*', '*education intervention*', '*self-management* intervention' *and* '*psychological intervention*'. The strategy was also informed by search strategies employed in systematic reviews of depression in diabetes as DD often features in such studies.

Selection of studies

Two reviewers independently assessed citations and full papers for eligibility. Inter-rater reliability was good ($\kappa = .88$). Identified conference abstracts and study protocols were included and the full papers were requested from authors once initially and then again prior to drafting the final paper.

Data extraction

Data were extracted by one investigator and quality checked by a second, with discrepancies resolved by discussion and consensus. No investigator extracted data from their own study. Data were extracted on population and setting, sample size, study design, measure of DD and the rate of elevated DD. Where studies were reported in more than one publication data were extracted from the paper reporting the rate of elevated DD. Where necessary demographic data were extracted from another publication on the same study (where n was equivalent). Baseline data were included for prospective studies. Rate data were requested from authors once where this was not reported in the paper(s).

Quality assessment

A number of tools are available for assessing the risk of bias in randomised controlled trials (RCTs), but assessment of observational study designs is controversial. Unlike aspects of RCT design, such as randomisation and allocation concealment, there is little evidence that criteria against which observational studies are appraised are related to risk of bias.[21] Consistent with the conclusion of authors of similar reviews, quality assessment was therefore not meaningful and not undertaken.[19] The synthesis was, however, informed by a more robust estimate of quality; studies were inverse-variance weighted to ensure that larger, and more precise, estimates were given more weight.

Publication bias

Risk of publication bias was determined by visual inspection of funnel symmetry in the plot of each studies estimate against its standard error (SE) and statistical test (Egger's test).

Specification of outcome

'Rate data' constituted the number, and proportion, of participants completing the PAID scale or DDS that scored ≥40 or ≥3, respectively. In the absence of a gold standard criterion for identifying clinically relevant DD other means of establishing this have been proposed. A PAID score ≥40 is one standard deviation (SD) above the mean for clinic patients and research populations[24,25] and has discriminant validity.[25] A DDS score ≥3 exhibits maximal associations with diabetes outcomes (i.e. SMBs and HbA1c).[11] These thresholds are typically employed in clinical and research settings.[26,27]

Data synthesis

Meta-analysis was used to estimate the average proportion of elevated DD (and 95% confidence intervals, CIs) across studies and pre-defined sources of heterogeneity in the estimate were explored using meta-regression. These analyses were undertaken using Metafor (R). Inspection of the data suggested normal distributions thus parametric analyses were appropriate. Rate data were combined, and covariates explored, in random/mixed effects models as statistical heterogeneity beyond that which can be explained by sampling error/chance (and the included covariates) is anticipated amongst observational studies.[21] This accounts for such heterogeneity and derives more conservative estimates of precision and significance. Data were pooled irrespective of diabetes type because preliminary analysis, including only exclusively Type 1 or Type 2 samples, suggested this was not prognostic ($\beta = -0.27$, 95% CIs −0.80 to 0.25, $p = 0.31$).

Exploration of heterogeneity

Statistical heterogeneity was quantified by visual inspection of forest plots and statistical test (Q, τ^2 and I^2). τ^2 provides an estimate of the total variance between

studies (i.e. its square root reflects the standard deviation of the individual study estimates about the average). I^2 represents the percentage of this variance that is above that which would be expected as a result of sampling error; 25%, 50% and 75% indicate low, medium and high levels of heterogeneity, respectively.[28]

Covariates

Covariates were age, gender (% male), HbA1c and health care context (i.e. community/primary care versus secondary care). Covariates were limited to study-level variables consistently reported across studies and with a substantive evidence base suggesting an association with DD. Multicollinearity was assessed with Pearson's correlations, independent *t* tests and Chi-square tests (in SPSS). Covariates were explored in separate models then forced simultaneously into a multivariate model to explore the independent influence of each.

Sensitivity analyses

Rate data were pooled irrespective of outcome measure because the PAID and DDS were largely developed by the same investigators and there are few discernible differences in their theoretical underpinnings, development work and broad item content. Nonetheless the meta-analysis was repeated excluding studies that utilised the DDS to observe the resiliency of the pooled estimate to the outcome measure employed. The multivariate meta-regression was also repeated with multiple imputation of missing values to observe the resiliency of the conclusions to listwise deletion of studies with missing data on one or more variables ($n = 14$ studies; 24%). The imputation process consisted of four stages: extraction of the incomplete data set; imputation of the missing data set; analysis of the results from each data set; and pooling of these results. An assumption was made that data were missing at random. Imputation was undertaken using MICE (R), with 24 iterations[29] using predictive mean matching for numerical variables and logistic regression for 2-level factors.[30,31] The resulting pooled data set was passed to Metafor for subsequent analysis.[32] The complete code for this is available upon request. Pooled QE and QM Chi-square statistics were estimated in SAS.[33]

Results

Identification and selection of studies

The search identified 16 627 unique citations and 149 unique studies, that used the full PAID or DDS and with a sample ≥50, were included. Figure 1 illustrates the study flow. Rate data were available in 15 papers and were requested from 101 authors 41 (41%) of whom provided this. In some instances, anonymised patient-level data were provided with an unexplained discrepancy between the number of participants reported in the paper and those included in the data set. Authors were contacted once to resolve this. Failing this studies were included if the discrepancy was ≤10% (and demographic data were estimated from the data set provided where possible). Three studies were excluded owing to a >10% unresolved discrepancy. Rate data were available for another four studies acquired during contact with authors, or whilst cross-checking included studies with PAID and DDS authors, or identified since the search was completed. The final number of included studies was 58 (one study reported on two distinct samples; s44 and s45), representing 17 667 participants. DD data were available for 16 659 of these participants. Table 1 comprises the reference list of included studies.

Publication bias

Funnel plot symmetry and a non-significant Egger's test suggested publication bias was unlikely ($p = 0.41$).

Characteristics of included studies

The characteristics of the included studies are summarised in Table 2. Studies were undertaken in 14 different countries, predominantly the USA ($n = 14$), the UK ($n = 11$) and the Netherlands ($n = 11$), and samples were largely derived in community settings ($n = 15$) and hospital diabetes clinics ($n = 35$). Thirty were intervention studies, two thirds of which were RCTs, whilst the remaining studies were observational (and all data were baseline except for one RCT; s19). Average participant characteristics were male 49% and mean age was 54.5 years. Where ethnicity was reported samples were predominantly Caucasian ($n = 11$) or African American/Black ($n = 6$). Type 2 and Type 1 diabetes were the sole populations in 33 and 11 studies, respectively, whilst the remainder of the samples were mixed. Of the mixed and Type 2 samples reporting this, on average 76% and 35% of participants were treated with insulin or other injectables, respectively. Most studies used the PAID ($n = 51$). One of these studies employed both the PAID and DDS (s27). To ensure that this study was not too heavily weighted in the meta-analysis only the PAID data were included to promote homogeneity in outcome. Hba1c ($n = 9$), depression ($n = 7$), DD ($n = 3$) and physical co-morbidity ($n = 1$) inclusion criteria were employed in 18 studies (one study employed both HbA1c and DD and another both DD and depression). Mean HbA1c was 7.8% (61.7 mmol/mol) and was ≥7.5% (58.5 mmol/mol) in 36 studies ($n = 51$). Levels of DD as measured via the PAID and DDS were 28.3 ($n = 43$; range 10.2–51.0) and 2.3 ($n = 5$; range 1.9–2.5), respectively.

Meta-analysis

The average proportion of elevated DD was 0.22 (95% CIs 0.19–0.26, $p < .001$). This was associated with a significant amount of heterogeneity ($Q(\mathrm{df} = 57) = 1456.7$, $p < 0.001$; $\tau^2 = 0.51$), almost all of which reflected real differences between the studies rather than sampling error ($I^2 = 96.1\%$). The forest plot is illustrated in Figure 2.

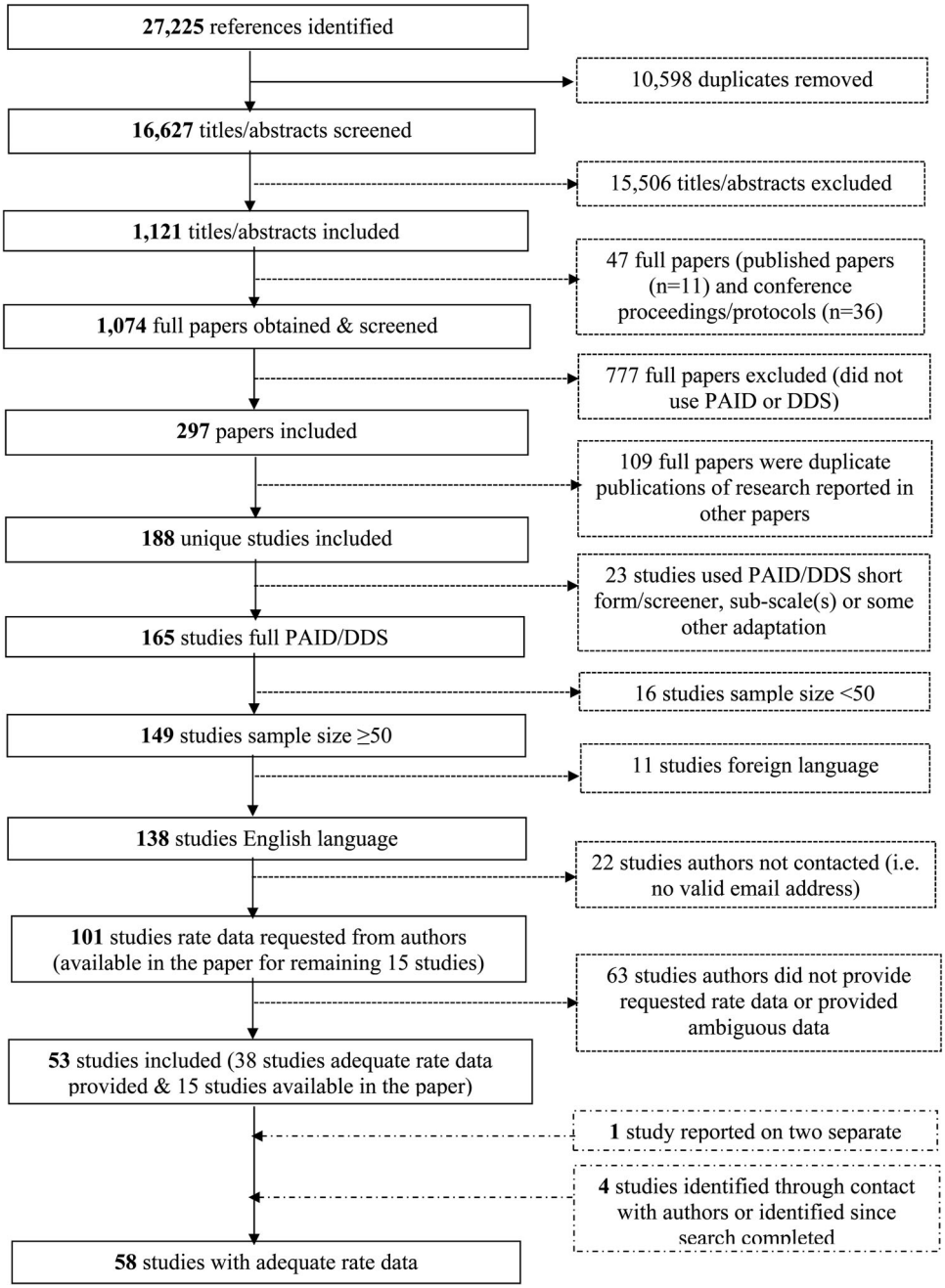

Figure 1 Flowchart of included studies.

Meta-regression

Age was associated with all of the other variables; gender ($r = 0.3$, $p = 0.03$), HbA1c ($r = -0.5$, $p < 0.001$) and health care context ($t(46.18) = -3.7$, $p = 0.001$) whilst none of the other variables were related ($p > 0.05$). The results from the meta-regression analyses are presented in Table 3. In the univariate analyses gender, age and healthcare context were significantly prognostic ($p < 0.05$), whilst HbA1c was not ($p > 0.05$). The multivariate model was significant (QM (df = 4) = 21.6, $p = <0.001$) but only 10% of the heterogeneity in study estimates was accounted for. Only gender and healthcare context emerged as significantly prognostic ($p < 0.05$). Significant heterogeneity remained (QE(df = 39) = 924.5, $p < 0.001$; $\tau^2 = 0.49$), almost all of which reflected real differences between the studies ($I^2 = 95.8\%$).

Sensitivity analysis

The observed estimate was not apparently influenced by variation in the measures of DD employed; the proportion of elevated DD based on samples utilising the PAID was 0.23 (95% CIs 0.19–0.26, $p < 0.001$) and this was still associated with substantial heterogeneity (Q(df = 50) = 1207.8, $p < 0.001$, $\tau^2 = 0.51$; $I^2 = 95.9\%$). Imputation of missing data largely generated the same conclusions (QM(df = 4)

Table 1 Reference list of included studies.

s1	Shibayama 2007	Shibayama T, Kobayashi K, Takano A, Kadowaki T, Kazuma K. Effectiveness of lifestyle counseling by certified expert nurse of Japan for non-insulin-treated diabetic outpatients: a 1-year randomized controlled trial. Diabetes Res Clin Pract. 2007;76(2):265–68
s2	Rosenbek Minet 2011	Rosenbek Minet LK, Wagner L, Lonvig EM, Hjelmborg J, Henriksen JE. The effect of motivational interviewing on glycaemic control and perceived competence of diabetes self-management in patients with type 1 and type 2 diabetes mellitus after attending a group education programme: a randomised controlled trial. Diabetologia. 2011;54(7):1620–29
s3	Rygg 2012	Rygg LO, Rise MB, Gronning K, Steinsbekk A. Efficacy of ongoing group based diabetes self-management education for patients with type 2 diabetes mellitus. A randomised controlled trial. Patient Educ Couns. 2012;86(1):98–105
s4	Tang 2008	Tang TS, Brown MB, Funnell MM, Anderson RM. Social support, quality of life, and self-care behaviors among African Americans with type 2 diabetes. Diabetes Educ. 2008;34(2):266–76
s5	Sigurdardottir 2009	Sigurdardottir AK, Benediktsson R, Jonsdottir H. Instruments to tailor care of people with type 2 diabetes. J Adv Nurs. 2009; 65(10): 2118–30
s6	Snoek 2011	Snoek FJ, Kersch NY, Eldrup E, Harman-Boehm I, Hermanns N, Kokoszka A, et al. Monitoring of Individual Needs in Diabetes (MIND): baseline data from the Cross-National Diabetes Attitudes, Wishes, and Needs (DAWN) MIND study. Diabetes Care. 2011;34(3):601–3
s7	Byrne 2012	Byrne M, Newell J, Coffey N, MC OH, Cooke D, Dinneen SF. Predictors of quality of life gains among people with type 1 diabetes participating in the Dose Adjustment for Normal Eating (DAFNE) structured education programme. Diabetes Res Clin Pract. 2012;98(2):243–48
s8	Chawla 2010	Chawla A, Saha C, Marrero DG. A novel application of the Problem Areas in Diabetes (PAID) instrument to improve glycemic control and patient satisfaction. Diabetes Educ. 2010;36(2):337–44
s9	Due-Christensen 2012	Due-Christensen M, Zoffmann V, Hommel E, Lau M. Can sharing experiences in groups reduce the burden of living with diabetes, regardless of glycaemic control? Diabet Med. 2012;29(2):251–56
s10	Engel 2011	Engel L, Cummins R. Impact of dose adjustment for normal eating in Australia (OzDAFNE) on subjective wellbeing, coping resources and negative affects in adults with type 1 diabetes: a prospective comparison study. Diabetes Res Clin Pract. 2011;91(3):271–79
s11	Fisher 2011	Fisher L, Polonsky W, Parkin CG, Jelsovsky Z, Amstutz L, Wagner RS. The impact of blood glucose monitoring on depression and distress in insulin-naive patients with type 2 diabetes. Curr Med Res Opin. 2011;27(Suppl. 3):39–46
s12	Heinrich 2010	Heinrich E, Candel MJ, Schaper NC, de Vries NK. Effect evaluation of a Motivational Interviewing based counselling strategy in diabetes care. Diabetes Res Clin Pract. 2010;90(3):270–78
s13	Hermanns 2009	Hermanns N, Kulzer B, Gulde C, Eberle H, Pradler E, Patzelt-Bath A, et al. Short-term effects on patient satisfaction of continuous glucose monitoring with the GlucoDay with real-time and retrospective access to glucose values: a crossover study. Diabetes Technol Ther. 2009;11(5):275–81
s14	Hermanns 2012	Hermanns N, Kulzer B, Maier B, Mahr M, Haak T. The effect of an education programme (MEDIAS 2 ICT) involving intensive insulin treatment for people with type 2 diabetes. Patient Educ Couns. 2012;86(2):226–32
s15	Hopkins 2012	Hopkins D, Lawrence I, Mansell P, Thompson G, Amiel S, Campbell M, et al. Improved biomedical and psychological outcomes 1 year after structured education in flexible insulin therapy for people with type 1 diabetes: the U.K. DAFNE experience. Diabetes Care. 2012;35(8):1638–42
s16	Keen 2012	Keen AJ, Duncan E, McKillop-Smith A, Evans ND, Gold AE. Dose Adjustment for Normal Eating (DAFNE) in routine clinical practice: who benefits? Diabet Med. 2012;29(5):670–76
s17	Keers 2005	Keers JC, Groen H, Sluiter WJ, Bouma J, Links TP. Cost and benefits of a multidisciplinary intensive diabetes education programme. J Eval Clin Pract. 2005;11(3):293–303
s18	Sturt 2008	Sturt JA, Whitlock S, Fox C, Hearnshaw H, Farmer AJ, Wakelin M, et al. Effects of the Diabetes Manual 1:1 structured education in primary care. Diabet Med. 2008;25(6):722–31
s19	Khunti 2012	Khunti K, Gray LJ, Skinner T, Carey ME, Realf K, Dallosso H, et al. Effectiveness of a diabetes education and self management programme (DESMOND) for people with newly diagnosed type 2 diabetes mellitus: three year follow-up of a cluster randomised controlled trial in primary care. BMJ 2012;344
s20	van Bastelaar 2010	van Bastelaar KM, Pouwer F, Geelhoed-Duijvestijn PH, Tack CJ, Bazelmans E, Beekman AT, et al. Diabetes-specific emotional distress mediates the association between depressive symptoms and glycaemic control in Type 1 and Type 2 diabetes. Diabet Med. 2010;27(7):798–803
s21	van Bastelaar 2012	van Bastelaar KM, Pouwer F, Cuijpers P, Riper H, Twisk JW, Snoek FJ. Is a severe clinical profile an effect modifier in a Web-based depression treatment for adults with type 1 or type 2 diabetes? Secondary analyses from a randomized controlled trial. J Med Internet Res. 2012;14(1):e2
s22	Fisher 2013	Fisher L, Hessler D, Glasgow RE, Arean PA, Masharani U, Naranjo D, et al. REDEEM: a pragmatic trial to reduce diabetes distress. Diabetes Care. 2013;36(9):2551–58
s23	Malanda 2015	Malanda UL, Bot SD, Kostense PJ, Snoek FJ, Dekker JM, Nijpels G. Effects of self-monitoring of glucose on distress and self-efficacy in people with non-insulin-treated Type 2 diabetes: a randomized controlled trial. Diabetes Med. 2016;3(4):537–46
s24	Pibernik-Okanovic 2015	Pibernik-Okanovic M, Hermanns N, Ajdukovic D, Kos J, Prasek M, Sekerija M, et al. Does treatment of subsyndromal depression improve depression-related and diabetes-related outcomes? A randomised controlled comparison of psychoeducation, physical exercise and enhanced treatment as usual. Trials. 2015;16:305
s25	Elliott 2012	Elliott J, Heller SR, Hopkinson HE, Mansell P. Does duration of type 1 diabetes affect the outcomes of structured education? In: 48th Annual Meeting of the European Association for the Study of Diabetes (EASD) 2012, Berlin, Germany, p. 225
s26	Archer 2012	Archer A, Cooper T, Marks S, Ackroyd K, Wan M, Bullock B, et al. Reflection: a benchmark for future audits of counselling services for people with diabetes. In: Diabetes UK Professional Conference 2012, Glasgow, United Kingdom, p. 158
s27	Hermanns 2015	Hermanns N, Schmitt A, Gahr A, Herder C, Nowotny B, Roden M, et al. The effect of a Diabetes-Specific Cognitive Behavioral Treatment Program (DIAMOS) for patients with diabetes and subclinical depression: results of a randomized controlled trial. Diabetes Care. 2015;38(4):551–60
s28	Lindsay 2011	Lindsay G, Inverarity K, McDowell JR. Quality of life in people with type 2 diabetes in relation to deprivation, gender, and age in a new community-based model of care. Nurs Res Pract 2011;2011:613589

Continued

Table 1 Continued

s29	Van Dijk de Vries 2015	van Dijk-de Vries A, van Bokhoven MA, Winkens B, Terluin B, Knottnerus JA, van der Weijden T, et al. Lessons learnt from a cluster-randomised trial evaluating the effectiveness of Self-Management Support (SMS) delivered by practice nurses in routine diabetes care. BMJ Open. 2015;5(6):e007014
s30	Stoop 2014	Stoop CH, Nefs G, Pop VJ, Wijnands-van Gent CJ, Tack CJ, Geelhoed-Duijvestijn PH, et al. Diabetes-specific emotional distress in people with Type 2 diabetes: a comparison between primary and secondary care. Diabet Med. 2014;31(10):1252–59
s31	Karlsen 2012	Karlsen B, Oftedal B, Bru E. The relationship between clinical indicators, coping styles, perceived support and diabetes-related distress among adults with type 2 diabetes. J Adv Nurs. 2012;68(2):391–401
s32	Miller 2008	Miller ST, Elasy TA. Psychometric evaluation of the Problem Areas in Diabetes (PAID) survey in Southern, rural African American women with Type 2 diabetes. BMC Public Health 2008;8:70
s33	Fisher 2008	Fisher L, Skaff MM, Mullan JT, Arean P, Glasgow R, Masharani U. A longitudinal study of affective and anxiety disorders, depressive affect and diabetes distress in adults with Type 2 diabetes. Diabet Med 2008;25(9):1096–101
s34	Lehmann 2011	Lehmann V, Makine C, Karsidag C, Kadioglu P, Karsidag K, Pouwer F. Validation of the Turkish version of the centre for epidemiologic studies depression scale (ces-d) in patients with type 2 diabetes mellitus. BMC Med Res Methodol. 2011;11:109
s35	Fleer 2013	Fleer J, Tovote KA, Keers JC, Links TP, Sanderman R, Coyne JC, et al. Screening for depression and diabetes-related distress in a diabetes outpatient clinic. Diabet Med. 2013;30(1):88–94
s36	Fritschi 2012	Fritschi C, Quinn L, Hacker ED, Penckofer SM, Wang E, Foreman M, et al. Fatigue in women with type 2 diabetes. Diabetes Educ. 2012;38(5):662–72
s37	Kokoszka 2009	Kokoszka A, Pouwer F, Jodko A, Radzio R, Mucko P, Bienkowska J, et al. Serious diabetes-specific emotional problems in patients with type 2 diabetes who have different levels of comorbid depression: a Polish study from the European Depression in Diabetes (EDID) Research Consortium. Eur Psychiatry. 2009;24(7):425–30
s38	Nichols 2000	Nichols GA, Hillier TA, Javor K, Brown JB. Predictors of glycemic control in insulin-using adults with type 2 diabetes. Diabetes Care. 2000;23(3):273–7
s39	Hermanns 2006	Hermanns N, Kulzer B, Krichbaum M, Kubiak T, Haak T. How to screen for depression and emotional problems in patients with diabetes: comparison of screening characteristics of depression questionnaires, measurement of diabetes-specific emotional problems and standard clinical assessment. Diabetologia. 2006;49(3):469–77
s40	Hermanns 2010	Hermanns N, Mahr M, Kulzer B, Skovlund SE, Haak T. Barriers towards insulin therapy in type 2 diabetic patients: results of an observational longitudinal study. Health Qual Life Out. 2010;8:113
s41	Nozaki 2009	Nozaki T, Morita C, Matsubayashi S, Ishido K, Yokoyama H, Kawai K, et al. Relation between psychosocial variables and the glycemic control of patients with type 2 diabetes: a cross-sectional and prospective study. Biopsychosoc Med. 2009;3:4
s42	Wagner 2010	Wagner JA, Tennen H, Osborn CY. Lifetime depression and diabetes self-management in women with Type 2 diabetes: a case-control study. Diabet Med. 2010;27(6):713–7
s43	Duda-Sobczak 2012	Duda-Sobczak A, Zozulinska-Ziolkiewicz D, Wierusz-Wysocka B. The assessment of factors determining fatigue in subjects with long history of type 1 diabetes. In: 48th Annual Meeting of the European Association for the Study of Diabetes (EASD) 2012, Berlin, Germany, p. 971
s44	Ikeda 2014 JAPAN sample	Ikeda K, Fujimoto S, Morling B, Ayano-Takahara S, Carroll AE, Harashima S, et al. Social orientation and diabetes-related distress in Japanese and American patients with type 2 diabetes. PloS One. 2014;9(10):e109323
s45	Ikeda 2014 USA sample	Ikeda K, Fujimoto S, Morling B, Ayano-Takahara S, Carroll AE, Harashima S, et al. Social orientation and diabetes-related distress in Japanese and American patients with type 2 diabetes. PloS One 2014;9(10):e109323
s46	Joensen 2013	Joensen LE, Almdal TP, Willaing I. Type 1 diabetes and living without a partner: psychological and social aspects, self-management behaviour, and glycaemic control. Diabetes Res Clin Pract. 2013;101(3):278–85
s47	Sheils 2012	Sheils E, Knott J, Cavan D, Shaban C. Fear of hypoglycaemia: Is there an association with glycaemic control, hypoglycaemic symptoms and diabetes emotional distress in people with Type 1 diabetes? In: Diabetes UK Professional Conference, 2012, Glasgow, United Kingdom, p. 157
s48	Crosby-Nwaobi 2013	Crosby-Nwaobi RR, Sivaprasad S, Amiel S, Forbes A. The relationship between diabetic retinopathy and cognitive impairment. Diabetes Care 2013;36(10):3177–86
s49	Baek 2014	Baek RN, Tanenbaum ML, Gonzalez JS. Diabetes burden and diabetes distress: The buffering effect of social support. Ann Behav Med. 2014;48(2):145–55
s50	Aikens 2012	Aikens JE. Prospective associations between emotional distress and poor outcomes in type 2 diabetes. Diabetes Care. 2012;35(12):2472–78
s51	Keers 2004	Keers JC, Links TP, Bouma J, Gans RO, ter Maaten JC, Wolffenbuttel BH, et al. Do diabetologists recognise self-management problems in their patients? Diabetes Res Clin Pract. 2004;66(2):157–61
s52	Bot 2010	Bot M, Pouwer F, Ormel J, Slaets JP, de Jonge P. Predictors of incident major depression in diabetic outpatients with subthreshold depression. Diabet Med. 2010;27(11):1295–301
s53	Pouwer 2006	Pouwer F, Beekman AT, Lubach C, Snoek FJ. Nurses' recognition and registration of depression, anxiety and diabetes-specific emotional problems in outpatients with diabetes mellitus. Patient Educ Couns. 2006;60(2):235–40
s54	Sigurdardottir 2008	Sigurdardottir AK, Benediktsson R. Reliability and validity of the Icelandic version of the Problem Area in Diabetes (PAID) Scale. Int J Nurs Stud. 2008;45(4):526–33
s55	Aikens 2014	Aikens JE, Zivin K, Trivedi R, Piette JD. Diabetes self-management support using mHealth and enhanced informal caregiving. J Diabetes Complications. 2014;28(2):171–76
s56	Lange 2013	Lange K, Matthaei S, Lueg A, Lutze B, Roelver KM, on behalf of the Diabetesakademie Niedersachsen e. V. VNDN Versorgungsforschung. Life chances ("Lebenschancen") of young adults with onset of type 1 diabetes during childhood. Pediatr Diabetes. 2013;14(Suppl. 18):35
s57	Hearnshaw 2007	Hearnshaw H, Wright K, Dale J, Sturt J, Vermeire E, van Royen P. Development and validation of the Diabetes Obstacles Questionnaire (DOQ) to assess obstacles in living with Type 2 diabetes. Diabet Med. 2007;24(8):878–82
s58	Grant 2005	Grant RW, Cagliero E, Chueh HC, Meigs JB. Internet use among primary care patients with Type 2 diabetes. J Gen Intern Med. 2005;20(5):470–73

Table 2 Characteristics of included studies.

Author Country	Initial sample size	Healthcare context (study design)	Diabetes type	DD inclusion criteria?	Depression inclusion criteria?	High HbA1c inclusion criteria?	Physical co-morbidity inclusion criteria?	DD (mean (SD)	HbA1c (% mean (SD) (mmol/mol)	Age (mean (SD)	Gender (*N*/% male)	Predominant ethnicity	*N*/ %insulin/ other injectables	Rate of DD (DD cases/ available DD data)
s1 Shibayama 2007[a] Japan	134	Diabetes clinic (I/ RCT)	T2	N	N	Y	N	36.5 (NR)	7.4 (.75) (57.4)	61.5 (7.5)	87/134 (64.9%)	NR	None	55/131 (42.0%)
s2 Rosenbek Minet 2011 Denmark	349	Diabetes clinic (I/ RCT)	T1/2	N	N	N	N	19.8 (17.0)	7.0 (1.2) (53)	56.4 (12.1)	176/349 (50%)	NR	134/349 (38%)	41/349 (11.7%)
s3 Rygg 2012 Norway	146	Primary care (I/ RCT)	T2	N	N	N	N	20.2 (16.4)	7.0 (1.4) (53)	66 (NR)	80/146 (55%)	All Caucasian	26/146 (18%)	17/146 (11.6%)
s4 Tang 2008[a] USA	89	Community (I/ non-RCT)	T2	N	N	N	N	32.4 (16)	NR	60.0 (10.5)	29/89 (33%)	All African American	NR	12/82 (14.6%)
s5 Sigurdardottir 2009[a] Iceland	58 (demographics for no. analysed; 53)	Diabetes clinic and primary care (I/RCT)	T2	N	N	Y	N	20.2 (15.0)	8.0 (.93) (63.9)	60.5 (10.5)	36/53 (68%)	NR	16/53 (30%)	13/52 (25.0%)
s6 Snoek 2011 Croatia, Denmark, Germany, Ireland, Israel, Netherlands, Poland and UK	1567	Diabetes clinic (I/ non-RCT)	T1/2	Y	Y	N	N	23.1 (18.8)	7.9 (1.4) (62.8)	54.2 (14.8)	814/1567 (52%)	NR	NR	297/1567 (18.9%)
s7 Byrne 2012[a] UK	437	Diabetes clinic (I/ RCT)	T1	N	N	Y	N	29.9 (19.0)	NR	40.8 (11.7)	202/437 (46%)	NR	All	129/423 (30.5%)
s8 Chawla 2010[a] USA	62 (demographics for 61 included in analysis)	Primary care (I/ non-RCT)	T1/2	N	N	N	N	16.0 (13.2)	7.7 (1.5) (60.7)	60.8 (NR)	30/61 (49%)	All Caucasian	NR	4/61 (6.6%)
s9 Due-Christensen 2012 Denmark	54	Diabetes clinic (I/ non-RCT)	T1	N	N	N	N	37.4 (16.16)	8.2 (1.3) (66.1)	43.8 (10.5)	11/54 (20%)	NR	All	29/54 (53.7%)
s10 Engel 2011[b] Australia	648 (MDI&CSII groups at baseline – demographics for n providing data on that variable)	Diabetes clinic (I/ non-RCT)	T1	N	N	N	N	29.6 (21.2)	7.6 (1.2) (59.6)	48.8 (14.7)	265/636 (42%)	NR (Australian (81.5%)	All	172/594 (28.9%)
s11 Fisher 2011 USA	483	Primary care (I/ RCT)	T2	N	N	Y	N	2.33 (0.94)	8.9 (1.2) (73.8)	55.8 (10.7)	257/483 (53%)	Caucasian (63.1%)	NR	123/483 (26.2%)
s12 Heinrich 2010[a] Netherlands	584 (demographics for 537 completing baseline questionnaire/ 570 providing clinical data)	Primary care (I/ RCT)	T2	N	N	N	N	16.9 (13.6)	6.5 (.80) (47.5)	59 (5.3)	269/584 (46%)	NR	NR	37/533 (7.0%)
s13 Hermanns 2009[a] Germany	50	Diabetes clinic (I/ RCT)	T1	N	N	N	N	30.7 (18.8)	8.1 (1.5) (65.0)	41.7 (12.3)	26/50 (52%)	NR	All	14/49 (28.0%)

Continued

Table 2 Continued

Author Country	Initial sample size	Healthcare context (study design)	Diabetes type	DD inclusion criteria?	Depression inclusion criteria?	High HbA1c inclusion criteria?	Physical co-morbidity inclusion criteria?	DD (mean (SD)	HbA1c (% mean (SD) (mmol/mol)	Age (mean (SD)	Gender (*N*/% male)	Predominant ethnicity	*N*/ %insulin/ other injectables	Rate of DD (DD cases/ available DD data)
s14 Hermanns 2012 Germany	186 (demographics for 167 included in per protocol analysis)	Diabetes clinic (I/ RCT)	T2	N	N	N	N	50.0 (9.7)	8.3 (1.3) (67.2)	63.5 (7.9)	92/167 (55%)	NR	All	31/167 (18.6%)
s15 Hopkins 2012[b] UK	639 (with at least some pre AND post data)	Diabetes clinic (I/ non-RCT)	T1	N	N	N	N	25.2 (17.4)	8.7 (1.6) (71.6)	38.8 (12.8)	NR	NR	All	103/484 (21.2%)
s16 Keen 2012 UK	124 (completing DAFNE course with pre and post data)	Diabetes clinic (I/ non-RCT)	T1	N	N	Y	N	NR	8.6 (1.4) (70.5)	42.5 (11.1)	51/124 (41%)	NR	All	21/124 (16.9%)
s17 Keers 2005[a] Netherlands	69 (with at least some pre and post data)	Diabetes clinic (I/ non-RCT)	T1/2	Y	N	Y	N	38.0 (22.0)	8.5 (1.3) (69.4)	44.0 (13.0)	34/69 (49.3%)	NR	NR	27/56 (48.0%)
s18 Sturt 2008[b] UK	245	Primary care (I/ RCT)	T2	N	N	Y	N	18.7 (15.6)	8.8 (1.5) (72.7)	62.0 (NR)	148/245 (60%)	Caucasian (79.2%)	NR	26/216 (12.0%)
s19 Khunti 2012[b] UK	824 (demographics for 604 providing clinical data and 536 completing questionnaires)	Primary care (I/ RCT)	T2	N	N	N	N	NR	8.0 (2.1) (63.9)	60.1 (11.8)	271/604 (55%)	Caucasian (97.1%)	17/604 (28%)	35/461 (7.6%)
s20 van Bastelaar 2010 Netherlands	1012 (demographics for 627 with complete data)	Diabetes clinic (I/ RCT)	T1/2	N	Y	N	N	20.0 (18.0)	7.8 (1.3) (61.7)	53.0 (15.0)	313/627 (50%)	NR ('Native Dutch' (90%)	571/627 (91%)	93/627 (15.0%)
s21 van Bastelaar 2012 Netherlands and Belgium	255	Community (I/ RCT)	T1/2	N	Y	N	N	40.0 (19.0)	7.4 (1.3) (57.4)	50.0 (12.0)	100/255 (39%)	Caucasian (89%)	183/255 (72%)	127/255 (49.8%)
s22 Fisher 2013 USA	392 (with pre and post data)	Diabetes clinic and community (I/ RCT)	T2	Y	N	N	N	2.4 (0.9)	7.4 (1.61) (57.4)	56.1 (9.6)	181/392 (46%)	Caucasian (40.1%)	70/392 (18%)	95/392 (24.2%)
s23 Malanda 2015[a] Netherlands	181	Diabetes clinic (I/ RCT)	T2	N	N	Y	N	10.2 (7.2)	7.6 (0.8) (59.6)	61.5 (7.8)	120/181 (66%)	NR	None	7/173 (4.0%)
s24 Pibernik-Okanovic 2015[a] Croatia	209	Diabetes clinic (I/ RCT)	T2	N	Y	N	N	39.8 (19.9)	7.3 (1.1) (56.3)	58.1 (5.8)	96/209 (46%)	NR	93/209 (44%)	101/208 (48.5%)
s25 Elliott 2012[b] UK	479	Diabetes clinic (I/ non-RCT)	T1	N	N	N	N	29.1 (20.2)	8.7 (1.5) (71.6)	41.2 (13.9)	230/479 (48%)	NR	All	112/357 (31.0%)
s26 Archer 2012 UK	99	Diabetes clinic (I/ non-RCT)	T1/2	NR	NR	NR	NR	37.4 (18.6)	NR	44.3 (13.2)	63/96 (64%)	NR	73/99 (74%)	46/99 (46.5%)
s27 Hermanns 2015[a] Germany	214	Diabetes clinic (I/ RCT)	T1/2	N	Y	N	N	38.6 (18.3)	8.9 (1.8) (73.8)	43.3 (14.3)	93/214 (44%)	NR	NR	104/208 (50.0%)
s28 Lindsay 2011[a] UK	136	Diabetes registry (I/non-RCT)	T2	N	N	N	N	13.0 (NR)	NR	65.4 (12.0)	81/136 (59%)	NR (Asian 6%)	NR	18/131 (13.7%)

s29 Van Dijk de Vries 2015[a] Netherlands	264	Diabetes clinic (I/RCT)	T2	N	N	N	N	29.3 (18.3)	6.9 (NR) (52.3)	64.6 (9.5)	142/264 (54%)	NR (Non-Western .8%)	60/264 (23%)	64/257 (24.9%)
s30 Stoop 2014 Netherlands	774	Primary care (I/RCT)	T2	N	N	N	N	3.0 (NR)	6.6 (NR) (48.6)	68.0 (NR)	439/774 (57%)	NR (Ethnic Minority Groups 1%)	123/757 (16%)	29/774 (3.7%)
s31 Karlsen 2012 Norway	425 (demographics for 378 completing questionnaire adequately)	Primary care and community (CS)	T2	N	N	N	N	26.0 (18.0)	7.1 (1.1) (54.1)	58.1 (8.7)	205/378 (54%)	NR	108/378 (29%)	84/378 (22.2%)
s32 Miller 2008 USA	160 (demographics for 131 that 'completed the study')	Community (CS)	T2	N	N	N	N	34.6 (23)	9.0 (2.4) (74.9)	39.4 (8.2)	All female	All African American	47/131 (37%)	52/131 (40.0%)
s33 Fisher 2008 USA	506	Diabetes clinic (L)	T2	N	N	N	N	NR	NR	57.8 (9.9)	218/506 (43%)	Caucasian (36.7%)	76/506 (15%)	91/506 (18.0%)
s34 Lehmann 2011 Turkey	154 (most demographics for 151 included on analysis)	Diabetes clinic (CS)	T2	N	N	N	N	26.8 (18.7)	6.7 (1.0) (49.7)	56.0 (10.0)	69/151 (46%)	NR	None	40/151 (26.5%)
s35 Fleer 2013[a] Netherlands	347	Diabetes clinic (L)	T1/2	N	N	N	N	NR	7.8 (1.4) (61.7)	50.4 (13.2)	181/347 (52.2%)	NR	313/347 (91%)	34/346 (9.8%)
s36 Fritschi 2012 USA	83	Diabetes clinic (CS)	T2	N	N	N	N	2.5 (1.0)	7.4 (1.9) (57.4)	53.0 (6.5)	All female	Black (42.2%)	12/83 (14%)	27/83 (32.5%)
s37 Kokoszka 2009 Poland	101	Diabetes clinic (CS)	T2	N	N	N	N	27.5 (18.4)	8.1 (1.8) (65.0)	63.2 (10.7)	51/101 (50%)	NR	67/101 (66%)	25/101 (24.8%)
s38 Nichols 2000[b] USA	1178	Diabetes registry (CS)	T2	N	N	N	N	NR	7.9 (1.4) (62.8)	65.6 (NR)	NR	NR	All	477/1033 (46.2%)
s39 Hermanns 2006 Germany	376	Diabetes clinic (CS)	T1/2	N	N	N	N	30.6 (18.1)	8.5 (1.6) (69.4)	52.2 (14.3)	228/376 (61%)	NR	286/376 (76%)	116/376 (30.9%)
s40 Hermanns 2010 Germany	130	Diabetes clinic (L)	T2	N	N	Y	N	30.0 (16.7)	8.7 (1.6) (71.6)	55.8 (8.8)	85/130 (65%)	NR	57/130 (44%)	39/130 (30.0%)
s41 Nozaki 2009 Japan	304	Diabetes clinic (L)	T2	N	N	N	N	33.0 (21.0)	7.3 (1.2) (56.3)	61.9 (11.0)	170/304 (56%)	NR	NR	107/304 (35.2%)
s42 Wagner 2010[a] USA	153	Primary care and community (L)	T2	N	Y	N	N	51.0 (24.1)	6.7 (1.2) (49.7)	60.1 (9.7)	All female	NR	26/153 (17%)	75/140 (53.6%)
s43 Duda-Sobczak 2012[b] Poland	213	NR (CS)	T1	NR	NR	NR	NR	NR	8.2 (1.4) (66.1)	26.6 (6.0)	97/213 (46%)	NR	All	43/165 (26.1%)
s44 Ikeda 2014[a] Japan	152 (demographics reported for 149 included in analysis)	Diabetes clinic (CS)	T2	N	N	N	N	29.8 (18.7)	7.6 (1.2) (59.6)	60.6 (8.6)	91/149 (61%)	All Japanese	46/149 (31%)	52/152 (34.2%)
s45 Ikeda 2014[a] USA	64 (demographics reported for 50 included in analysis)	NR (CS)	T2	N	N	N	N	24.9 (23.1)	7.6 (1.6) (59.6)	60.0 (10.1)	25/50 (50%)	NR (All Euro–Americans)	23/50 (46%)	14/51 (27.5%)
s46 Joensen 2013[b] Denmark	2419	Diabetes clinic (CS)	T1	N	N	N	N	1.9 (NR)	8.1 (NR) (65)	51.6 (NR)	1258/ 2419 (52%)	NR	All	225/2295 (9.8%)

Continued

Table 2 Continued

Author Country	Initial sample size	Healthcare context (study design)	Diabetes type	DD inclusion criteria?	Depression inclusion criteria?	High HbA1c inclusion criteria?	Physical co-morbidity inclusion criteria?	DD (mean (SD)	HbA1c (% mean (SD) (mmol/mol)	Age (mean (SD)	Gender (*N*/% male)	Predominant ethnicity	*N*/ %insulin/ other injectables	Rate of DD (DD cases/ available DD data)
s47 Sheils 2012 UK	124 (demographics for 108 with complete PAID data)	Diabetes clinic (CS)	T1	N	N	N	N	20.7 (17.5)	8.8 (1.5) (72.7)	44 (12.9)	49/108 (45%)	NR	All	18/108 (16.6%)
s48 Crosby-Nwaobi 2013[a] UK	380	Primary care (CS)	T2	N	N	N	Y	NR	8.3 (1.9) (67.2)	64.8 (10.8)	214/380 (56%)	Black (50.4%)	193/380 (51%)	10/374 (2.7%)
s49 Baek 2014 USA	119	Diabetes clinic, primary care and previous research study (CS)	T2	N	N	N	N	2.3 (1.2)	7.9 (1.9) (62.8)	56.3 (9.7)	43/119 (36%)	Black or African American (61.4%)	49/119 (41%)	33/119 (27.7%)
s50 Aikens 2012[b] USA	287 (demographics for 253 providing baseline data)	Diabetes registry (L)	T2	N	N	N	N	22.1 (19.0)	7.6 (1.6) (59.6)	57.3 (8.3)	127/253 (50%)	African American (55%)	101/253 (40%)	53/253 (21.0%)
s51 Keers 2004 Netherlands	315	Diabetes clinic and patients attending education programme (CS)	T1/2	NR	NR	NR	N	30.0 (19.8)	8.1 (1.2) (65.0)	46.4 (13.1)	147/315 (46.7%)	NR	NR	98/315 (31.1%)
s52 Bot 2010[b] Netherlands	114	Diabetes clinic (L)	T1/2	N	Y	N	N	29.4 (10.9)	7.5 (1.1) (58.5)	65.3 (8.2)	62/114 (54%)	NR	NR	22/75 (29.3%)
s53 Pouwer 2006[b] Netherlands	112	Diabetes clinic/ previous research study (CS)	T1/2	N	N	N	N	44.0 (22.0)	7.8 (1.2) (61.7)	52.0 (18.0)	61/112 (54%)	NR	104/112 (93%)	22/89 (24.7%)
s54 Sigurdardottir 2008[a] Iceland	92 (demographics for 90 completing questionnaires)	Diabetes clinic (CS)	T1/2	N	N	N	N	27.9 (18.1)	7.7 (1.41) (60.7)	38.1 (11.1)	48/90 (53%)	NR	All	19/85 (22.4%)
s55 Aikens 2014[a] USA	303	Diabetes clinic (L)	T2	N	N	N	N	16.4 (16.4)	NR	66.6 (9.8)	294/303 (97%)	Caucasian (92.9%)	NR	24/300 (8.0%)
s56 Lange 2013 Germany	306	Diabetes clinic (CS)	T1	N	N	N	N	26.8 (20.0)	8.3 (1.6) (67.2)	24.1 (3.5)	162/306 (53%)	NR	All	77/306 (25.0%)
s57 Hearnshaw 2007[b] UK	180 (demographics for 176 completing questionnaires)	Primary care (CS)	T2	N	N	N	N	NR	NR	62.2 (10.4)	89/176 (51%)	Caucasian (91%)	NR	24/136 (17.6%)
s58 Grant 2005[b] USA	909 (Type 2 sample) – demographics for 896 classifiable re: internet use)	Primary care (CS)	T2	N	N	N	N	NR	7.4 (1.4) (57.4)	66.2 (12.4)	461/896 (51.5%)	Caucasian (82.7%)	NR	126/815 (15.5%)

NR: not reported; NA: not applicable; N: no; Y: yes.
I/RCT: randomised controlled trial; I/non-RCT: intervention study but not a randomised controlled trial; L: longitudinal observation study; CS: cross-sectional study.
[a]Difference between the number of participants for which elevated DD rate data was provided and those included in the study/for whom demographic data were reported.
[b]Substantial difference between the number of participants for which elevated DD rate data was provided and those included in the study/for whom demographic data were reported.

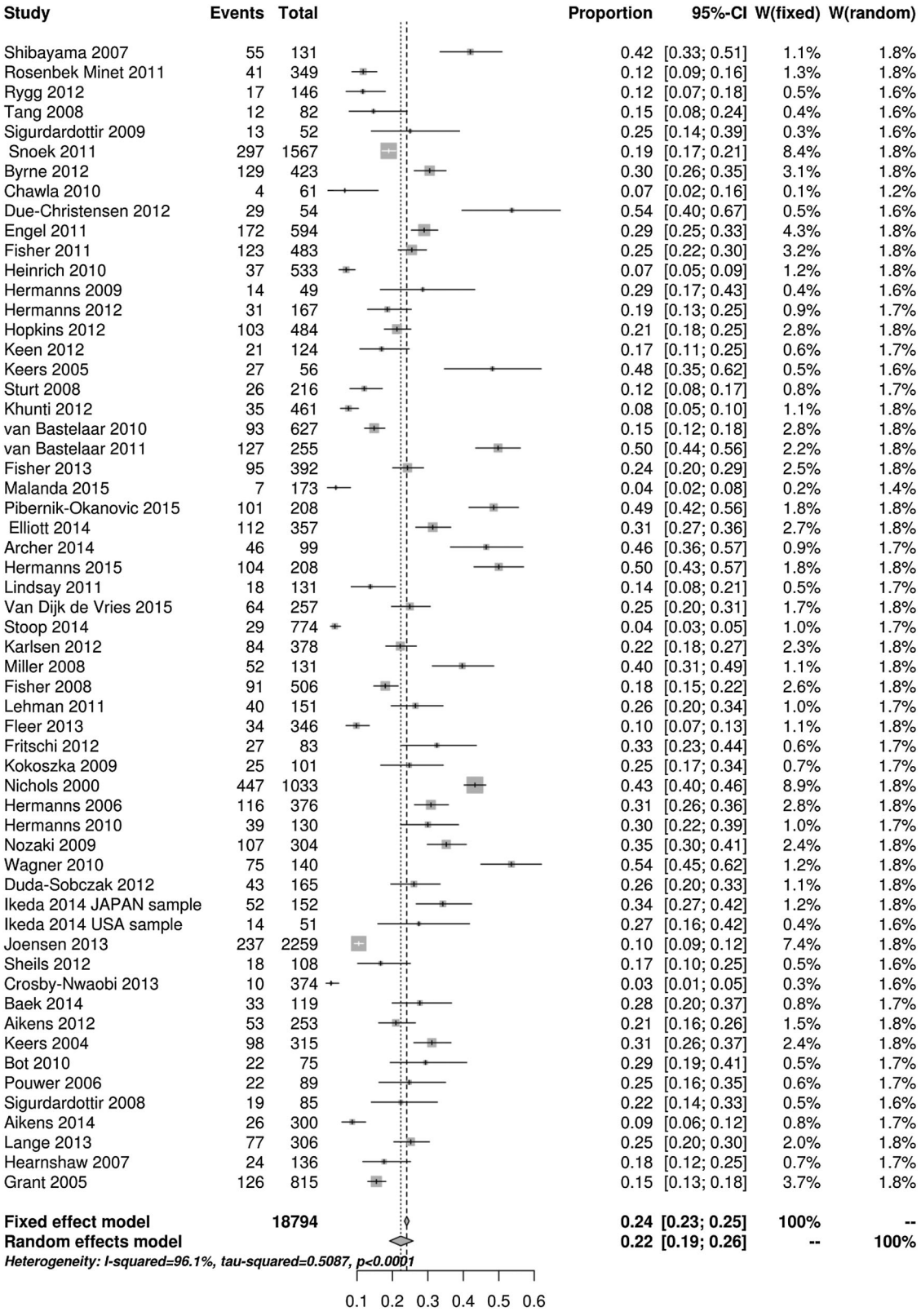

Figure 2 Forest plot illustrating the rate of elevated diabetes distress across all study populations.

= 4.64, $p = <0.001$; QE(df = 53) = 24.3, $p < 0.001$); gender ($\beta = -1.34$, 95% CIs −2.49 to −0.20, $p = 0.02$) remained within conventional significance levels in the multivariate meta-regression but health care context was reduced to marginal significance ($\beta = -0.35$, 95% CIs −0.73 to 0.02, $p = 0.07$). Age ($\beta = -0.01$, 95% CIs −0.03 to 0.01, $p = 0.31$) and HbA1c ($\beta = 0.04$, 95% CIs −0.24 to 0.31, $p = 0.79$) were again not significantly prognostic.

Conclusions

Summary of findings

We identified a substantial number of studies that included a measure of DD suggesting it to be a universally relevant phenomenon. On average one in every four people with diabetes has a level of DD likely to impact clinical outcomes. This estimate was apparently relatively precise. The estimated prevalence of diabetes amongst adults in England in 2015 was 2 913 538[34]; translating to almost 650 000 people with diabetes who may be experiencing elevated DD at any one time. In the univariate analysis, there were multiple significant predictors of elevated DD; younger age, female gender and secondary rather than primary care, but in a multivariate model only gender emerged as significant in both the complete case and multiple imputation analyses suggesting that gender may be the strongest and most consistent determinant. A 1% increase in the proportion of females in study samples was associated with at least a 1.3% higher rate of elevated DD. Healthcare context was reduced to marginal significance in the imputation analysis yet this is still a potentially important effect; p values reflect the strength of evidence against the null hypothesis and those falling slightly outside the arbitrary convention of $p < 0.05$ may still be of importance.[35] The rate of elevated DD does not appear to be sensitive to diabetes type or the measure of DD employed.

The observed estimate was associated with significant heterogeneity, though, with rates ranging from 3 to 54% and only 10% of this variance was explained by the covariates tested. There are likely other unexplored variables that would explain the rates of elevated DD observed. The average estimate should therefore be interpreted with caution and considered an initial indication of the potential rate of elevated DD in any particular population.

Our findings in relation to wider evidence

The potential rate of elevated DD observed is equivalent to depression in diabetes.[20,36] Elevated DD has been reported to be more prevalent in secondary than primary care[16] and levels of DD are consistently higher for women.[12,37–41] The latter is also consistent with systematic reviews of depression and anxiety in diabetes.[20,42] This association may be explained by increased mood reporting, albeit this has been contested,[43] or other unmeasured third variables; elevated rates of DD in women are at least partially underpinned by a known greater propensity for diabetes morbidity in women.[44,45] Younger age[12,46,47] has previously demonstrated an independent association with DD but this was not confirmed. Whilst gender, and to a far lesser extent healthcare context, emerged as the 'strongest' predictors of elevated DD, however, health care practitioners should consider that younger age was prognostic in the univariate analyses. Clinically, it is dangerous to conclude that these variables explain everything and ignore other such determinants. This is especially important given the multicollinearity between age and the other predictor variables and that this resulted in limited the statistical power for detecting individual effects. The previously demonstrated association between DD and HbA1c[4,5,39] was additionally not confirmed. This relationship is modest,[23,48] somewhat variable,[49,50] and influenced by study characteristics such as the measure of DD used; DD exhibits a stronger association with HbA1c when measured via the DDS rather than the PAID (which the majority of the included studies employed).[51] Equivalent rates of elevated DD by diabetes type, when measured via the PAID, have similarly been observed in primary studies.[51]

Strengths and limitations

Despite the now vast DD evidence base this is the first systematic attempt to identify the presence, potential magnitude and determinants of elevated DD and isolate candidate populations with the greatest need for intervention. We employed a comprehensive search to ensure capture of papers not indexed in terms of DD, endeavoured to eliminate bias at each stage of the review process, and made a concerted effort to obtain outcome data. Owing to the large number of studies with highly variable results, we do not anticipate that additional studies would alter the conclusions. We recently updated our search and reviewed studies undertaken in samples with Type 1 diabetes and again observed that 20–30% of participants experience elevated DD.[52] Recent studies in mixed and Type 2 samples also fall within the observed range.[51,53,54]

This review is notwithstanding limitations, though. Firstly, the observed estimate may be influenced by sampling bias. Only three databases were searched,[21] rate data could not be obtained for over half of the studies identified, studies rarely employed sampling strategies to derive a representative sample, and demographic and DD data were occasionally reported for participants completing the study or included in analysis; in 31 (57%) studies the number of participants for whom rate data were available was less than those included in the study and for whom demographic data were reported (mean difference in n was 37 (SD 47.6), range 1–155). People with elevated DD are hard to reach, and perhaps less likely to participate in research and more likely to 'drop out' when they do. There was additionally a bias to the western world and non-ethnic minorities, and non-English language papers were not translated. The findings cannot therefore be extended to other cultures and ethnic minorities.

Secondly, there are issues associated with the measurement of DD. The thresholds taken to indicate elevated DD are not diagnostic. Whilst the sensitivity analysis suggested equivalence in the rate of DD indicated by the PAID and DDS thresholds employed, these thresholds were derived via different assumptions and whether they actually equate to 'clinically meaningful'

Table 3 Participant characteristics as predictors of the rate of elevated diabetes distress.

	R^2 (%)	β	SEβ	95% cis	p value
Model 1	<0.01				
Age		−0.03	0.01	−0.05 to −0.01	0.003**
Model 2	12.48				
Gender		−2.05	0.59	−3.21 to −0.89	<0.001***
Model 3	<0.1				
HbA1c		0.19	0.16	−0.13 to 0.52	0.24
Model 4	<0.01				
Health care context		−0.51	0.23	−0.96 to −0.07	0.02*
Model 5	9.79				
Age		−0.01	0.02	−0.04 to 0.02	0.56
Gender		−2.57	0.82	−4.17 to −0.97	0.002**
HbA1c		0.07	0.19	−0.31 to 0.45	0.72
Health care context		−0.66	0.27	−1.18 to −0.14	0.01*

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

DD is to some extent unknown, especially for the PAID. There is also a lack of standardisation in the scoring of the PAID. This is scored on a 5-point Likert scale from 1 to 5 or 0 to 4 yielding scores that range from 0 to 80 or 20 to 100, respectively, and it is recommended that the 0–80 scores are standardised to a 0–100 scale. These distinct scoring systems result in different estimates of the rate of elevated DD. Evidence of variation in approach was observed but the impact could not be explored owing to poor reporting of the scoring system used. In addition, DD arises from multiple sources and a moderate total score may result should a respondent endorse one aspect of DD but not another hence underestimating the clinical impact of DD for this person. Exploration of the distinct sources of DD would likely result in higher rates of elevated DD.

Implications for clinical practice

Healthcare practitioners should work on the assumption that a quarter of their patients may be experiencing a level of DD that requires attention. For some people, DD is transient arising at certain points in the diabetes illness trajectory and subsiding again.[55] Screening for elevated DD as part of routine practice is indicated, especially when milestones such as progressing to insulin treatment and issues relating to glycemic control, acute episodes/inpatient admissions, and the development of complications, are encountered. Importantly, secondary care practitioners should be particularly vigilant of younger, female patients. Validated screening tools exist for this purpose. Clinicians should explore the source(s) of even moderate DD. The DDS sub-scales lend themselves particularly well to this task. Screening is only appropriate, though, when clear care pathways for DD exist[56] and at present this is infrequently the case. The research evidence, and detection and management of DD in clinical practice, is in its infancy; few intervention studies have specifically targeted DD.[57] The emerging evidence base is encouraging though; we previously identified interventions, and intervention components, that may be associated with improvement in DD.[52,57]

Recommendations for further research

Epidemiological studies establishing the population level prevalence, and predictors, of elevated DD are required. Such endeavours should extend beyond the western world to other cultures and ethnic minorities known to be particularly afflicted with diabetes, for instance South East Asians, and should adopt consistency in the use of thresholds and scoring systems for the PAID. Given the transient nature of DD estimates of 'point prevalence' underestimate the magnitude of the problem,[18] and prospective studies are required to further explore the 'lifetime prevalence' of DD. Finally, intervention development endeavours specifically targeting elevated DD for female, and perhaps younger patients, with more complex diabetes should now be considered.

Acknowledgments

The study was internally funded by the Florence Nightingale Faculty of Nursing and Midwifery, King's College London, the employer of JS and KD. A travel fellowship was awarded to JS by the National Institute for Health Research (NIHR) Mental Health Biomedical Research Centre at South London and Maudsley NHS Foundation Trust and King's College London to fund BH and collaborate with LF & DH. The views expressed are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health. We would like to thank statistician Trevor Murrells for his advice regarding multiple imputation and Maria Barratt for her administrative support (Florence Nightingale Faculty of Nursing and Midwifery, King's College London) and Professor Jane Speight for her input and advice regarding the measurement of diabetes distress (School of Psychology, Deakin University).

References

1. Dennick KJ, Sturt J, Speight J. What is diabetes distress and how can we measure it? A narrative review. In preparation.
2. Aikens JE. Prospective associations between emotional distress and poor outcomes in type 2 diabetes. Diabetes Care. 2012;35(12):2472–78.
3. Fisher L, Glasgow RE, Strycker LA. The relationship between diabetes distress and clinical depression with glycemic control among patients with type 2 diabetes. Diabetes Care. 2010;33(5):1034–36.
4. Fisher L, Mullan JT, Arean P, Glasgow RE, Hessler D, Masharani U. Diabetes distress but not clinical depression or depressive symptoms is associated with glycemic control in both cross-sectional and longitudinal analyses. Diabetes Care. 2010;33(1):23–28.
5. Hessler D, Fisher L, Glasgow RE, Strycker LA, Dickinson LM, Arean PA, *et al.* Reductions in regimen distress are associated with improved management and glycemic control over time. Diabetes Care. 2014;37(3):617–24.
6. Strandberg RB, Graue M, Wentzel-Larsen T, Peyrot M, Rokne B. Relationships of diabetes-specific emotional distress, depression, anxiety, and overall well-being with HbA1c in adult persons with type 1 diabetes. J Psychosom Res. 2014;77(3):174–79.
7. Strandberg RB, Graue M, Wentzel-Larsen T, Peyrot M, Thordarson HB, Rokne B. Longitudinal relationship between diabetes-specific emotional distress and follow-up HbA_{1c} in adults with Type 1 diabetes mellitus. Diabet Med. 2015;32:1304–10.
8. Fonda SJ, McMahon GT, Gomes HE, Hickson S, Conlin PR. Changes in diabetes distress related to participation in an internet-based diabetes care management program and glycemic control. J Diabetes Sci Technol. 2009;3(1):117–24.
9. Zagarins SE, Allen NA, Garb JL, Welch G. Improvement in glycemic control following a diabetes education intervention is associated with change in diabetes distress but not change in depressive symptoms. J Behav Med. 2012;35(3):299–304.
10. Weinger K, Jacobson AM. Psychosocial and quality of life correlates of glycemic control during intensive treatment of type 1 diabetes. Patient Educ Couns. 2001;42(2):123–31.
11. Fisher L, Hessler DM, Polonsky WH, Mullan J. When is diabetes distress clinically meaningful?: establishing cut points for the Diabetes Distress Scale. Diabetes Care. 2012;35(2):259–64.
12. Joensen LE, Tapager I, Willaing I. Diabetes distress in Type 1 diabetes-a new measurement fit for purpose. Diabet Med. 2013;30(9):1132–39.
13. Sturt J, Mccarthy K, Dennick K, Narasimha M, Sankar S, Kumar S. What charaterises diabetes distress and it's resolution? A documentary analysis. Int Diabetes Nurs. 2015;12(2):1–7.
14. Gonzalez JS, Fisher L, Polonsky WH. Depression in diabetes: have we been missing something important? Diabetes Care. 2011;34(1):236–39.
15. Sturt JA, Whitlock S, Fox C, Hearnshaw H, Farmer AJ, Wakelin M, *et al.* Effects of the Diabetes Manual 1:1 structured education in primary care. Diabet Med. 2008;25(6):722–31.
16. Stoop C, Nefs G, Pop V, Wijnands-van Gent C, Tack CJ, Geelhoed-Duijvestijn P, *et al.* Diabetes-specific emotional distress in people with Type 2 diabetes: a comparison between primary and secondary care. Diabet Med. 2014;31(10):1252–59.
17. Speight J, Browne JL, Holmes-Truscott E, Hendrieckx C, Pouwer F, on behalf of the Diabetes MILES – Australia reference group (2011). Diabetes MILES – Australia 2011 Survey Report. Canberra: Diabetes Australia 2011.
18. Fisher L, Skaff M, Mullan J, Arean P, Glasgow R, Masharani U. A longitudinal study of affective and anxiety disorders, depressive affect and diabetes distress in adults with Type 2 diabetes. Diabet Med. 2008;25(9):1096–101.
19. Ali S, Stone MA, Peters JL, Davies MJ, Khunti K. The prevalence of comorbid depression in adults with Type 2 diabetes: a systematic review and meta-analysis. Diabet Med. 2006;23(11):1165–73.
20. Anderson RJ, Freedland KE, Clouse RE, Lustman PJ. The prevalence of comorbid depression in adults with diabetes: a meta-analysis. Diabetes Care. 2001;24(6):1069–78.
21. Stroup DF, Berlin JA, Morton SC, Olkin I, Williamson GD, Rennie D, *et al.* Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis of Observational Studies in Epidemiology (MOOSE) group. JAMA. 2000;283(15):2008–12.
22. Polonsky WH, Anderson BJ, Lohrer PA, Welch G, Jacobson AM, Aponte JE, *et al.* Assessment of diabetes-related distress. Diabetes Care. 1995;18(6):754–60.
23. Polonsky W, Fisher L, Earles J, Dudl RJ, Lees J, Mullan J, *et al.* Assessing psychosocial distress in diabetes: development of the diabetes distress scale. Diabetes Care. 2005;28(3):626–31.
24. Welch GW, Jacobson AM, Polonsky WH. The problem areas in diabetes scale: an evaluation of its clinical utility. Diabetes Care. 1997;20(5):760–66.
25. Snoek FJ, Pouwer F, Welch GW, Polonsky WH. Diabetes-related emotional distress in Dutch and U.S. diabetic patients: cross-cultural validity of the problem areas in diabetes scale. Diabetes Care. 2000;23(9):1305–9.
26. Schmitt A, Reimer A, Kulzer B, Haak T, Gahr A, Hermanns N. Negative association between depression and diabetes control only when accompanied by diabetes-specific distress. J Behav Med. 2015;38(3):556–64.
27. Pouwer F, Beekman AT, Lubach C, Snoek FJ. Nurses' recognition and registration of depression, anxiety and diabetes-specific emotional problems in outpatients with diabetes mellitus. Patient Educ Couns. 2006;60(2):235–40.
28. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. BMJ. 2003;327(7414):557–60.
29. Allison P. Why you probably need more imputations than you think. http://statisticalhorizons.com/more-imputations [March 2016]; 2012.
30. van Buuren S, Groothuis-Oudshoorn K, Robitzsch A, Vink G, Doove L, Jolani S. Mice: Multivariate imputation by chained equations (version 2.25). https://cran.r-project.org/web/packages/mice/index.html.
31. van Buuren S, Groothuis-Oudshoorn K. Mice: multivariate imputation by chained equations. R J Stat Softw. 2011;45(3):1–67.
32. Viechtbauer W. Metafor: meta-analysis package for R (version 1.9–8). https://cran.r-project.org/web/packages/metafor/index.html.
33. Ratitch B, Lipkovich I, O'Kelly M. Combining analysis results from multiply imputed categorical data. Chicago, USA: PharmaSUG; 2013. pp. 1–19.
34. Diabetes UK. Diabetes: facts and stats. London: Diabetes UK; 2015.
35. Whitley E, Ball J. Statistics review 3: hypothesis testing and P values. Crit Care. 2002;6(3):222–5.
36. Gavard JA, Lustman PJ, Clouse RE. Prevalence of depression in adults with diabetes: an epidemiological evaluation. Diabetes Care. 1993;16(8):1167–78.
37. Brierley S, Johnson B, Young V, Eiser C, Heller S. The importance of measuring diabetes distress in young people with Type 1 diabetes. In: Diabetes UK Professional Conference, Glasgow, United Kingdom; 2012. p. 159.
38. Fisher L, Mullan JT, Skaff MM, Glasgow RE, Arean P, Hessler D. Predicting diabetes distress in patients with Type 2 diabetes: a longitudinal study. Diabet Med. 2009;26(6):622–27.
39. Graue M, Haugstvedt A, Wentzel-Larsen T, Iversen MM, Karlsen B, Rokne B. Diabetes-related emotional distress in adults: reliability and validity of the Norwegian versions of the Problem Areas in Diabetes Scale (PAID) and the Diabetes Distress Scale (DDS). Int J Nurs Stud. 2012;49(2):174–82.
40. Luyckx K, Rassart J, Weets I. Illness self-concept in Type 1 diabetes: a cross-sectional view on clinical, demographic, and psychosocial correlates. Psychol Health Med. 2015;20(1):77–86.
41. Zoffmann V, Vistisen D, Due-Christensen M. A cross-sectional study of glycaemic control, complications and psychosocial functioning among 18- to 35-year-old adults with type 1 diabetes. Diabet Med. 2014;31(4):493–99.
42. Grigsby AB, Anderson RJ, Freedland KE, Clouse RE, Lustman PJ. Prevalence of anxiety in adults with diabetes: a systematic review. J Psychosom Res. 2002;53(6):1053–60.
43. Kessler RC. Epidemiology of women and depression. J Affect Disord. 2003;74(1):5–13.
44. Gregg EW, Gu Q, Cheng YJ, Narayan KM, Cowie CC. Mortality trends in men and women with diabetes, 1971 to 2000. Ann Intern Med. 2007;147(3):149–55.
45. Franzini L, Ardigo D, Cavalot F, Miccoli R, Rivellese AA, Trovati M, *et al.* Women show worse control of type 2 diabetes and cardiovascular disease risk factors than men: results from the MIND.IT Study Group of the Italian Society of Diabetology. Nutr Metab Cardiovasc Dis. 2013;23(3):235–41.
46. Hessler D, Fisher L, Mullan J, Glasgow RE, Masharani U. Patient age: a neglected factor when considering disease management in adults with type 2 diabetes. Patient Educ Couns. 2011;85(2):154–59.
47. Lerman-Garber I, Barron-Uribe C, Calzada-Leon R, Mercado-Atri M, Vidal-Tamayo R, Quintana S, *et al.* Emotional dysfunction associated with diabetes in Mexican adolescents and young adults with type-1 diabetes. Salud Publica Mex. 2003;45(1):13–18.
48. Delahanty LM, Grant RW, Wittenberg E, Bosch JL, Wexler DJ, Cagliero E, *et al.* Association of diabetes-related emotional distress with diabetes treatment in primary care patients with Type 2 diabetes. Diabet Med. 2007;24(1):48–54.
49. Sheils E, Knott J, Cavan D, Shaban C. Fear of hypoglycaemia: Is there an association with glycaemic control, hypoglycaemic symptoms and diabetes emotional distress in people with Type 1 diabetes? In: Diabetes UK Professional Conference, Glasgow, United Kingdom; 2012. p. 157.
50. Ali Z, Patel NH. Glycaemic control, emotional attitudes and quality of life in patients living with Type 1 diabetes. In: Diabetes UK Professional Conference, Manchester, United Kingdom; 2013. p. 104.
51. Schmitt A, Reimer A, Kulzer B, Haak T, Ehrmann D, Hermanns N. How to assess diabetes distress: comparison of the Problem Areas in Diabetes Scale (PAID) and the Diabetes Distress Scale (DDS). Diabet Med. 2015;33(6):835–843.

52. Sturt J, Dennick K, Due-Christensen M, McCarthy K. The detection and management of Diabetes Distress in people with Type 1 Diabetes. Curr Diab Rep. 2015;15(11):101.
53. Islam MR, Islam MS, Karim MR, Alam UK, Yesmin K. Predictors of diabetes distress in patients with type 2 diabetes mellitus. Int J Res Med Sci. 2014;2(2):631–38.
54. Pandit AU, Bailey SC, Curtis LM, Seligman HK, Davis TC, Parker RM, *et al.* Disease-related distress, self-care and clinical outcomes among low-income patients with diabetes. J Epidemiol Commun Health. 2014;68(6):557–64.
55. Lipscombe C, Burns RJ, Schmitz N. Exploring trajectories of diabetes distress in adults with type 2 diabetes; a latent class growth modeling approach. J Affect Disord. 2015;188:160–66.
56. The Diabetes Times Website. Ninjabetic – It's not just a questionnaire. http://diabetestimes.co.uk/ninjabetic-its-not-just-a-questionnaire/#sthash.3mK7vTFq.7vg1HrpW.dpbs [February 2016]; 2015.
57. Sturt J, Dennick K, Hessler D, Fisher L, Hunter B, Oliver J. Effective interventions for reducing diabetes distress: systematic review and meta-analysis. Int Diabetes Nurs. 2015;12(2):1–16.