

Systematic Review or Meta-Analysis

What psychosocial interventions work to reduce hospital admissions in people with diabetes and elevated HbA_{1c}: a systematic review of the evidence

H. Moulson , S. Sanders, S. Coppin and J. Meyrick

Department of Psychology, University of West England, Bristol, UK

Accepted 18 May 2020

Abstract

Background Diabetes is a chronic condition that can lead to devastating complications if not managed effectively. Individuals with elevated HbA_{1c} are at higher risk of developing complications resulting in diabetes-related hospital admissions, an additional pressure and expense for healthcare systems.

Aim To systematically review evidence of the effectiveness of psychosocial interventions among individuals with elevated HbA_{1c}, as indicated by hospital admissions.

Methods Electronic databases (MEDLINE, PsycINFO, CINAHL, AMED, Embase and Scopus) were used to identify studies systematically. Studies were screened against eligibility criteria and included if they evaluated the effectiveness of a psychosocial intervention on diabetes-related hospital admissions in individuals with elevated HbA_{1c}. Risk of bias was assessed using the Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies, and a narrative synthesis was conducted.

Results Of 15 362 studies, five were included in the review. Psychosocial interventions were found to significantly reduce diabetes-related hospital admissions in four of these studies and interventions involving psychotherapy in particular were found to reduce admissions. The methodological quality of studies ranged from weak to moderate, due to lack of blinding, weak study design and issues with withdrawals and drop-outs.

Conclusions Psychosocial interventions may reduce diabetes-related hospital admissions in individuals with elevated HbA_{1c}; however, due to variability in methodological rigour, the conclusion remains tentative. Further research targeting this group, particularly within the adult population, is recommended. (PROSPERO registration number: CRD42019133456).

Diabet. Med. 37, 1280–1290 (2020)

Introduction

It is reported that the National Health Service (NHS) spends at least £10bn per year on diabetes, with almost 80% of this money spent on treating complications, many of which are preventable [1]. When diabetes is uncontrolled, there are increased healthcare costs resulting from costly complications such as diabetic ketoacidosis, heart disease, blindness and kidney failure which are often preventable through

ongoing glycaemic control [2,3,4,5,6]. Ketoacidosis is a frequent occurrence among people with diabetes who have elevated HbA_{1c} levels, particularly among adolescents with type 1 diabetes, and is often preventable [7]. Such admissions cost the NHS £2064 per adult treated and £1387 per adolescent treated [8,9]. Reducing ketoacidosis admissions as well as other diabetes-related complications will significantly reduce NHS costs. Since the risk of hospitalisation for individuals with diabetes is almost twice that of others [10,11] it is important to understand which interventions are effective among people with diabetes and elevated HbA_{1c}, with the goal of reducing admissions.

HbA_{1c} levels provide a good indication of glycaemic control, with levels of 53 mmol/mol (7.0%) or below indicating good glycaemic control with risk of complications

Correspondence to: Hannah Moulson.
E-mail: hannah2.moulson@live.uwe.ac.uk.

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

What's new?

- People with diabetes and elevated HbA_{1c} concentrations are more likely to develop complications resulting in hospital admissions. Psychosocial factors play a key role in determining self-management outcomes, and psychosocial interventions are shown to improve psychological well-being and physical health outcomes.
- This review found that psychosocial interventions, in particular psychotherapy, may reduce hospital admissions among individuals with diabetes who have elevated HbA_{1c}.
- Results indicate that designing and testing psychosocial interventions targeting individuals with elevated HbA_{1c} has the potential to improve psychological well-being and therefore reduce preventable hospital admissions and associated costs among this population.

at a similar level to that of the general population, and levels of 58 mmol/mol (7.5%) and above indicating substantial risk of complications and the need for further intervention [12]. Crucially, individuals with elevated HbA_{1c} are more likely to have higher utilisation of healthcare services, resulting in additional costs for the healthcare system [13].

Elevated HbA_{1c} is likely to stem from a wide range of psychosocial factors, and the interventions examined in the present review are therefore limited to this category.

Although diabetes is a physiological disease with effective medication available, management is largely behavioural [14]. It is well recognized that environmental, social, behavioural and emotional factors, known as psychosocial factors, play a key role in determining management outcomes in individuals with diabetes [6,15]. Psychosocial difficulties impact an individual's ability to undertake the extensive behavioural demands required to effectively manage diabetes, and it is estimated that up to a third of those living with diabetes experience such difficulties [16,17,18,19,20]. As a result of these difficulties, many individuals with diabetes do not achieve optimal blood glucose control even with an effective medication regime in place.

Many individuals living with diabetes experience diabetes distress, as a result of becoming overwhelmed by the demands of diabetes. High levels of diabetes-related distress are linked to elevated HbA_{1c} and a decline in self-management as individuals experience 'diabetes burnout', increasing the risk of diabetes-related complications and hospital admissions [21]. This is also found with other mental health problems including anxiety and depression, and there is consistent evidence that diabetic ketoacidosis presentations are associated with psychological difficulties [16,22]. Such psychological comorbidities interfere with the person's ability to carry out diabetes self-management and are associated with reduced adherence to treatment and increased risk of diabetes complications [23].

It is widely recognised that psychosocial care should be integrated with a collaborative approach to optimise health outcomes and health-related quality of life [24]. Lack of adequate psychosocial support is shown to have a negative effect on various outcomes, including blood glucose control, thus psychosocial support is an integral part of diabetes care and should be accessible to individuals living with diabetes [25,26]. Psychosocial interventions are associated with a reduction in psychological and diabetes-related distress, improved quality of life and reported self-management in individuals with diabetes [27,28,29]. There is also evidence that psychosocial interventions are effective at improving glycaemic control and reducing outpatient appointments and emergency inpatient admissions, leading to a significant reduction in healthcare costs [30,31,32]. Psychosocial interventions are diverse, integrating psychological, behavioural and environmental aspects of diabetes to improve mental health outcomes associated with the diagnosis and management of diabetes alongside the lifestyle and behaviour changes required.

To develop effective interventions for individuals with elevated HbA_{1c}, we need to understand what works. To date, the literature has focused on the psychological impact of diabetes, with the majority of existing systematic reviews exploring the impact of psychosocial interventions on depressive symptoms, diabetes-related distress and quality of life in people living with diabetes [33,34,35]. Whilst some reviews have explored the impact of psychosocial interventions on general diabetes management and physical health outcomes [36,37,38], the impact of diabetes on healthcare utilisation and what interventions are effective to reduce utilisation and pressure on services has been overlooked. Therefore, the present review will address the current gap in the literature and exclusively focus on hospital admission reduction.

The aim of the review was to identify all eligible psychosocial interventions targeted at reducing diabetes-related hospital admissions among individuals with elevated HbA_{1c} (defined as individuals with an HbA_{1c} level of >58 mmol/mol (7.5%)). This adds to the current literature on the impact of interventions on diabetes self-management and addresses a gap in the literature by looking at interventions targeted at individuals with elevated HbA_{1c} and their effectiveness with regard to diabetes-related hospital admissions. Whilst there is no universal consensus within the literature to identify an HbA_{1c} threshold indicating uncontrolled diabetes, for the purposes of this review, the level of 58 mmol/mol (7.5%) and above was used to define elevated HbA_{1c}, as previously stated by National Institute for Health and Care Excellence (NICE; 2015) and Buckinghamshire Healthcare NHS Trust (2017).

Method**Protocol and registration**

This study was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses

(PRISMA) guidelines [39]. A protocol for this systematic review was published and can be accessed on PROSPERO (CRD42019133456; available at: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42019133456).

Eligibility criteria

Articles meeting the following eligibility criteria were included:

1. Studies published in the English language in a peer-reviewed journal with a quantitative methodology. No limitations were applied to year of publication to identify as many potentially eligible studies as possible.
2. Studies that included a psychosocial intervention aimed at improving outcomes in people with diabetes were included. Psychosocial interventions were defined as any intervention emphasising psychological or social factors as opposed to biological factors [40]. Interventions targeting multiple chronic conditions were excluded as the focus of the review was to identify interventions targeting individuals with elevated HbA_{1c} levels specifically.
3. Studies evaluating the effectiveness of the intervention on individuals diagnosed with either type 1 or type 2 diabetes with elevated HbA_{1c} were included. In this review elevated levels were defined as an HbA_{1c} level of >58 mmol/mol (7.5%) as individuals diagnosed with diabetes are recommended to control HbA_{1c} levels between 48 and 53 mmol/mol (6.5–7.0%) to avoid complications [26]. Participants of all ages were included.
4. Studies reporting diabetes-related hospital admissions, e.g. diabetic ketoacidosis, as either the primary or secondary outcome were included.

Information sources

Six electronic databases (MEDLINE, PsychINFO, CINAHL, AMED, Embase and Scopus) were used to identify eligible studies. Searches were conducted in November 2018 and updated in February 2019. Citations of studies where full texts were screened were hand-searched to identify additional studies and study authors were contacted to request a copy of full text when not available and to identify any additional relevant studies. An expert in the field of diabetic ketoacidosis was contacted to identify further possible studies. RefWorks was used to organize the results from each search engine and to remove duplicates.

Search terms

The search strategy was developed using the 'PICO' (Population, Intervention, Comparison and Outcomes) approach. Population terms aimed to identify all references

related to individuals with either type 1 or type 2 diabetes and elevated HbA_{1c} (diabetes or 'diabetes mellitus' or 'poor manage* diabetes' or 'poor glycaemic control' or diabet* or diabetic). Intervention search terms related to intervention delivery and aimed to capture psychosocial interventions ('psycho* intervention' or psychother* or intervention* or 'digital intervention' or telemedicine or 'psychosocial intervention' or psychoeducation or 'motivation* interview' or counselling or 'cognitive behavioural therapy' or 'group therapy' or self-help) and outcome terms related to diabetes-related hospital admissions ('hospital admission' or hospitalization or ketoacidosis or acidosis or DKA or 'diabetic ketoacidosis').

No limitations were applied to databases during the search to ensure as many eligible studies as possible were identified. Studies were then excluded according to eligibility criteria throughout the screening process.

Study selection

On completion of electronic database searches, papers were exported to RefWorks from all databases. Once duplicates were removed, an eligibility assessment was performed, which involved the screening of titles and abstracts against the inclusion criteria (Appendix S1). Studies that were retained after screening of titles and abstracts were fully screened by two independent reviewers (H.M., S.S.) and any discrepancies were discussed and resolved with a third independent reviewer (S.C.). The process is summarized in the PRISMA flow diagram (Fig.1).

Data collection process and data items

Data extraction was undertaken for all studies that met the inclusion criteria using a structured data extraction form designed for the review (Appendix S2), adapted from the Cochrane Collaboration data collection form (Appendix S3). The data extraction sheet was pilot-tested on two randomly selected studies and refined accordingly. Two reviewers (H.M., S.S.) independently extracted data from each full paper, with any discrepancies resolved by discussion and consensus. Where information was not available, study authors were contacted for clarification. The extracted information captured details on the study population, intervention and outcomes. Data extracted from studies using the data extraction form was summarized and tabulated to identify key characteristics of each study (Table 1).

Risk of bias

Studies were evaluated using the Effective Public Health Practice Project Quality Assessment Tool [10] to assess internal and external validity by rating risk of bias for each study. Each study was assessed on: selection bias, study

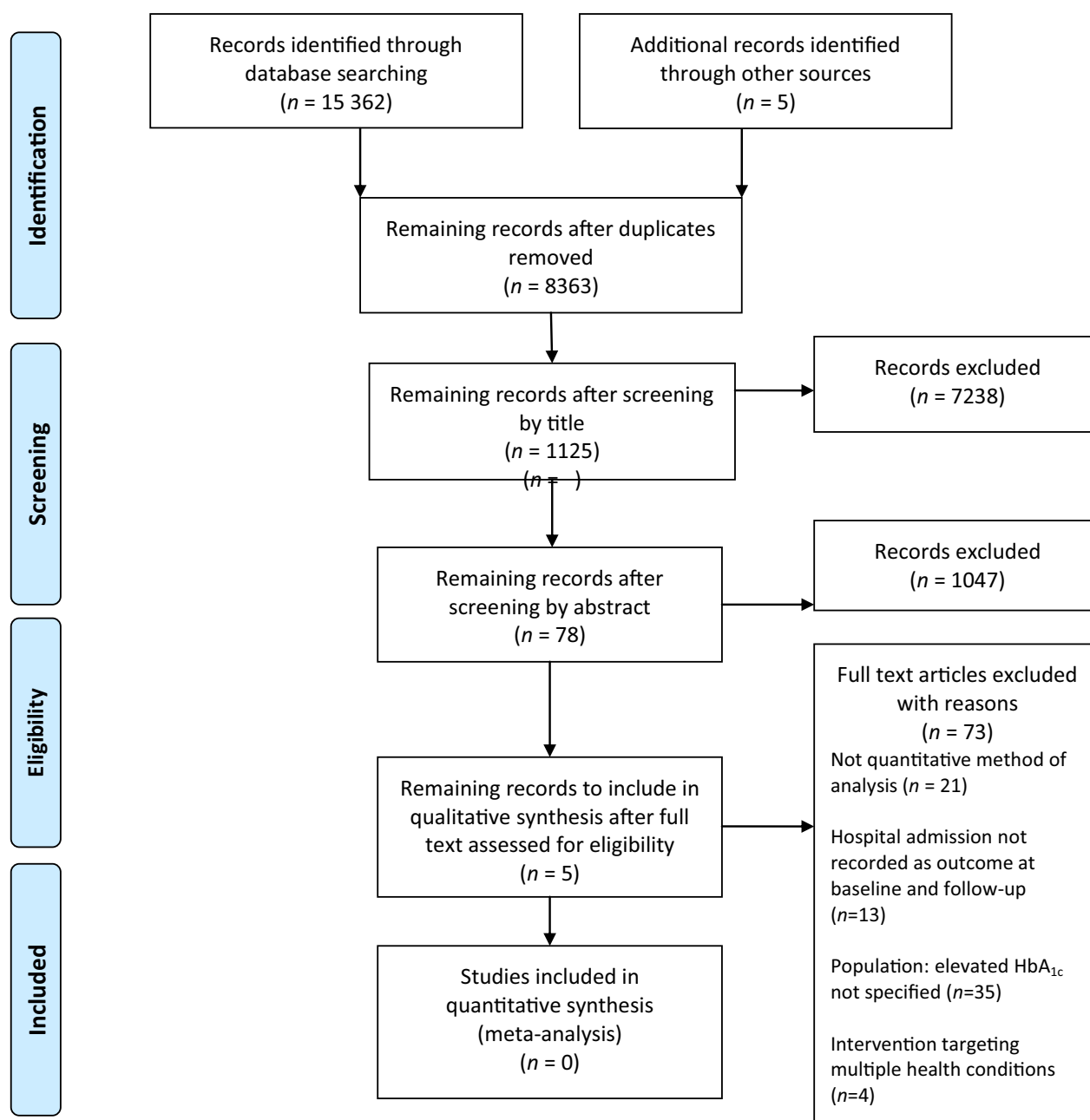


FIGURE 1 PRISMA flow diagram of studies that were screened, excluded (with reasons) and included. [Colour figure can be viewed at wileyonlinelibrary.com]

design, confounders, blinding, data collection methods, withdrawals and drop-outs, intervention integrity and analyses. Papers were assessed independently by two reviewers (H.M. and S.S.) and discrepancies were discussed and resolved by a third reviewer (S.C.). In line with the tool, studies were rated as having strong, moderate or weak methodological quality following assessment of bias. The methodological quality overall and in each domain is summarized in Table 2 for individual studies and will be discussed further throughout the review in relation to the effectiveness of interventions.

Summary measures

The outcome of interest for this systematic review is diabetes-related hospital admissions. The principal summary measure used was difference in diabetes-related hospital admissions before and after the intervention. The time interval between pre- and post-intervention measures ranged from 5 to 18 months across studies. Odds ratios and confidence intervals (CIs) are reported with other measures in Table 1, however, for the purpose of this review only the main outcome will be discussed in detail.

Table 1 Characteristics of included studies

Study (year), country	Study design	Participants	Intervention	Control or comparison	Measures	Results	Effect Size	Global Quality Score
Adepoju et al. (2014), USA [1]	Retrospective cohort analysis using secondary data from recently conducted RCT	N = 376; age 18+ years (mean age 57.56 years), type 2 diabetes, mean HbA _{1c} 7.7 mmol/mol (9.2%)	6-week CDSMP involving weekly 2.5-h training sessions on diabetes self-management (n=101). 24-month follow-up	PDA handheld device (n=81), usual care (n=95), and combined PDA and CDSMP (n=99)	HbA _{1c} levels, acute hospital events relating to diabetes, length of stay for each acute event, healthcare financing and reimbursement, comorbidities, pharmaceutical data, sociodemographics, technological experiences, self-reported health-related quality of life, summary of diabetes self-care activities, pain and fatigue measures, physical activity measures	Participants enrolled in the CDSMP-only arm had a statistically significant lower odds of diabetes-related hospitalisation (P ≤0.01) and also had a statistically significant lower risk/shorter time-to-hospitalisation (P ≤0.01) when compared to participants in the control arm	Diabetes-related admissions odds ratio 0.12 (CI 0.03–0.43) Diabetes-related emergency department visits odds ratio 0.05 (CI 0.01–0.21)	Weak
Ellis et al. (2005), USA [11]	RCT	N = 127; 10–17 years (mean 13.25 years), type 1 diabetes, mean HbA _{1c} 10.0 mmol/mol (11.3%).	MST delivered 2–3 times per week for 6 months (n=64). 24-month follow-up.	Control group of standard medical care (n=63)	Hospital utilisation data, 24-h recall interview, frequency of blood testing, HbA _{1c}	There was a significant reduction in inpatient admissions for adolescents receiving MST (P ≤0.05). The intervention group also had significantly fewer diabetic ketoacidosis admissions relative to baseline frequency at 6-month (P ≤0.01), 12-month (P ≤0.05), 18-month (P ≤0.05) and 24-month follow ups (P ≤0.05).	Inpatient admissions: d = 0.65 (medium)	Moderate
Wagner et al. (2017), USA [45]	Retrospective analysis	N = 25; mean age 15.8 years, type 1 and type 2 diabetes, mean HbA _{1c} 11.0 mmol/mol (12.2%)	Personalized text messages tailored to individual needs. 12-month follow-up	None	Number of diabetic ketoacidosis admissions, HbA _{1c} , number of hospital admissions, number of admitted, number of emergency department visits. Measured year prior to intervention onset and year subsequent to onset.	No significant difference between number of emergency department visits during year prior to NICH onset and year subsequent to NICH onset (P = 0.57), but significant decrease in diabetic ketoacidosis episodes from the year prior to NICH onset to the year during intervention (P <0.01)	Number of admissions: d = 0.31 (small), number of emergency department visits: d = 0.17 (small), number of visits in diabetic ketoacidosis: d = 0.56 (medium)	Weak
Moran et al. (1991), UK [29]	Non-randomized control trial	N = 22; age 6–18 years (mean age 13.7 years), type 1 diabetes, HbA _{1c} > 11.9 mmol/mol (13.0%) no means stated.	45-minute Psychotherapy sessions delivered 3–5 times weekly for an average of 15 weeks (n=11).	Control group (n=11) received usual medical care and diabetes education	M value, HbA _{1c} , number of readmissions to hospital	Significant reduction in hospital admissions solely for diabetic imbalance (P ≤0.05) in intervention group.	d = 0.83 (large)	Moderate

Table 1 (Continued)

Study (year), country	Study design	Participants	Intervention	Control or comparison	Measures	Results	Effect Size	Global Quality Score
Nunn <i>et al.</i> (2006), Australia [31]	RCT	N = 123; age 3+ years (mean age 11.9 years), type 1 diabetes, mean HbA _{1c} 66 mmol/mol (8.2%)	12 month follow-up. Bi-monthly phone calls including management advice, psychological support and education. 8 month follow-up	Control group received usual care and in addition could contact the diabetes team by phone	HbA _{1c} level, admission rates, Test of Diabetes Knowledge, compliance, Strengths and Difficulties Questionnaire, Indicators of Social and Family Functioning	Additional phone contact did not significantly improve rate of hospital admissions (number of admissions $P = 0.57$ and admission days $P = 0.50$)	Not sufficient information to calculate	Strong

CDSMP, Chronic Disease Self-Management Programme; diabetic ketoacidosis, diabetic ketoacidosis; MST, multisystemic therapy; NICH, Novel Interventions In Children's Healthcare; PDA, Personal Digital Assistant; RCT, randomized controlled trial.

Cohen's *d* was used to interpret effect sizes of results reported within the reviewed studies. Effect sizes of 0.20 were considered to be small, while effect sizes of approximately 0.50 were considered to be medium. Effect sizes of approximately 0.80 or above were considered to be large [42].

Synthesis of results

Because there was considerable heterogeneity in study design, methodology and statistical approaches, a meta-analysis was not possible. A narrative synthesis was conducted, following the guidance on the conduct of narrative synthesis in systematic reviews [43].

Results

Study selection

The study selection process and reasons for exclusion were documented using a PRISMA flow chart (Fig. 1). Characteristics across studies and interventions are described below, and the effectiveness of these interventions is summarized, taking into account methodological quality.

Study characteristics

Table 1 shows the main characteristics of each study included in the review. Study designs varied and included two randomized controlled trials (RCTs) [44,45], one non-RCT [46], and two retrospective analyses of existing data from a previous RCT [47] and a previous intervention [48]. Across studies, 673 participants were included, with sample sizes ranging from 22 to 376. Four of the five included studies had a female sample bias [44,46,47,48], meaning there was an overall female sample bias across studies. Only one study included adult participants [47], with the majority of studies including young people with diabetes. Range and mean of participant ages could not be calculated because of missing data. The studies included participants with both type 1 and type 2 diabetes, although only two included individuals with type 2 diabetes [47,48]. Ethnicity was only documented in three of the included studies. In two of these, white participants accounted for between 64% [47] and 100% [45] of the sample. Ellis *et al.* [44] reported that 62% of participants were African American, but no information on country of origin is stated.

The included studies reported a number of outcomes and the effectiveness of interventions on these outcomes; however, as the present review focuses specifically on the impact on diabetes-related hospital admissions, only the effectiveness for this outcome is discussed. All studies assessed the effectiveness of an intervention on diabetes-related hospital admissions as either a primary or secondary outcome, and results of individual studies evaluating the effectiveness are

presented in Table 1, with statistics reported to two decimal places (for full data see original papers cited). Diabetes-related hospital admissions were recorded and measured using electronic patient records [44,47,48] and used the International Classification of Diseases, Ninth Revision – Clinical Modification codes to capture hospital admissions specifically related to diabetes. Two of the studies do not report how diabetes-related hospital admissions were recorded [45,46].

Intervention characteristics

The rationale for interventions across studies was to improve outcomes by engaging individuals in diabetes self-management. A range of psychosocial interventions was used across the included studies, including structured education, some form of psychotherapy and personalised support delivered via telephone.

Two psychological interventions [44,46] explored the impact of individual psychotherapy on diabetes-related hospital admissions. Moran *et al.* [46] delivered individual psychotherapy in hospital alongside medical treatment which involved a detailed formulation of the child's condition from a combined endocrinological and psychological viewpoint. Ellis *et al.* [44] delivered multisystemic therapy at home to adolescents and their families, targeting adherence-related problems.

Two of the interventions included in this review were telephone-based. Nunn *et al.* [45] investigated the impact of bi-monthly telephone calls on diabetes outcomes among individuals with elevated HbA_{1c} levels. Telephone calls lasted between 15 and 30 minutes and covered a range of topics including management advice, psychological support and education. Parents were also included in discussions if they usually made the treatment decisions at home. Wagner *et al.* [48] explored the effectiveness of a personalized text-messaging intervention delivered by Novel Interventions In Children's Healthcare (NICH) interventionists. Text messages were personalized and tailored to individual needs, providing reinforcement for diabetes management, skills coaching, and assistance with problem-solving.

One study involved a structured education course [47], which was delivered face to face over a number of weeks in a classroom setting and delivered by trained coaches who had received standardized training in diabetes self-management. Sessions were based on an educational model developed by Stanford University which focused on equipping individuals to be proactive in managing their chronic condition, however, it is not clear from the study what specific topics the education course covered.

The time interval between measurements of diabetes-related hospital admissions varied across studies. Pre-intervention measures ranged from 0 to 12 months and follow-up post-intervention measurements were between 5 and 24 months.

Effectiveness of interventions by intervention type

The effectiveness of these interventions at reducing diabetes-related hospital admissions among individuals with elevated HbA_{1c} is presented in Table 1. Of the five interventions identified, four demonstrated a significant reduction in diabetes-related hospital admissions [1,29,45].

Results indicated moderate evidence for the effectiveness of individual psychotherapy at reducing diabetes-related hospital admissions in individuals with elevated HbA_{1c} [11,44]. Ellis *et al.* [44] found that those receiving multisystemic therapy had significantly fewer admissions than control participants, with a medium effect size ($P \leq 0.05$, $d = 0.65$). This effect was maintained over the 24-month follow-up period. Moran *et al.* [46] also reported a reduction in hospital admissions related to diabetes among children and adolescents receiving psychotherapy, with a large effect size ($P \leq 0.05$, $d = 0.83$). Both studies had a strong study design with little bias across domains, however, overall had a moderate global rating for quality (Table 2), providing moderate evidence for the effectiveness of interventions involving individual psychotherapy.

Evidence in support of telephone-based interventions was weak. Wagner *et al.* [48] reported a significant decrease in the number of ketoacidosis episodes as a result of a text-messaging intervention ($P \leq 0.01$, $d = 0.56$), despite no significant difference in emergency department visits ($P = 0.57$, $d = 0.17$). However, this was a retrospective study design with a small sample and data were only for individuals with available text message data meeting criteria so may not be generalizable to other populations. There was also a risk of confounders and blinding bias, therefore, evidence to support the effectiveness of text-messaging interventions at reducing diabetes-related hospital admissions is weak. Furthermore, there was strong evidence to suggest bi-monthly telephone calls are ineffective at reducing diabetes-related hospital admissions among individuals with elevated HbA_{1c}. Nunn *et al.* [45] reported an increase in admissions in both intervention and control groups with a small effect size ($P = 0.57$, $d = 0.31$).

Adepoju *et al.* [47] reported that individuals in the intervention group receiving structured education on diabetes management had significantly lower odds of healthcare utilization ($P \leq 0.05$) when compared to participants in other arms, however, the methodological quality was poor because of a lack of clarity on data collection methods and measures and risk of confounder, blinding and withdrawal bias. Despite statistically significant results, therefore, we cannot confidently draw conclusions regarding the effectiveness of this intervention.

Methodological quality

The methodological quality of the included studies was assessed using the Effective Public Health Practice Project

Table 2 Risk of bias according to Effective Public Health Practice Project Quality Assessment Tool (1998)

Author	Selection bias rating	Study design rating	Confounders rating	Blinding rating	Data collection method rating	Withdrawals and drop-outs rating	Global rating
Adepoju <i>et al.</i> (2014) [48]	Strong	Strong	Moderate	Weak	Weak	Weak	Weak
Ellis <i>et al.</i> (2005) [44]	Moderate	Strong	Strong	Weak	Strong	Strong	Moderate
Wagner <i>et al.</i> (2017) [47]	Strong	Weak	Weak	Weak	Strong	Strong	Weak
Moran <i>et al.</i> (1991) [46]	Strong	Strong	Strong	Weak	Strong	Moderate	Moderate
Nunn <i>et al.</i> (2006) [45]	Strong	Strong	Strong	Moderate	Strong	Strong	Strong

Quality Assessment Tool [41] for quality assessment and is summarized in Table 2.

Selection bias across studies was generally low, therefore, studies were likely to be representative of the target population, and study design was also rated as strong, with the exception of one retrospective analysis [48]. In most cases, data collection tools were shown to be valid and reliable [44,45,46,48], however, it was unclear in one study [47] as data collection methods and measures used were not stated.

It was clear in three studies that there were no important differences between groups prior to the intervention [44,45,46], however, in the remaining studies there is a risk of bias as both differences between groups, and whether confounders were controlled if differences were present were unclear. There was also a risk of blinding bias across studies as two studies reported that outcome assessors were aware of the intervention or exposure status of participants [45,46], and blinding status in the remaining studies was unclear.

Three studies [44,45,48] reported withdrawals and drop-outs in terms of numbers and the reasons. For the remaining two studies withdrawals and reasons were not reported, therefore, there is a risk of bias across studies when considering withdrawals and drop-outs.

Overall, the risk of bias across studies was moderate. The main methodological flaw was risk of bias because of a lack of blinding or not enough information about blinding in individual studies. None of the included studies received a 'strong' rating for blinding (Table 2) and this has an impact on the conclusions that can be drawn from the results of the present review.

Discussion

The aim of the present systematic review was to explore the effectiveness of psychosocial interventions on diabetes-related hospital admissions among individuals with elevated HbA_{1c}. To our knowledge this is the first study to address what might work better in this higher-risk group in relation to reducing the burden on healthcare. Results from this systematic review provide moderate evidence for the effectiveness of psychosocial interventions at reducing diabetes-related hospital admissions in the high-risk population. Five

quantitative studies met the inclusion criteria and four of these reported significant improvements in hospital admissions related to diabetes, with effect sizes ranging from small to large and mixed methodological quality.

Results provided moderate evidence to support the effectiveness of interventions involving individual psychotherapy to reduce diabetes-related hospital admissions among adolescents with elevated HbA_{1c} with medium to large effect sizes [44,46]. Interventions delivering individual psychotherapy [44,46] should be considered for such individuals to reduce the risk of complications and hospital admissions related to diabetes. Such interventions are costly as they involve intensive interventions and therapists have small caseloads, however, Ellis *et al.* [44] reported that whilst providing multisystemic therapy was costly (£5,380 per youth), there was still a substantial cost offset due to reductions in diabetic ketoacidosis admissions, therefore, there is the potential for overall savings despite initial costs incurred.

The effectiveness of other interventions included in this review is less clear. Text-messaging-based interventions and structured education programmes targeted at individuals with elevated HbA_{1c} levels do have potential to reduce diabetes-related hospital admissions and as these interventions are less resource-intensive, they are likely to be more cost-effective [47,48]. Adepoju *et al.* [47] found that participants receiving the self-management programme had significantly lower odds of diabetes-related hospital admissions, which supports previous research [49], however, due to methodological flaws the generalizability of results cannot be guaranteed, and further research with strong methodological quality is needed.

Support for the effectiveness of telephone-based interventions was also inconclusive. A personalized text-messaging intervention with tailored messages providing reinforcement, skills coaching and problem-solving was reported to significantly reduce diabetic ketoacidosis episodes and hospitalization with a medium effect size [48], however, this was a retrospective analysis and due to underpowered analyses and lack of a control group it is not possible to determine the effectiveness of text-messaging-based interventions on reducing diabetes-related hospital admissions. Furthermore, there

was strong evidence to suggest that bi-monthly telephone calls offering management advice, psychological support and education does not improve the rate of diabetes-related hospital admissions [45], therefore, more research is needed to determine the effectiveness of telephone-based interventions in this population.

Recommendations drawn from this review must consider the scientific quality of methods used in the field as methodological flaws were identified in the design of many studies included in this review (Table 2). The most common methodological flaw was found to be issues with blinding, however, there were methodological weaknesses identified in all studies therefore further research is needed in this area to improve knowledge and understanding of the effectiveness of psychosocial interventions at reducing diabetes-related hospital admissions in individuals with elevated HbA_{1c}.

Limitations at review level should also be acknowledged. Because of the specific focus on diabetes-related hospital admissions as an outcome, only five studies met the inclusion criteria (Figure 1), therefore, the sample of studies reviewed was small and further research is needed. This was considered as a potential issue when defining the search terms, and a broad study population including all ages and individuals diagnosed with both type 1 and type 2 diabetes was chosen, with the aim of capturing as many relevant studies as possible to assess the effectiveness of current interventions.

As this research reviewed interventions aimed at both type 1 and type 2 diabetes, it is important to consider that intervention needs are likely to differ because of differences in the aetiology of disease, and in the management and psychological needs of people living with the conditions. Such differences must be considered when designing interventions to reduce diabetes-related hospital admissions in order to address specific needs relevant to type 1 or type 2 diabetes.

Furthermore, there is a lack of explicit theoretical rationale for interventions included in this review, which is important to consider as previous research suggests theoretically based interventions may be more beneficial [36].

Despite the small number of final papers included, focusing on diabetes related hospital admissions as an outcome was required for the purpose of this review; however, further research is required in order to draw significant conclusions. Results from this study may also be subject to publication bias as, although reference lists were hand-searched, there was no extensive review of grey literature. Potential papers may also have been missed as a result of excluding papers that were not published in the English language.

Only one of the five included studies [47] included adults in the study sample, therefore, results cannot be generalized to the general population of individuals with elevated HbA_{1c} values. Most studies only included participants with type 1 diabetes, therefore, results are unlikely to be applicable to individuals with type 2 diabetes. Future research should

therefore target adults diagnosed with type 2 diabetes and are identified as having elevated HbA_{1c}.

The majority of individuals living with diabetes are diagnosed with type 2 diabetes and are adults [1], therefore, without addressing this key population gap the ability to draw conclusions from research regarding the effectiveness of interventions is limited.

Furthermore, whilst all the studies were conducted in western countries (UK, USA and Australia), only one of the studies included in this review was conducted in the UK, therefore, generalisability to the UK population and health-care system should be considered and further research conducted in the UK is needed.

In conclusion, this systematic review provides an evaluation of current intervention research in this area and has identified four psychosocial interventions that have reduced diabetes-related hospital admissions among individuals with elevated HbA_{1c}. In particular, there is good evidence that interventions involving psychotherapy for the high-risk population have the potential to reduce the risk of complications, hospital admissions and related costs. Designing and testing psychosocial interventions targeting individuals with elevated HbA_{1c} should be considered, but the results of this review indicate the need for further research with methodological rigour to build on existing evidence.

As found previously [36], this review highlights the need for psychosocial interventions to be guided by principles of psychological theory.

Funding sources

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Competing interests

None declared.

References

- 1 Diabetes UK. Us, diabetes and a lot of facts and stats. 2019. Available at https://www.diabetes.org.uk/resources-s3/201902/1362B_Facts%20and%20stats%20Update%20Jan%202019_LOW%20RES_EXTERNAL.pdf. Last accessed 4 June 2019.
- 2 Herman WH, Braffett BH, Kuo S, Lee JM, Brandle M, Jacobson AM *et al.* What are the clinical, quality-of-life, and cost consequences of 30 years of excellent vs. poor glycaemic control in type 1 diabetes? *J Diabetes Complications* 2018; 32: 911–915.
- 3 Joint British Diabetes Societies for Inpatient Care. Admissions avoidance and diabetes: guidance for clinical commissioning groups and clinical teams. 2013. Available at <https://diabetes-resources-production.s3-eu-west-1.amazonaws.com/diabetes-storage/migration/pdf/admissions-avoidance-diabetes-0114.pdf>. Last accessed 20 November 2019.
- 4 Matthews DR. The natural history of diabetes-related complications: the UKPD experience. United Kingdom Diabetes Study. *Diabetes Obes Metab* 1999; 9: S7–13.

- 5 Patel A, MacMahon S, Chalmers J, Neal B, Billot L, Woodward M *et al*. Intensive blood glucose control and vascular outcomes in patients with type 2 diabetes. *N Engl J Med* 2008; 358: 2560–2572.
- 6 Van Dieren S, Beulens JW, Van Der Schouw YT, Grobbee DE, Neal B. The global burden of diabetes and its complications: an emerging pandemic. *Eur J Cardiovasc Prev Rehab* 2010; 17: S3–S8.
- 7 Garrett CJ, Choudhary P, Amiel SA, Fonagy P, Ismail K. Recurrent diabetic ketoacidosis and a brief history of brittle diabetes research: contemporary and past evidence in diabetic ketoacidosis research including mortality, mental health and prevention. *Diabet Med* 2019; 36: 982–987.
- 8 Dhatariya KK, Parsekar K, Skedgel C, Datta V, Hill P, Fordham R. The cost of treating diabetic ketoacidosis in an adolescent population in the UK: A national survey of hospital resource use. *Diabet Med* 2019; 36: 982–987.
- 9 Dhatariya KK, Skedgel C, Fordham R. The cost of treating diabetic ketoacidosis in the UK: a national survey of hospital resource use. *Diabet Med* 2017; 34: 1361–1366.
- 10 Allan B. Reducing admissions for people with diabetes. *Nurs Times* 2014; 110(10): 12–13.
- 11 Moghissi ME, Korytkowski T, DiNardo M, Einhorn D, Hellman R, Hirsch IB. American Association of Clinical Endocrinologists and American Diabetes Association Consensus Statement on Inpatient Glycaemic Control. *Diabetes Care* 2009; 32: 1119–1131.
- 12 Buckinghamshire Healthcare NHS Trust. Complications of Diabetes explained. 2017. Available at <https://www.buckshealthcare.nhs.uk/Downloads/Patient-leaflets-diabetes-folder/Complications%20of%20diabetes%20explained.pdf>. Last accessed 27 November 2019.
- 13 Govan L, Wu O, Briggs A, Colhoun HM, Fischbacher CM, Lindsay RS. Achieved levels of HbA1c and likelihood of hospital admissions in people with type 1 diabetes in the Scottish population. *Diabetes Care* 2011; 34: 1992–1996.
- 14 Hood KK, Hilliard M, Piatt G, Levers-Landis CE. Effective strategies for encouraging behaviour change in people with diabetes. *Diabetes Manag* 2015; 5: 499–510.
- 15 Young-Hyman D, De Groot M, Hill-Briggs F, Gonzalez JS, Hood K, Peyrot M. Psychosocial care for people with diabetes: A position statement of the American Diabetes Association. *Diabetes Care* 2016; 39: 2126–2140.
- 16 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: 1053–1060.
- 17 Paduch A, Kuske S, Schiereck T, Droste S, Loerbroks A, Sorensen M *et al*. Psychosocial barriers to healthcare use among individuals with diabetes mellitus: A systematic review. *Prim Care Diabetes* 2017; 11: 495–513.
- 18 Peyrot M, Rubin RR, Lauritzen T, Snoek FJ, Matthews DR, Skovlund SE. Psychosocial problems and barriers to improved diabetes management: results of the cross-national Diabetes Attitudes, Wishes and Needs (DAWN) Study. *Diabet Med* 2005; 22: 1379–1385.
- 19 Sabourin BC, Pursley S. Psychosocial issues in diabetes self-management: strategies for healthcare providers. *Can J Diabetes* 2013; 37: 36–40.
- 20 World Health Organisation. *Diabetes Factsheet*. 2018. Available at <https://www.who.int/news-room/fact-sheets/detail/diabetes>. Last accessed 1 July 2019.
- 21 Tareen RS, Tareen K. Psychosocial aspects of diabetes management: dilemma of diabetes distress. *Transl Paediatr* 2017; 6: 383–396.
- 22 Hessler DM, Fisher L, Polonsky WH, Masharani U, Strycker LA, Peters AL *et al*. Diabetes distresses is linked with worsening diabetes management over time in adults with Type 1 diabetes. *Diabet Med* 2017; 34: 1228–1234.
- 23 Wallace TM, Matthews DR. Poor glycaemic control in type 2 diabetes: a conspiracy of disease, suboptimal therapy and attitude. *QJM* 2000; 93: 369–374.
- 24 American Diabetes Association. Standards of medical care in diabetes, section 5: lifestyle management. *Diabetes Care* 2019; 42: S46–S60.
- 25 Betts P, Buckley M, Davies R, McEvilly E, Swift P. The care of young people with diabetes. *Diabet Med* 1996; 13: S54–S59.
- 26 National Institute for Health and Care Excellence. Diabetes (type 1 and type 2) in children and young people: diagnosis and management. 2015. Available at <https://www.nice.org.uk/guidance/ng17/chapter/1-Recommendations>. Last accessed 12 August 2019.
- 27 Harvey JN. Psychosocial interventions for the diabetic patient. *Diabetes Metab Syndr Obes* 2015; 8: 29–43.
- 28 Rizzo M, Creed F, Goldberg D, Meader N, Pilling S. A systematic review of non-pharmacological treatments for depression in people with chronic physical health problems. *J Psychosom Res* 2011; 71: 18–27.
- 29 Tang TS, Funnell MM, Oh M. Lasting effects of a 2-year diabetes self-management support intervention: outcomes at 1-year follow-up. *Prev Chronic Dis* 2012; 9: E109.
- 30 Doing diabetes differently: a novel way of contracting integrated psychological therapies to increase treatment adherence. [Internet]. The Health Foundation; 2014. Available at https://www.health.org.uk/sites/default/files/Shine2012_DoingDiabetesDifferently_report.pdf. Last accessed 1 March 2020.
- 31 Ismail K, Winkley K, Rabe-Hesketh S. Systematic review and meta-analysis of randomised controlled trials of psychological interventions to improve glycaemic control in patients with type 2 diabetes. *Lancet* 2004; 363: 1589–1597.
- 32 Winkley K, Landau S, Eisler I, Ismail K. Psychological interventions to improve glycaemic control in patient with type 1 diabetes: systematic review and meta-analysis of randomised controlled trials. *BMJ* 2006; 333: 65.
- 33 Kolk JL, Williams A, Zhao L. Psychosocial interventions for people with diabetes and co-morbid depression. A systematic review. *Int J Nurs Stud* 2015; 52: 1625–1639.
- 34 Mathiesen AS, Egerod I, Jensen T, Kaldan G, Langberg H, Thomsen T. Psychosocial interventions for reducing diabetes distress in vulnerable people with type 2 diabetes mellitus: a systematic review and meta-analysis. *Diabetes Metab Syndr Obes* 2019; 12: 19–33.
- 35 Pascoe MA, Thompson DR, Castle DJ, Jenkins ZM, Ski CF. Psychosocial interventions and Wellbeing in Individuals with Diabetes Mellitus: A Systematic Review and Meta-Analysis. *Frontiers Psychol* 2017; 8: 2063.
- 36 Hampson SE, Skinner TC, Hart J, Storey L, Gage H, Foxcroft D, Walker J. Effects of educational and psychosocial interventions for adolescents with diabetes mellitus: a systematic review. *Health Technol Assess* 2001; 5: 1–79.
- 37 Harkness E, Macdonald W, Valderas J, Coventry P, Linda G, Bower P. Identifying Psychosocial Interventions That Improve Both Physical and Mental Health in Patients with Diabetes. *Diabetes Care* 2010; 33: 926–930.
- 38 O'Hara MC, Hynes L, O'Donnell M, Nery N, Byrne M, Heller SR *et al*. A systematic review of interventions to improve outcomes for young adults with type 1 diabetes. *Diabet Med* 2017; 34: 753–769.
- 39 Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med* 2009; 6: e1000097.
- 40 Ruddy R, House A. Psychosocial interventions for conversion disorder. *Cochrane Database Syst Rev* 2005; 19: CD005331.
- 41 Effective Public Health Practice Project. Quality Assessment Tool For Quantitative Studies. 1998. Available at <https://link.springer.com>

- om/content/pdf/bbm%3A978-3-319-17284-2/1.pdf. Last accessed 1 November 2019.
- 42 Durlak J. How to Select, Calculate and Interpret Effect Sizes. *J Pediatr Psychol* 2009; **34**: 917–928.
- 43 Popay J, Roberts H, Sowden A, Petticrew M, Arsi L, Rodgers M et al. Guidance on the conduct of narrative synthesis in systematic reviews. University of Lancaster, 2006. Available at <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.178.3100&rep=rep1&type=pdf>. Last accessed December 2018.
- 44 Ellis D, Frey MA, Naar-King S, Templin T, Cunningham P, Cakan N. Use of multisystemic therapy to improve regimen adherence among adolescents with type 1 diabetes in chronic poor metabolic control. *Diabetes Care* 2005; **28**: 1604–1610.
- 45 Nunn E, King B, Smart C, Anderson D. A randomized controlled trial of telephone calls to young patients with poorly controlled type 1 diabetes. *Paediatr Diabetes* 2006; **7**: 254–259.
- 46 Moran G, Fonagy P, Kurtz A, Bolton A, Brook C. A controlled study of the psychoanalytic treatment of brittle diabetes. *J Am Acad Child Adolesc Psychiatry* 1991; **30**: 926–935.
- 47 Adepoju OE, Bolin JN, Phillips CD, Zhao H, Ohsfeldt RL, McMaughan DK et al. Effects of diabetes self-management programs on time-to-hospitalization among patients with type 2 diabetes: a survival analysis model. *Patient Educ Couns* 2014; **95**: 111–117.
- 48 Wagner DV, Barry SA, Stoeckel M, Teplitsky L, Harris MA. NICH at Its Best for Diabetes at Its Worst: Texting Teens and Their Caregivers for Better Outcomes. *J Diabetes Sci Technol* 2017; **11**: 468–475.
- 49 Lorig KR, Sobel DS, Stewart AL, Brown BW, Bandura A, Ritter P et al. Evidence suggesting that a chronic disease self-management program can improve health status while reducing hospitalisation: a randomised control trial. *Medical Care* 1999; **37**: 5–14.

Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix S1. Systematic review inclusion/exclusion criteria.

Appendix S2. Data collection form.

Appendix S3. Cochrane Collaboration data collection tool.