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REVIEW ARTICLE

A systematic review of the use of common behavioural interventions in oral health and diabetes management

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ABSTRACT

There has been a global rise in the prevalence of type 2 diabetes (T2DM) and it is expected to triple by 2030. Periodontal disease is one common complication of T2DM. As a result, there is potential for the use of common behavioural interventions in the management of both oral diseases and T2DM as a single intervention. To investigate the effectiveness of common behavioural interventions in the management of T2DM and oral diseases, and to synthesize the evidence of its effectiveness on both clinical and behavioural outcomes, a systematic review was conducted and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA). Data were extracted from MEDLINE, PsycARTICLES, and Web of Science. Only two studies met the preset inclusion criteria for the systematic review. In the intervention arms of both trials, there was a statistically significant reduction in HbA1c; and there were also improvements in glycaemic control, fasting blood glucose, and periodontal health. Although there is evidence in favour of the use of common behavioural interventions in the management of both oral diseases and T2DM, there is a need for more randomized controlled trials (RCTs) to investigate the use of common behavioural interventions using different populations, socioeconomic backgrounds, age groups, as well as provide a long-term follow-up.

INTRODUCTION

The World Health Organization [WHO] (2016) and the World Dental Federation [FDI] (2012) view oral health as an essential component of general health that influences health, well-being, and the quality of life. With increasing public health concerns in both the developing and the developed

countries, dental caries and periodontal diseases are among the most common oral diseases that make up the global burden of oral diseases (Petersen and Ogawa, 2012; WHO, 2012). The risk of periodontal disease increases with exposure to behaviours that are detrimental to health (such as cigarette smoking, cannabis smoking, and alcohol consumption) (Poulton et al., 2002). Periodontal diseases are known to manifest as oral health complications in patients with major non-communicable diseases (NCDs) such as type 2 diabetes (T2DM) (Kim and Amar, 2006). The Tokyo Declaration on Dental Care and Oral Health for Healthy Longevity (WHO 2015) calls upon health policymakers and professionals to significantly reduce the global disease burden, promote greater equity, and integrate oral health promotion into the NCDs prevention and control and development (WHO 2015).

T2DM has become a major 21st-century public health concern in both developing and developed countries (Sherifali et al., 2016). T2DM is life-limiting and reduces the quality of life, making up to 90% of the total burden of diabetes worldwide. By 2014 the worldwide prevalence of T2DM had increased to over 410 million (WHO, 2016), thereby raising the global adult prevalence of T2DM by 3.8% from 1980 to 2014 (Orlando et al., 2010; WHO, 2016). The International Diabetes Federation has postulated that by the next generation, the prevalence of T2DM could reach 640 million cases (International Diabetes Federation [IDF], 2019).

Periodontal diseases and T2DM are recognized as major constituents of NCDs (Sheiham and Watt, 2000). Periodontal attachment loss and the depth of periodontal pockets on probing are higher in T2DM patients than in the general population, indicating a high prevalence of periodontal diseases in people with T2DM (Apoorva et al., 2013). There is evidence of a bilateral association between T2DM and periodontal disease; which increases the risk of periodontal attachment loss and subsequent tooth loss in T2DM patients (Apoorva et al., 2013; Kim and Amar, 2006). T2DM shares modifiable behavioural risk indicators (i.e. smoking and diet) with periodontal disease (Petersen et al., 2005); and may also share some common biological risk factors. Usually, this relationship manifests as the presence of severe periodontitis in T2DM patients; and/or poorer glycemic control observed in T2DM patients with periodontitis(Casqueiro et al., 2012; Cinar et al., 2014).

Owing to the complexity of periodontal diseases and the inflammatory response of the host tissues; a compromised immunity due to T2DM may increase the individual's susceptibility to periodontitis and aggravate alveolar bone destruction in response to plaque accumulation (Llambés et al., 2015). In a randomized controlled cross over the clinical trial, Ramya and Kumar (2014) found that the presence of Vascular Endothelial Growth Factor (VEGF) was highest in the diseased periodontal sites of T2DM patients when compared against their healthy site and the diseased site of non-T2DM patients (Ramya & Kumar, 2014). This result is consistent with Franek et al. (2012) who found that periodontal diseases contribute negatively as a risk indicator to the complications of T2DM such as cardiovascular diseases.

Improving the periodontal status of T2DM patients may help minimize the complications of T2DM (Simpson et al., 2015); and improvement in the periodontal status of T2DM patients can affect glycemic control (measured by glycosylated hemoglobin (HbA1c)) and quality of life (Wang et al., 2014). The bilateral relationship, which could mean a reduction in HbA1c in T2DM patients, can reduce the severity of periodontal disease and improve periodontal health and hence general well-being (Cinar & Schou, 2014; Cinar et al., 2014; Saengtipbovorn & Taneepanichskul, 2014; Simpson et al., 2015).

Description of the Intervention

Behavioural and/or psychological interventions have been effective in managing dental caries and periodontal diseases and have also been used to achieve a reduction in dental plaque accumulation and improvement in oral hygiene behaviour (Jaedicke et al., 2019), tooth brushing frequency, and self-efficacy (Cinar and Schou, 2014a; b; c; Cinar et al., 2014). The complexity of T2DM management requires coordinated care involving a variety of healthcare providers, settings, and individuals working together to overcome the challenges of providing continuous, long-term patient-led self-management through behavioural interventions (Jaedicke et al., 2019; Sherifali et al., 2016). Behavioural interventions such as health coaching (Cinar and Schou, 2014a; b; Cinar et al., 2018, 2014; Sherifali et al., 2016; Wolever et al., 2010), motivational interviewing (Saengtipbovorn & Taneepanichskul, 2015, 2014), behaviour modification therapy, computer-based behavioural interventions, and cognitive behavioural therapy (Hoare et al., 2011); and empowerment for self-

management, self-monitoring, and self-efficacy (Cinar and Schou, 2014b; Grady and Gough, 2014, p.), oral hygiene instruction using health action process approach model (Jaedicke et al., 2019), have been effective in patients with poor oral health and both controlled and poorly controlled T2DM (Sherifali et al., 2016; Wolever et al., 2010).

Health-related behaviours are a reflection of the norms, values, and beliefs that prevail in an individual's social context and characteristic physical environment where the person lives (Shaw et al., 2009; Watt, 2012). Although the achievement of behaviour change is one of the most complex challenges, it is among the health professional's professional responsibilities, that they are to engage their knowledge and skills relating to behavioural sciences in advocating and preparing patients for self-management which is a vital key to successful management of T2DM and oral diseases (Cinar & Schou, 2014a; Shrivastava et al., 2013). T2DM patients who received support for self-care management as a patient-centered intervention reported improvement in glycemic control and oral health-related self-efficacy (Cinar and Schou, 2014a;b; Minet et al., 2010).

Why It Is Important to Do This Review

The use of a common interventions in the management of both T2DM and oral diseases using common risk factors approach (CRFA) is in line with the goal of the WHO that preventative oral health policies and strategies should be inclusive of NCDs (Cinar et al., 2014; Petersen, 2003; WHO, 2012). Over the last few decades, the use of CRFA as a conceptual framework in the prevention and management of the behavioural and social determinates of health has been at the forefront of WHO, FDI, and IDF strategies for oral diseases and NCDs (Cinar & Schou, 2014a; Watt, 2012; WHO, 2012).

Objectives

The main aim of this systematic review is to investigate whether common behavioural interventions have been effective in the combined management of T2DM and oral disease (dental caries and periodontal disease). A more specific aim is to assess the effectiveness of common behavioural interventions in achieving either clinical and/or behavioural outcomes such as the reduction in the level of HbA1c, dental caries, periodontal diseases, dental plaque and thereby improving oral health and general well-being.

METHODS

Data Sources

This systematic review was conducted and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) (Moher et al., 2009) and a search for similarities with ongoing systematic reviews was carried out using the International Prospective Register of Systematic Reviews (PROSPERO) Database ("PROSPERO," 2017). The Medline, Web of Science, and PsycArticles databases were searched for articles written in the English language and published between 1945 and 2019. Search terms were developed from similar reviews of diabetes health coaching (Pirbaglou et al., 2018; Sherifali et al., 2016) and Cochrane review papers (O'Malley et al., 2016; Simpson et al., 2015). Terms for oral health ("dental caries", "periodontal diseases" and "dental plaque accumulation"), diabetes ("type II diabetes, well-controlled and poorly controlled diabetes"), and behavioural/psychological interventions (including health coaching, health education, motivational interviewing, self-efficacy, and self-monitoring) were used.

Inclusion and Exclusion Criteria

We planned to include any study design that used behaviour-based approaches for both T2DM, and one or more oral diseases (i.e. dental caries and/or periodontal disease) provided there was pre-and post-intervention outcome measurement. We excluded studies that did not measure T2DM alongside oral health outcomes.

Data Extraction and Synthesis

The data on clinical characteristics (e.g. HbA1c, fasting blood/plasma glucose, clinical attachment loss, plaque index, gingival index, and probing depth), and non-clinical characteristics (e.g. study design, setting, sample size, intervention and control characteristics, age, sex, type of behavioural intervention and study duration) were extracted using a designed form. Synthesis was undertaken following guidelines in the Cochrane Handbook for Systematic Reviews (Cochrane Handbook for Systematic Reviews of Interventions, 2019) and 5.3 Cochrane Review Manager (RevMan 5) (Cochrane Community, 2014).

Summarizing Findings and Assessing the Quality of the Evidence

The quality of the included studies was assessed in line with the general risk of bias and publication bias, the results' inconsistency and the directness of the evidence, the size of

the effect and precision of the estimate (GRADEpro GDT & Cochrane GRADEing, 2017; Simpson et al., 2015; Wang et al., 2016).

RESULTS

Of the 8351 records identified, 45 were selected for full-text examination by the lead reviewer, Co-reviewers were consulted where it was not clear if a study should be rejected. Eleven articles met inclusion criteria. Out of these, four were classified as duplicated leaving seven for analysis. The seven articles reported different aspects of the two studies. This provided two studies eligible for analysis; the first study conducted by Cinar and Schou in 2014 was reported in five papers (Cinar and Schou, 2014a; b; c; Cinar et al., 2018, 2014) and the second conducted by Saengtipbovorn and Taneepanichskul (2014), was reported in two papers (Saengtipbovorn and Taneepanichskul, 2015, 2014).

The present review found some evidence of the effectiveness of the interventions in most of the oral health-related clinical parameters (i.e. clinical attachment loss, probing depth, gingival index, and plaque index). Furthermore, there is some evidence of the effectiveness of the interventions found in some of the behavioural parameters such as tooth brushing and tooth brushing self-efficacy. Generally, across the studies, the results showed an apparent and consistent reduction in HbA1c and an improvement in the oral health (periodontal health) of T2DM patients. This common behavioural intervention applied using a CRFA had a significant positive effect over the short (3 -6 months) follow-up period. The short-term effectiveness observed in this review is in agreement with the 3-4 month reduction in HbA1c estimated in a Cochrane review of the treatment of periodontal disease for glycemic control in people with diabetes mellitus (Simpson et al., 2015).

Characteristics of Included Studies

The key characteristics of included studies are shown in **Table 1**. Although both studies compared the effectiveness of a common behavioural intervention on both oral health and T2DM, each used different behavioural interventions, health coaching (Cinar & Schou, 2014a; b; c; Cinar et al., 2018, 2014) and lifestyle counseling via motivational interviewing (Saengtipbovorn & Taneepanichskul, 2015, 2014) compared to patients' routine diabetes-related activities. The comparators used in the studies were standard health education (Cinar & Schou, 2014a; b; c; Cinar et al., 2018, 2014) and patients' routine T2DM activities (Saengtipbovorn & Taneepanichskul, 2015, 2014). Both studies carried out baseline nonsurgical periodontal treatment. The study duration ranged from 6 to 18 months with assessments at 3 and 6-month after the start of the intervention.

The two studies involved a total of 318 participants; 186 (58.5%) (Cinar & Schou, 2014a; b; c; Cinar et al., 2018; 2014) and 132 (41.5%) (Saengtipbovorn & Taneepanichskul, 2015, 2014). One study involved middle-age adults between 30 to 65 years (Cinar & Schou, 2014a; b; c; Cinar et al., 2018, 2014); and the other older adults between 60 to 82 years (Saengtipbovorn & Taneepanichskul, 2015, 2014). Both studies included participants who had a previous clinical diagnosis of T2DM; with a slight difference in the baseline cutoff for HbA1c in both studies. Only one of the studies reported gender imbalance in favour of the females in both arms of the trials (Saengtipbovorn & Taneepanichskul, 2015, 2014). The exclusion of participants also varied based on communication ability, general health condition, and the number of teeth present. One study excluded those who could not speak Thai, those with serious blood and systemic diseases, severe periodontitis with less than 16 natural teeth (Saengtipbovorn & Taneepanichskul, 2015, 2014); whereas, less than four natural teeth, psychological treatment, and hospitalization led to exclusion in the other study (Cinar & Schou, 2014a; b; c; Cinar et al., 2018, 2014).

UNIT OF ANALYSIS ISSUES

Risk of Bias in the Included Studies

We assessed the risk of bias in all the included studies following the Cochrane Collaborative Tool for Assessing Risk of Bias in Randomized Controlled Trials (Higgins et al., 2011). Following this guide, the six domains of bias were assessed for each included study, and the risk of bias table **(Table 2)** was completed for each of the studies. One study was at high risk of bias while the other was at an unclear risk of bias.

Measurement of Treatment Effect

The studies were not large enough to conduct sensitivity analysis and meta-analysis regression. We also planned to use reported mean values and standard deviations to estimate the effects of the interventions using mean difference and 95% confidence interval.

Figure 1:
Study flow diagram

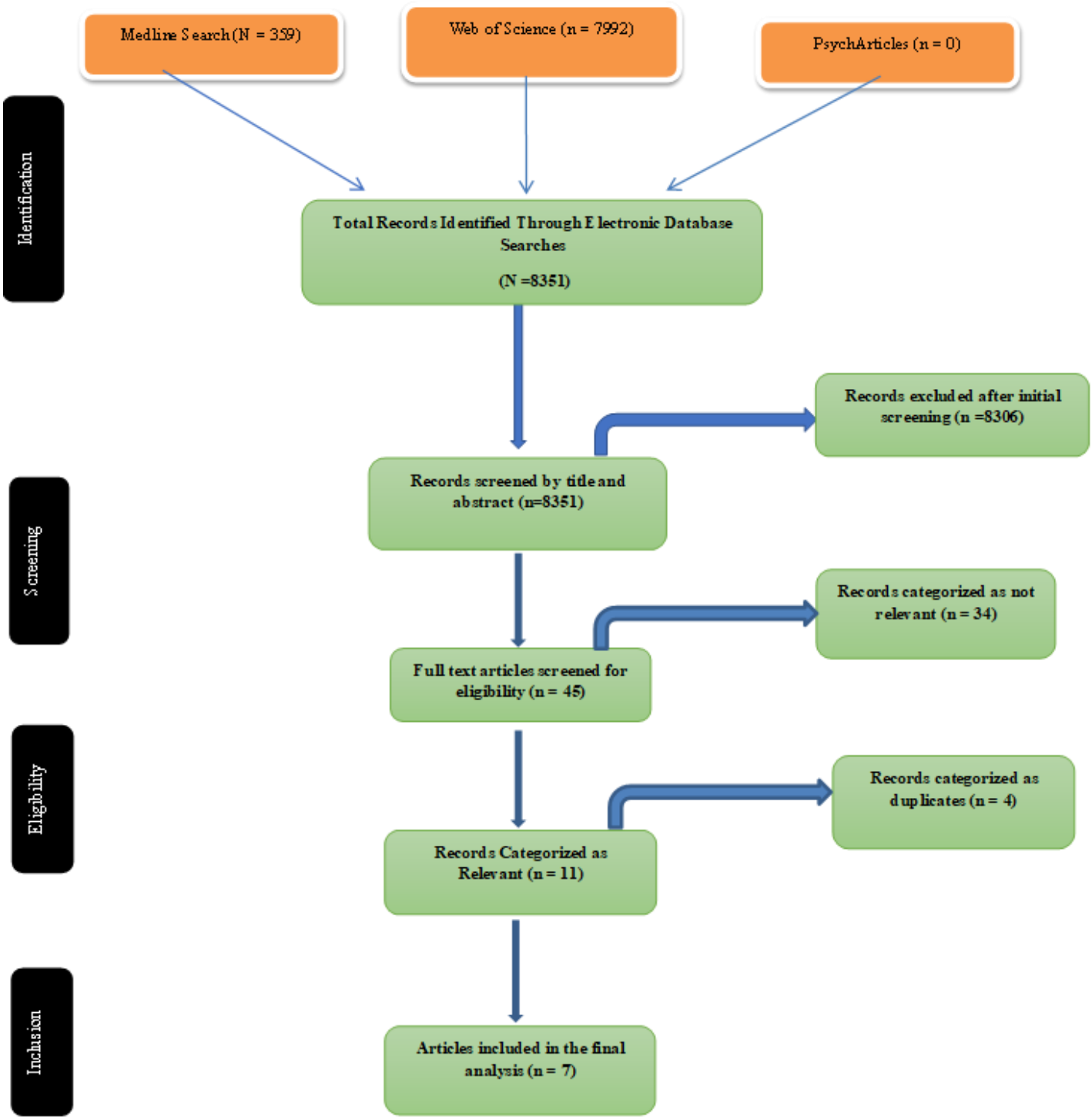

Table 1A:
Characteristics of Included Studies

STUDY	PLACE /YEAR	AIMS	PARTICIPANTS	SAMPLE SIZE	AGE	STUDY DESIGN	ALLOCATION METHOD
Cinar & Schou	Turkey 2014	Determine if a health coaching intervention will be more effective than formal health education in improving oral health status and glycaemic control in T2DM patients than	T2DM patients were randomly selected from an outpatient department of two hospitals in Istanbul Turkey	186. (Intervention= 77 / Control = 109)	30 - 65 years	prospective intervention study	Random allocation
Saengtipbovorn & Taneepanichskul	Thailand 2014	To assess the effectiveness of lifestyle change and a dental care program in the improvement of glycaemic control and periodontal status in aging T2DM patients	T2DM patients, 60 years and above	132. (Male = 47 & Females = 85) (Treatment = 66/ Control = 66)	≥ 60 years	A Cluster Randomized Controlled Trial	Random sample allocation

Table 1B:
Characteristics of Included Studies

STUDY	SELECTION	INTERVENTION	CONTROL	ANALYSIS	INCLUSION CRITERIA	EXCLUSION CRITERIA	DURATION	OUTCOME
Cinar & Schou	identified T2DM patients were selected from two different outpatient clinics in Istanbul turkey	Health coaching	Formal health education	Spearman's ranked correlation coefficient and independent sample t-test.	T2DM diagnosis 30 to 65 years old patient Presence of ≥4 functional teeth Non hospitalized and no psychological treatment	Declined from participation Not meeting all the criteria for inclusion	18 months	Patients in the health coaching group, more likely to be physically active, brush their teeth more than once a day, and had higher self-efficacy and improvement in tooth brushing self-efficacy from baseline. Tooth brushing self-efficacy groups in both arms showed a significant reduction in clinical attachment, but only patients in the health coaching group showed improvement in HbA1c and a greater reduction in clinical attachment level
Saengtipbovorn & Taneepanichskul	Participants were selected from two health centres in Bangkok Thailand (health centre 59 and health centre 54)	Individual Lifestyle counseling using motivational interviewing lifestyle and oral health education. goal setting 15-mins education buster video	Collected diabetes medications from the pharmacy Monthly Visited the doctor Making an appointment for the next visit	descriptive statistics, chi-squared Fisher exact test, and t-test.	The formal diagnosis of T2DM, Male and females. Presence of 16> natural teeth, 60 > years old	Presence of serious systemic disease Communication disorder Couldn't speak the Thai language Declined to participate	6 months	The use of an FDI for both glycaemic control and oral health improvement was effective in aging T2DM patients. At post-intervention, participants in the intervention group had lower HbA1c, probing depth, and attachment level. Improvement in all primary and secondary outcome measures sustained over the 6 months.

Table 2:
Risk of Bias Summary Table

DOMAIN OF BIAS	SELECTION BIAS		PERFORMANCE BIAS	DETECTION BIAS	ATTRITION BIAS	REPORTING BIAS	OTHERS
Type of Bias	Random Sequence Generation	Allocation Concealment	Blinding of Participants or Personnel	Blinding of Outcome Assessment	Incomplete Outcome Data	Selective Reporting	Anything Else
Cinar And Shou	Low	Low	unclear	Unclear	Low	Unclear	Low
Saengtipbovorn And Taneepanichskul	Low	Unclear	High	Unclear	Low	Unclear	Low

DISCUSSION

This systematic review is the first of its kind to evaluate as a primary research question the effectiveness of using common behavioural interventions in a combined approach for oral diseases (dental caries and periodontal disease) and T2DM management. Systematic reviews of the different components of the present review have found that diabetes health coaching is effective in the reduction of HbA1c (Sherifali et al., 2016) and that periodontal treatment may be associated with glycaemic control thereby reducing periodontal disease and HbA1c significantly within 3 to 4 months (Simpson et al., 2015).

Only two studies met the inclusion criteria with both evaluating the effect of individual lifestyle behavioural intervention as a CRFA in managing oral diseases and T2DM. These studies found some evidence that using a lifestyle change approach, delivered using lifestyle counseling via motivational interviewing (Saengtipbovorn & Taneepanichskul, 2015, 2014) and health coaching (Cinar & Schou, 2014a; b; c; Cinar et al., 2018, 2014) alongside dental care programme was effective in improving clinical and behavioural outcomes in T2DM patient populations. In the intervention arms of the trials, there were statistically significant reductions in the levels of HbA1c, improvements in glycaemic control, fasting blood glucose, and periodontal health (reduction in probing depth and attachment loss).

Based on the critical appraisal, the included studies have well-reported and useful results which can be used to answer the primary question of this review. The results of both trials are valid and clearly stated but may only be applicable globally if further evidence can be obtained from similar studies conducted in other countries where there may be different healthcare systems. The populations studied in the trials are adult T2DM patients with oral diseases. All the participating T2DM patients were identified from cluster-randomized health centres in Turkey and Thailand. For both psychological and clinical outcomes, health coaching was more effective than health education in the management of T2DM and oral health as a single non-pharmaceutical therapy. At the 3 monthly follow up the results of the study showed improvement in favour of the intervention groups for most of the parameters measured such as the biomedical outcomes, periodontal status, and knowledge and attitude towards oral health and T2DM.

Improvements were also observed in HbA1c, clinical attachment loss, tooth brushing self-efficacy, Stress and Problem Area in Diabetes Scale (SPADS). Furthermore, in the health coaching group, HbA1c had a 7% reduction but in the health education group, there was a negligible reduction in follow-up (change <1 %). For the fasting blood glucose, the health coaching group had almost twice as much reduction (12% reduction) than in the control group (6.2% reduction). On the other hand, the health coaching had a lower reduction in HDL cholesterol (2.4% reduction) than in the health education group (6.2% reduction).

Motivational interviewing (3-months post-intervention) improved biomedical outcomes, periodontal status, knowledge, and attitude towards oral health and T2DM. For the biomedical result reported, all the participants in the motivational interviewing group had a statistically significant reduction in the level of the HbA1c and fasting plasma glucose to about 0.29% decrease from baseline measurement in HbA1c level and 14.26mmol/l decrease for fasting plasma glucose. There was a statistically significant decrease in plaque and gingival indexes within the 3-months.

There was also a notable decrease in the periodontal pocket depth and clinical attachment in the intervention group; with the group being more likely to perform good oral health habits than those in the control groups. However, statistically, significant differences were only observed in the use of the salt solution and interdental flossing. The overall differences between the intervention and the control group for clinical attachment level, bleeding on probing, and periodontal pocket depth were statistically significant at 3 months of follow-up. There were statistically significant differences in the HbA1c and fasting plasma glucose between the intervention and the control group at 3-months follow-up. The differences between the intervention and the control groups for the measurement of knowledge and attitudes towards oral health and diabetes were statistically significant in favour of the intervention groups.

The major clinically important outcomes were considered in both studies with slight variation in the choice of primary and secondary outcomes. Both studies considered HbA1c, clinical attachment level/loss, and fasting blood/plasma glucose level as primary outcomes. One study considered cholesterol (HDL/LDL), tooth brushing, tooth brushing

self-efficacy, stress, and problem areas in diabetes as secondary outcomes(Cinar & Schou, 2014a; b; c; Cinar et al., 2018, 2014) while the other study considered plaque index (PI), gingival index (GI), and probing depth (PD) as secondary outcomes (Saengtipbovorn & Taneepanichskul, 2015, 2014). Both studies used a level of significance set at 5% with a 95% confidence interval while the power and sample size calculations were not properly documented. One study only reported using an 80% power and a required sample size of 55 based on an unreported calculation. The authors of both studies did not report how precise the estimate of their treatment effect was nor did they report any health economic analysis.

We were unable to conduct a meta-analysis because there was no minimum of four studies with little statistical and clinical heterogeneity between these studies. Once further work is conducted, a random effect model could be used to combine qualitative data for meta-analysis. Considering the overall completeness and applicability of the evidence, the review assessed two sets of populations - middle age and elderly with the age range of 30 to 82 years old. The studies were carried out in only two countries where the health centres served a population of similar socio-economic status (SES) and socio-cultural characteristics. Most of the participants were between 50 – 69 years old, only had primary education or less, were mostly unemployed, and with gender imbalance in favour of women. The applicability of behavioural intervention in clinical practice in terms of management of T2DM and periodontal disease, therefore, needs further investigation using different populations.

CONCLUSION

This systematic review is the first attempt to bring together the available body of evidence surrounding the use of common behavioural intervention in the combined management of T2DM and oral diseases. The findings from the reviewed studies remain the only available evidence; hence there is a need for further research. While clinical decisions about treatments cannot completely be based on this level of evidence, we are confident that a good scientific foundation has been laid by these two studies for further exploration of this common behavioural intervention approach, for oral health and T2DM management. In practice, although common behavioural interventions are advocated by the WHO, FDI and IDF, as a comprehensive care approach using CRFA, they are still under-researched. A Cochrane review has recommended that continuous professional periodontal therapy may be needed to sustain the observed clinical improvement beyond six months (Simpson et al., 2015). Larger, well-conducted randomized controlled trials are needed to evaluate the use of this approach on different populations, from different SES backgrounds, age groups, as well as provide a long-term follow-up period that is at least one year. In addition to being instrumental in identifying major gaps in knowledge; the findings from this review may be used as a basis for future behavioural intervention studies; designed to manage both T2DM and oral diseases using a CRFA. Nevertheless, we advocate for more robust studies to be carried out on the T2DM patient groups that were not examined in these papers to generate further understanding of the use of this approach for both T2DM and oral diseases.

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Conflict of Interest: The authors declare no conflict of interest.

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