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International Diabetes Federation

Review

Systematic review of clinical practice guidelines to identify recommendations for sleep in type 2 diabetes mellitus management

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ABSTRACT

Introduction: Sleep quality, quantity and timing have been shown to impact glycaemic control, with a role in insulin sensitivity, glucose tolerance and HbA1C levels, in both diabetic and non-diabetic populations. The aim of this study was to identify recommendations for sleep assessment and management in international clinical practice guidelines focused on type 2 diabetes mellitus management in adults.

Study design: Systematic Review.

Methodology: Clinical practice guidelines which focused on the management of type 2 diabetes mellitus in adults were included (n = 35). Two independent reviewers utilised the Appraisal of Guidelines for Research and Evaluation tool (AGREE) II and a third reviewer resolved any disagreements. Included guidelines were assessed for recommendations about sleep in diabetes management (n = 14). Data were extracted on sleep recommendations ,themes were generated from the extracted data and narrative syntheses were created.

Results: From 1114 identified papers, 35 guidelines met the inclusion criteria. Fourteen of these guidelines included recommendations pertaining to sleep, which broadly fell into five categories; sleep assessment, sleep as a therapeutic target, sleep and co-morbidities of type 2 diabetes mellitus, shift work and sleep and driving. Recommendations varied across guidelines.

Conclusion: Few guidelines provided recommendations relating to assessment and management of sleep in type 2 diabetes care. Most of the recommendations were related to obstructive sleep apnoea. However, few guidelines discussed sleep as a therapeutic intervention for diabetes mellitus or described the potential importance of sleep quality and duration in glycaemic control.

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Contents

1. Introduction

Diabetes is an increasing global health challenge affecting 8% of the adult population worldwide [1]. The International Diabetes Federation (IDF) estimates that there will be 578 million adults living with diabetes by 2030 and 700 million by 2045 [2]. There are multiple diabetes complications including microvascular (retinopathy, nephropathy, and neuropathy) and macrovascular (cardiovascular disease and stroke) difficulties that translate to reduced quality of life and longevity [3,4].

Lifestyle modification is the cornerstone for managing type 2 diabetes mellitus (T2DM), the most prevalent type of diabetes [5]. Diet, exercise, stress, and medication management are key mediators and enablers of glycaemic control [6]. These are strongly influenced by self-management through individual behaviour and action [7]. Apart from the traditional lifestyle factors, such as diet, physical activity, and smoking, there is increasing awareness of the impact of sleep behaviours and sleep disorders on glycaemic control. Short sleep and sleep disturbance are common amongst people with T2DM with approximately 39% sleeping less than 6.5 h per night [8], and 55% experiencing poor sleep quality [9]. A number of systematic reviews have highlighted the impact of sleep quantity and quality on glycaemic control in both people with [10,11] and without [12] diabetes. Short and long sleep duration have been identified as risk factors for developing T2DM [12,13]. Sleep duration and quality [14] are associated with decreased insulin sensitivity, increased fasting plasma glucose [10,11], and elevated HbA1c [10,11]. Sleep duration of less than 6 h or>9 h is associated with increased cardiometabolic risk in people with T2DM [15]. As well as sleep duration, altered sleep timing associated with shift work have also been associated with an increased risk of T2DM [16] and poorer glycaemic control in those with T2DM [17]. Furthermore,'catch up' weekend sleep is not enough to reverse the impeded insulin sensitivity seen in prolonged short sleep duration periods [18]. Obstructive sleep apnoea (OSA) has also been implicated in dysregulated glucose homeostasis and diabetes [19–24]. The mechanisms accounting for OSA and metabolic disease include hypoxaemia, sleep fragmentation and systemic inflammation [25–28]. Optimal sleep quality and subsequent reduction in HbA1c among people with type 2 diabetes has been associated with a 3% reduction in deaths, 2% reduction in myocardial infarction and a 5% reduction in microvascular complications [11].

The assessment of sleep duration and quality can be achieved through self-monitoring of sleep and its disorders as well as specific clinical assessments conducted at home or within the sleep laboratory [29]. These can be linked to a range of specific measures to address issues with sleep duration and quality. Addressing sleep duration, quality, and sleep disorders may provide an effective strategy to support optimal glycaemic control. With the emerging body of evidence on sleep and glycaemic control [11], this review explores the extent to which recommendations for sleep assessment and sleep management for people living with T2DM have been incorporated into international clinical practice guidelines.

Furthermore, for those guidelines that include recommendations relating to sleep, we aimed to identify the recommendations, assess methodological quality of the guidelines, the levels of evidence underpinning the recommendations and consistency of advice across guidelines. Assessment and management of sleep in patients with T2DM is a quick, inexpensive process, which can support in optimising glycaemic control.

2. Methods

This systematic review has been registered with PROSPERO (registration number: CRD42020142136) and was conducted according to PRISMA guidelines.

2.1. Eligibility criteria

This review considered any clinical practice guideline (CPG) on the management of type 2 Diabetes Mellitus as per the definition from the National Guideline Clearinghouse, "Clinical practice guidelines are statements that include recommendations intended to optimize patient care that are informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options." [30]. Clinical practice guidelines that were evidence-based and published by a professional society, government bodies, or national and international diabetes associations that focused on the treatment of T2DM in adults, were included in this study. Clinical practice guidelines for the prevention of diabetes, gestational diabetes, pre-diabetes, type 1 diabetes mellitus, and specifically for T2DM in children, adolescents, and elderly populations, were excluded. However, if a guideline covered all populations, and a section addressed the management or assessment of T2DM in adults, it was included. If a guideline exclusively covered the management of diabetes comorbidities, then it was excluded. A guideline was excluded if it was a draft, unpublished, a conference paper, included position statements, an opinion piece, a discussion paper, or a review and summary of a CPG where the full guideline was available elsewhere. Any historical CPGs that had subsequently been updated, or published before 2010 were excluded, as these were considered to be out of date with respect to current clinical practice. Only CPGs written in English, or an English summary of CPG were included.

This review focused on diabetes management, lifestyle factors, sleep (including OSA), and comorbidities linked with sleep. Nocturnal hypoglycaemia was excluded, as the focus of this study was to identify recommendations around sleep assessment and sleep management.

2.2. Search strategy

The Guidelines International Network (GIN), Guideline Central, National Heath & Medical Research Council (NHMRC), National Institute for Health and Care Excellence (NICE), Scottish Intercollegiate Guidelines Network (SIGN), and Google were searched using the terms "type 2 diabetes mellitus" and "clinical practice guidelines". Websites of national and international diabetes organisations were also hand searched. The search was completed in September 2020. Databases searches for published CPGs were conducted in MEDLINE, CINAHL, and EMBASE, with the following search string: (adult* OR ((MH "Adult"))) AND (("clinical practice guideline*") OR ("clinical practice guidelines") OR ((MH "Practice Guideline") OR (MH "Practice Guidelines as Topic"))) AND (("type 2 diabetes") OR ("diabetes type 2") OR ("diabetes mellitus type 2") OR ("diabetes 2") OR ("non insulin dependent diabetes") OR ("non insulin dependent diabetes mellitus") OR ((MH "Diabetes Mellitus, Type 2")) OR T2DM). Publication dates were limited to 2010–2020 and English language.

2.3. Study screening and selection

References were exported to Endnote, then duplicates removed and hand-checked to remove additional duplicates. Titles and abstracts were screened by one reviewer using inclusion and exclusion criteria. The CPG titles were sourced from these research articles, and full text CPGs were searched via Google Search or the relevant international diabetes associations.

2.4. Appraisal of guidelines

Fourteen CPGs which contained sleep recommendations were independently appraised by two reviewers (Table 2) using the AGREE-II instrument [65] Where there was disagreement among reviewers, a third reviewer also appraised the guideline. The AGREE-II tool is used to assess the quality of CPGs, and contains 23 items organised into six domains (Scope and Purpose, Stakeholder Involvement, Rigour of Development, Clarity of Presentation, Applicability, Editorial Independence) [65]. A seven point Likert scale is used to answer each question which ranges from strongly disagree (1) to strongly agree (7), total score range 23–161. The final score assigned to each guideline was an average of the reviewer's scores. Overall confidence in the guidelines were judged as follows: 'the guideline was strongly recommended' (four of six domains $\geq$ 60%; 'the guideline was recommended with modifications (at least two domains > 60%); 'the guideline was not recommended due to serious problems according to AGREE criteria appraisal (three of six domains less than 30% or no domain > 60%) [66]. Any bias in the guidelines were accounted for in the appraisals.

2.5. Data extraction and synthesis

The following descriptive data were extracted from all 35 CPGs: country, guideline organisation/society/authors, guidelines name(s) (including whether the guideline was a new or updated version), year of publication, target users, guideline writers, guideline review process, and search strategy for evidence (Table 1). Textual descriptive synthesis was undertaken of all included CPGs (n = 14) to analyse the scope and context of each guideline. Guidelines were initially read by one author (MD) to identify content within the CPGs pertaining to sleep. Another author (AS) extracted and coded relevant content to separate data out into relevant domains. Each CPG was compared across each domain for context and consistency of

Table 1 – Characteristics of included guidelines.

Guideline organisation/society/ authors	Guideline name(s)	Year of publication	Target users	Guideline writers	Guideline review process	Search strategy for evidence
Australia, JBI [31]	Educational interventions to promote oral hypoglycaemic adherence in adults with type 2 diabetes	2011	Health professionals	N/A	N/A	Systematic literature review
Australia, JBI [32]	The experiences of, and meaning for, women living and coping with type 2 diabetes	2012	Health professionals	Multidisciplinary	N/A	Systematic literature review
Australia, JBI [33]	The effectiveness of nurse-led care in general practice on clinical outcomes in adults with type 2 diabetes	2012	Health professionals	Multidisciplinary	N/A	Systematic literature review
Australia, Royal Australian College of General Practitioners/Diabetes Australia [34]	General practice management of type 2 diabetes	2016	Health professionals	Diabetes experts	N/A	Literature search
Belgium, International Diabetes Federation [35]	IDF Clinical practice recommendations for managing type 2 diabetes in primary care	2017	Primary care physicians who care for patients with T2DM	Multidisciplinary	Reviewers	Systematic literature review
Canada, CADTH- Canadian Agency for drugs and Technologies in Health [36]	CADTH optimal use report. Second-Line Pharmacotherapy for Type 2 Diabetes – Update	2013	Canadian healthcare decision-makers, healthcare professionals, health systems leaders, and policy-makers	N/A	N/A	Systematic literature review
Canada, CADTH- Canadian Agency for drugs and Technologies in Health [37]	Optimal use report- optimal use recommendations for second- and third-line therapy for patients with type 2 diabetes	2013	Canadian healthcare decision-makers, healthcare professionals, health systems leaders, and policy-makers	Multidisciplinary	N/A	Systematic literature review
Canada, Diabetes Canada [38]	Diabetes Canada 2018 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada	2018	Healthcare professionals for individuals with diabetes, and individuals at risk of diabetes	Multidisciplinary	National and international expert reviewers	Systematic literature review
China, Diabetes Association of the Republic of China (Taiwan) [39]	Executive summary of the DAROC clinical practice guidelines for diabetes care-2018. The full guideline is in Chinese	2018	N/A	Multidisciplinary	N/A	N/A

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Guideline organisation/society/ authors	Guideline name(s)	Year of publication	Target users	Guideline writers	Guideline review process	Search strategy for evidence
Columbia, Columbia Medica [40]	Clinical practice guideline for the prevention, early detection, diagnosis, management and follow up of type 2 diabetes mellitus in adults. The document is a summary. The full guideline is in Spanish	2016	Adults 18 years and over, who have diabetes, or are at risk of diabetes. Healthcare personnel involved in diabetes treatment, nutrition specialists, staff of insurance companies and healthcare service providers	Multidisciplinary	International reviewers	Systematic search (systematic reviews)
Columbia, Guide for Health Professionals [41]	Clinical Practice Guide for the diagnosis, treatment and follow up of type 2 diabetes mellitus in population over 18 years old	2016	Health professionals including GPs, endocrinology specialists, Primary Health care workers, Nutritionists, patients, insurance providers.	Multidisciplinary	N/A	N/A
International Diabetes Federation Guideline Development Group [42]	Global Guidelines for Type 2 Diabetes	2014	Healthcare professionals	Multidisciplinary	National and international expert reviewers	N/A
India, RSSDI [43]	RSSDI clinical practice recommendations for the management of type 2 diabetes mellitus 2017	2017	Healthcare professionals	Multidisciplinary	N/A	Literature searches
International, 2nd diabetes surgery summit [44]	Surgical treatment for type 2 diabetes, summary of recommendations and guidelines from the 2nd diabetes surgery summit (DSS-II) Paper: Metabolic surgery in the treatment algorithm for type 2 diabetes: a joint statement by International Diabetes organisations	2016	N/A	Multidisciplinary	N/A	N/A
International, WHO [45]	Guidelines on second-and third-line medicines and type of insulin for the control of blood glucose levels in non-pregnant adults with diabetes mellitus	2018	Policy-makers, national diabetes programme managers, procurement officers, clinicians, and healthcare professionals for treating diabetes	Multidisciplinary	National and international expert reviewers	Systematic literature review

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Guideline organisation/society/ authors	Guideline name(s)	Year of publication	Target users	Guideline writers	Guideline review process	Search strategy for evidence
Japan, Japan Diabetes Society [46]	Japanese Clinical Practice Guidelines for Diabetes 2016. The full guideline is in Japanese, and available from Diabetology International	2016	Clinical practitioners	Multidisciplinary	N/A	Systematic literature review
Korea, Korean Diabetes Association [47]	2019 Clinical Practice Guidelines for Type 2 Diabetes Mellitus in Korea	2019	N/A	Multidisciplinary	N/A	N/A
Malaysia, Ministry of Health, Malaysian Endocrine and Metabolic Society, Academy of Medicine, Diabetes Malaysia, Family Medicine Specialists Association of Malaysia [48]	Clinical Practice Guidelines Management of type 2 Diabetes Mellitus (5th edition)	2015	Healthcare professional treating patients with T2DM	Multidisciplinary	External reviewers	Systematic literature review
Pakistan, National Association of Diabetes Educators of Pakistan [49]	Pakistan's Recommendations for Optimal Management of Diabetes from Primary to Tertiary care level (PROMPT)	2017	Healthcare professionals	Multidisciplinary	N/A	N/A
Poland, Diabetes Poland (Polish Diabetes Association) [50]	2019 Guidelines on the management of diabetic patients, a position of Diabetes Poland	2019	N/A	Multidisciplinary	N/A	N/A
Portugal and Brazil, Diabetology & Metabolic Syndrome [51]	Portuguese-Brazilian evidence-based guideline on the management of hyperglycemia in type 2 diabetes mellitus	2020	Healthcare professionals	Multidisciplinary	Public consultation	Narrative Literature review
Qatar, Clinical Guidelines for the state of Qatar [52]	The diagnosis and management of type 2 diabetes in adults and the elderly	2016	Physicians in primary care and outpatient settings	Multidisciplinary	N/A	Literature search
Scotland, SIGN (Scottish Intercollegiate Guidelines Network) [53]	SIGN 154 Pharmacological management of glycaemic control in people with type 2 diabetes	2017	Healthcare professionals of T2DM, such as diabetologists, diabetes specialist nurses, general practitioners, pharmacists, practice nurses, people with T2DM, carers, voluntary organisations, policy makers	Multidisciplinary	Independent expert referees	Systematic literature review

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Guideline organisation/society/ authors	Guideline name(s)	Year of publication	Target users	Guideline writers	Guideline review process	Search strategy for evidence
Scotland, SIGN (Scottish Intercollegiate Guidelines Network) [54]	SIGN 116 Management of diabetes A national clinical guideline	2010	Healthcare professionals of diabetes, people with diabetes, carers, people who interact with diabetes patients outside of the NHS	Multidisciplinary	Independent expert referees	Systematic literature review
Singapore, Ministry of Health, Singapore [55]	Diabetes Mellitus MOH Clinical Practice Guidelines	2014	Physicians, patients	Multidisciplinary	N/A	N/A
South Africa, Society for Endocrinology, Metabolism and Diabetes of South Africa [56]	SEMDSA 2017 Guidelines for the Management of Type 2 diabetes mellitus	2017	Healthcare professionals	Multidisciplinary	N/A	Literature searches and reviews
UK, NICE (National Institute for Health and Care Excellence) [6]	Type 2 diabetes in adults: management NG28	2015	Healthcare professionals that care for adults with diabetes, commissioners and providers of diabetes services, adults with T2DM, families, carers	N/A	N/A	N/A
USA, American Association of Clinical Endocrinologists and American College of Endocrinology [57]	American Association of Clinical Endocrinologists and American College of Endocrinology-Clinical Practice Guidelines for developing a diabetes mellitus comprehensive care plan-2015	2015	Healthcare professionals	Multidisciplinary	Internal reviewers	Literature reviews
USA, American College of Physicians [58]	Oral Pharmacological Treatment of T2DM: A Clinical Practice Guideline Update from the American College of Physicians	2017	All clinicians, nonpregnant adults with T2DM	Physicians	Internal reviewers, and specialists	Systematic literature review
USA, American College of Physicians [59]	Haemoglobin A1c Targets for Glycaemic Control With Pharmacologic Therapy for Nonpregnant Adults With Type 2 Diabetes Mellitus: A Guidance Statement Update From the American College of Physicians	2018	All clinicians, nonpregnant adults with T2DM	Physicians	External review, and public panel reviewers	Consensus, expert-based guideline

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Guideline organisation/society/ authors	Guideline name(s)	Year of publication	Target users	Guideline writers	Guideline review process	Search strategy for evidence
USA, American Diabetes Association [60]	ADA Standards of medical care in diabetes-2020	2020	Clinically oriented physicians, researchers, epidemiologists, psychologists, diabetes educators, and other health professionals	Multidisciplinary	Internal reviewers	Literature search
USA, ICSI Institute for Clinical Systems Improvement [61]	Diagnosis and Management of Type 2 Diabetes Mellitus in Adults	2014	ICSI Member and Sponsor organisations, organisations delivering care within Minnesota borders, within the organisation, to employees, and anyone involved in the guideline creation process	Multidisciplinary	Internal reviewers	Systematic literature review
USA, Joslin Center [62]	Joslin Diabetes Center and Joslin Clinic Clinical Guidelines for adults with diabetes	2017	Primary care physicians, and specialists	Multidisciplinary	N/A	Literature review
USA, University of Michigan [63]	Management of type 2 diabetes	2012	N/A	Multidisciplinary	N/A	Literature search
USA, VA/DoD [64]	VA/DoD Clinical Practice Guidelines for the management of type 2 diabetes mellitus in primary care	2017	Healthcare providers	Multidisciplinary	External reviewers	Systematic literature review

Table 2 – Quality appraisal according to AGREE for the 14 sleep studies.

Guideline organisation/ society/authors	Domain scores (%) Scope and purpose	Stakeholder involvement	Rigour of development	Clarity and presentation	Applicability	Editorial independence	Mean domain scores (%)	Overall guideline recommendation Recommended for future use
Australia, Royal Australian College of General Practitioners/Diabetes Australia (2016) [34]	58.7	57.1	52.4	76.2	54.8	33.3	55.7	Not recommended
Canada, Diabetes Canada (2018) [38]	71.4	71.4	73.2	100.0	57.1	50.0	71.4	Strongly recommended
International Diabetes Federation (2014) [42]	76.2	57.1	60.7	92.9	62.5	60.7	66.8	Strongly recommended
India, RSSDI (2017) [43]	73.8	54.8	47.3	73.8	67.9	78.6	61.5	Strongly recommended
Japan, Japan Diabetes Society (2016) [46]	90.5	64.3	76.8	100.0	53.6	32.1	72.0	Strongly recommended
Malaysia, Ministry of Health, Malaysian Endocrine and Metabolic Society, Academy of Medicine, Diabetes Malaysia, Family Medicine Specialists Association of Malaysia (2015) [48]	92.9	71.4	75.0	95.2	62.5	75.0	77.3	Strongly recommended
Poland, Diabetes Poland (Polish Diabetes Association) (2019) [50]	73.0	34.9	33.3	79.4	39.3	31.0	45.5	Recommended with modification
Qatar, Clinical Guidelines for the state of Qatar (2016) [52]	73.8	64.3	31.3	88.1	33.9	35.7	49.4	Recommended with modification
Singapore, Ministry of Health, Singapore (2014) [55]	78.6	59.5	53.6	92.9	25.0	14.3	54.3	Recommended with modification
South Africa, Society for Endocrinology, Metabolism and Diabetes of South Africa (2017) [56]	76.2	57.1	60.1	76.2	57.1	45.2	62.1	Recommended with modification
USA, American Association of Clinical Endocrinologists and American College of Endocrinology (2015) [57]	95.2	61.9	58.9	97.6	30.4	46.4	63.0	Recommended with modification

Table 2 – Quality appraisal according to AGREE for the 14 sleep studies.

	Domain scores (%)							Overall guideline recommendation
Guideline organisation/ society/authors	Scope and purpose	Stakeholder involvement	Rigour of development	Clarity and presentation	Applicability	Editorial independence	Mean domain scores (%)	Recommended for future use
USA, American Diabetes Association (2020) [60]	76.2	63.5	49.4	95.2	60.7	73.8	64.8	Strongly recommended
USA, ICSI Institute for Clinical Systems Improvement (2014) [61]	82.5	65.1	58.9	90.5	51.2	78.6	67.3	Strongly recommended
USA, Joslin Center (2017) [62]	73.8	66.7	47.3	61.9	30.4	14.3	49.4	Recommended with modification

content. Individual sleep-related recommendations were graded based on the level of evidence provided within the guideline to support the recommendation (Table 3). Grading was based upon evidence rating levels for production of CPGs, as per the American Association of Clinical Endocrinologists [57]. Grade 1 evidence is comprised of randomised controlled trials, grade 2 evidence is comprised of systematic reviews, non-randomised controlled trials, cohort studies and case controls studies, grade 3 evidence includes cross sectional studies, surveillance studies, case series and case reports, and grade 4 evidence includes expert opinion, consensus or no evidence. Data extraction and syntheses was verified by a second reviewer (MJ).

3. Results

3.1. *Search and guideline characteristics*

The systematic electronic database search strategy identified 1035 publications, with 786 remaining after duplicates were removed. After screening titles and abstracts, 35 full text articles were assessed based on T2DM inclusion criteria, and six were identified as CPGs (Fig. 1: PRISMA) [67]. Further systematic searching of guideline databases was conducted, and 91 articles were found based on T2DM inclusion criteria. Fifty-seven articles were retrieved from the Guideline International Network (GIN), 10 articles were identified through Guideline central, while further hand searching identified 24 articles for inclusion. From these 127 articles, 35 CPGs were identified as relating to T2DM (Table 1). Guidelines were retrieved from Australia, Belgium, Canada, China, Columbia, India, Japan, Korea, Malaysia, Pakistan, Poland, Qatar, Scotland, Singapore, South Africa, United Kingdom, United States of America (USA), and from international collaborations. Of the 35 included CPGs focused on T2DM management, 14 mentioned sleep within the guidelines (Table 2).

3.2. *Methodological quality*

The AGREE-II tool was used to assess methodological quality of the included 14 sleep CPGs (Table 2). The domains with the mean scores from highest to lowest, were Clarity and Presentation (82.0%), Scope and Purpose (79.3%), Stakeholder Involvement (61.0%), Rigour of Development (56.0%), Editorial Independence (46.7%), and Applicability (46.0%). The mean score for all domains combined, is 60.5%. Based on the overall AGREE-II scores, guidelines were assigned a methodological quality (Not recommended; recommended with modification; strongly recommended). Seven guidelines were rated as strongly recommended, six guidelines were rated as recommended for use after modification, and one guideline was not recommended.

3.3. *Synthesis of recommendations*

Fourteen guidelines included sleep in their recommendations [34,38,42,43,46,48,50,52,55–57,60–62]. These CPGs were analysed and four major findings were identified regarding their sleep-related content: (i) sleep as a risk factor for T2DM along with sleep assessment in T2DM; (ii) sleep as a therapeutic target in T2DM; (iii) sleep and T2DM comorbidities; (iv) sleep and driving in T2DM; and (v) shift work. Recommendations were based on varied levels of evidence (Table 3).

3.3.1. *Sleep assessment/ sleep as a risk factor for type 2 diabetes mellitus*

Of the fourteen guidelines, eight included recommendations for assessment of sleep quality, quantity and/or symptoms of OSA [34,38,46,52,57,60–62]. Whilst some guidelines recommended either initial or periodic assessment of sleep quality and quantity and/or OSA [34,52,57,60,62], other guidelines included sleep as a potential risk factor for diabetes without providing any assessment recommendations [46]. Short and long sleep duration was described as a risk factor for diabetes in two CPGs [43,46]. Sleep apnoea was described as modifiable risk factor for T2DM, OSA was described as an independent or modifiable risk factor for diabetes in two CPG [38], and OSA, chronic sleep deprivation, and night-shift occupation were described as risk factors for both pre-diabetes and T2DM [57]. Several guidelines identified the prevalence of OSA [60,61] especially among obese T2DM and the importance of referring patients with potential OSA for specialist assessment [61]. Increased prevalence of general sleep disorders in those with T2DM compared to the general population was noted in one CPG [38].

3.3.2. *Sleep as a therapeutic target as a risk factor for type 2 diabetes mellitus*

Optimising sleep duration and quality and the management of sleep disorders was discussed as a therapeutic approach in six guidelines [34,43,50,57,60,61]. Three guidelines recommended optimal sleep duration as a therapeutic target of lifestyle intervention and self-management education [43,50,57] with one guideline identifying optimal sleep as a means of achieving glycaemic targets in T2DM [57]. One guideline suggested considering OSA if patients were having difficulty achieving treatment goals [61]. One guideline identified how successful treatment of OSA can lower fasting and post-prandial glucose levels and HbA1C equivalent to, or more than, oral medication with a concomitant improvement in cardiovascular outcomes [57]. Another CPG identifies that sleep disruption due to OSA or any other reason, can result in aggravated insulin resistance and hyperglycaemia [34]. One guideline identified the mixed evidence on glycaemic control effects of OSA treatment [60].

3.3.3. *Sleep and comorbidities as a risk factor for type 2 diabetes mellitus*

Sub-optimal sleep was identified as potentially causing or contributing to a number of diabetic comorbidities in 12 (86%) guidelines [34,38,42,43,48,50,55–57,60–62]. Six guidelines (43%) highlighted the role of OSA in cardiovascular diseases [34,50,56,60–62]. Two guidelines identified ‘sleep disruption of any cause’ as aggravating hypertension [34,57]. Obstructive sleep apnoea was described as prevalent in two CPGs [60,61] and an associated risk factor for hypertension (HTN) [60,61] and cardiovascular disease [56,60,61]. One guideline suggested testing for OSA in T2DM with persistent hypertension

Table 3 – Strength of evidence for sleep-related recommendations.

CPG	Sleep Assessment/ Sleep as a risk factor for T2DM	Sleep as a therapeutic target in T2DM	Sleep and comorbidities of T2DM	Sleep and Driving in T2DM	Shift work, sleep duration, sleep timing
USA, American Association of Clinical Endocrinologists and American College of Endocrinology (2015) [57]	4	4	3	N/A	4
USA, American Diabetes Association (2020) [60]	2	4	2	N/A	2
Canada, Diabetes Canada (2018) [38]	2	N/A	2	3	N/A
USA, ICSI Institute for Clinical Systems Improvement (2014) [61]	1	4	1	N/A	N/A
International Diabetes Federation (2014) [42]	N/A	N/A	4	N/A	N/A
India, RSSDI (2017) [43]	N/A	2	2	N/A	4
Japan, Japan Diabetes Society (2016) [46]	2	N/A	N/A	N/A	2
USA, Joslin Center (2017) [62]	1	N/A	1	N/A	4
Malaysia, Ministry of Health, Malaysian Endocrine and Metabolic Society, Academy of Medicine, Diabetes Malaysia, Family Medicine Specialists Association of Malaysia (2015) [48]	N/A	N/A	4	N/A	N/A
Poland, Diabetes Poland (Polish Diabetes Association) (2019) [50]	N/A	4	4	N/A	4
Qatar, Clinical Guidelines for the state of Qatar (2016) [52]	2	N/A	N/A	N/A	N/A
Australia, Royal Australian College of General Practitioners/ Diabetes Australia (2016) [34]	3	3	3	2	N/A
South Africa, Society for Endocrinology, Metabolism and Diabetes of South Africa (2017) [56]	N/A	N/A	4	4	N/A
Singapore, Ministry of Health, Singapore (2014) [55]	N/A	N/A	4	N/A	N/A

1- Evidence level 1; 2- Evidence level 2; 3- Evidence level 3; 4- Evidence level 4; N/A Not Applicable.

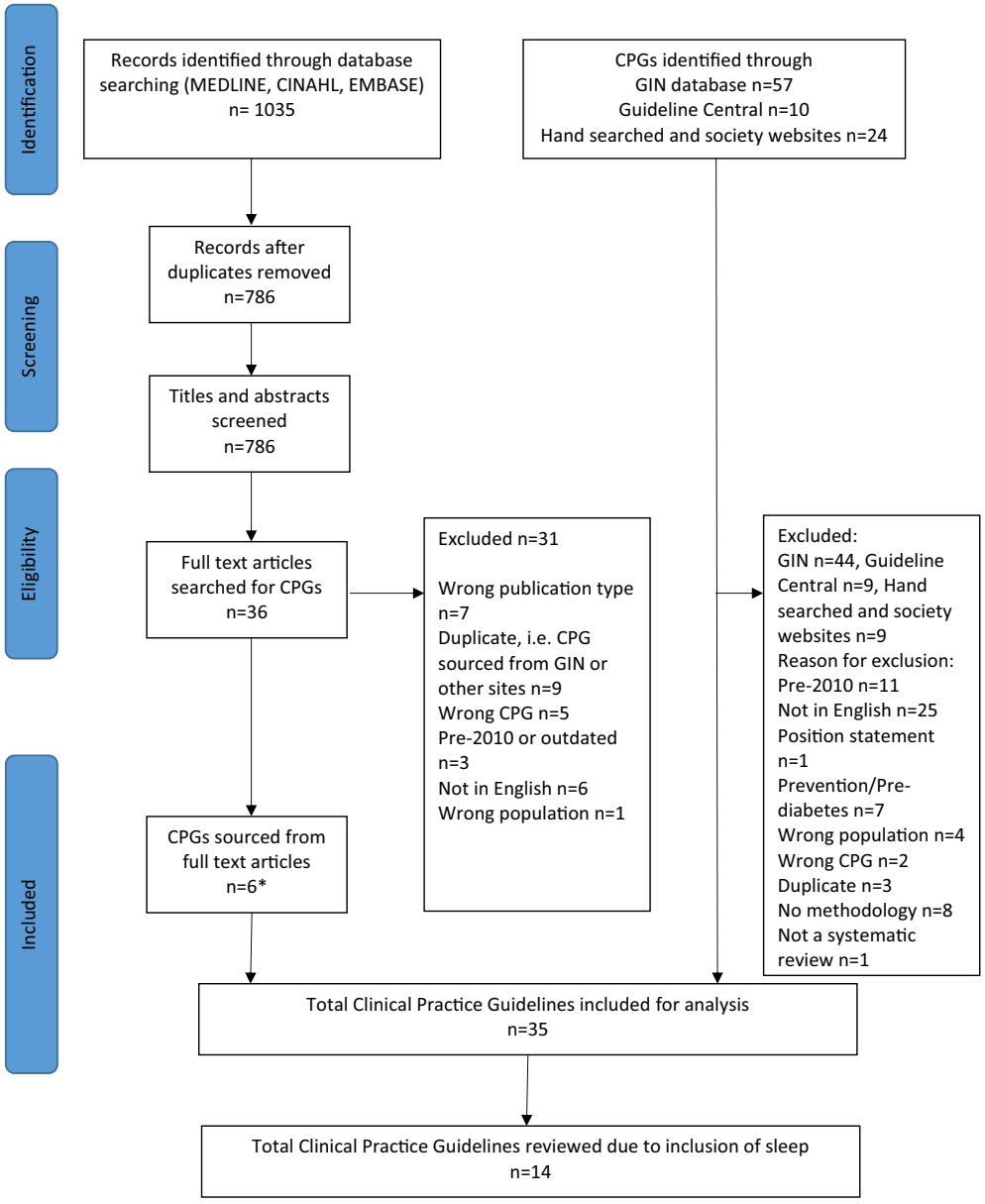

Fig. 1 – PRISMA flow diagram for selection of Clinical Practice Guidelines for type 2 diabetes mellitus in adults, * 2 CPGs obtained from one article.

[50]. Five guidelines identified a relationship between sleep and obesity [38,43,57,60,61]. Three of these guidelines focused on OSA specifically, while one guideline mentioned sleep generally [43]. Prevalence of OSA among patients with T2DM and obesity was identified in two CPGs [60,61]. One guideline also highlighted the presence of OSA may impact the ability to lose weight in T2DM [38]. Other comorbidities were mentioned in relation to sleep. Two guidelines discussed sleep disturbances as an indicator of mental health issues in people with T2DM, particularly depression [48,55]. Two other guidelines discussed OSA as a risk factor related to erectile dysfunction in men with T2DM [38,56]. Poor sleep as a result of painful diabetic neuropathy was discussed in two guidelines [42,43].

3.3.4. *Sleep and driving as a risk factor for type 2 diabetes mellitus*

Three CPGs discussed the effects of sleep on the ability to drive [34,38,56]. All three guidelines mentioned the potentially adverse impact on driving capabilities which may result due to OSA and the associated sleepiness. Assessment and management of OSA is an important aspect in regard to ensuring fitness to drive among people with diabetes [56].

3.3.5. *Shift work and type 2 diabetes*

Five CPGs mentioned the impact of sleep timing and/or shift work on Type 2 Diabetes management [43,46,50,57,62]. Night shift occupation was noted as a risk factor for prediabetes in one guideline [57] and as a risk factor for type 2 diabetes

in three guidelines [46,50,57]. Two guidelines [50,62] recommended special attention be given to shift workers by clinicians in regard to antidiabetic drug choice, tailoring care to their schedules and assessing the impact of shift work on their glycaemic control. It was also advised that shift workers with diabetes intensively self-monitor their blood sugar while working [50]. One guideline also suggested, where possible, employers should support employees with diabetes to discontinue shift work, if they chose to do so [50]. One guideline [43] acknowledged the high risk of hypoglycaemia to shift workers with diabetes that fast during Ramadan.[41]

4. Discussion

The review of CPGs identified that the impact of sleep and sleep disorders on diabetes and its complications is recognised in approximately 40% of diabetes CPGs reviewed. The key areas that were identified in CPGs reflect the various ways in which sleep and its disorders can affect people with T2DM. Whilst some CPGs recognised the potential impact of sleep on T2DM, several did not recommend any assessment of sleep. There were disagreements amongst guidelines regarding sleep optimisation or treatment of OSA to improve glycaemic outcomes. Several guidelines recognised the relationship between sleep and mental health, particularly depression, while others highlighted the bidirectional relationship between sleep and diabetes complications. Driving is a key issue for those with diabetes and assessing OSA as part of fitness to drive was highlighted.

Obstructive sleep apnoea is a common T2DM co-morbidity and most CPGs, especially from developed countries, highlight this common sleep disorder. Firstly, there is evidence that even snoring (a common symptom of sleep apnoea) is associated with glycaemic abnormalities. Hyperglycaemia is also associated with apnoea-hypopnoea index (AHI), the common measure of OSA as well as hypoxaemia [23,68,69]. Obstructive sleep apnoea is highly prevalent amongst people with T2DM with prevalence ranging from about 20% in primary care to over 80% in secondary care [70,71]. Obstructive sleep apnoea not only increases diabetes risk [72], but also impacts on diabetes complications [20,22,24] since it shares several pathophysiological pathways [28] with diabetic macro- and micro- vascular disease. Receiving treatment for OSA is associated with improved glycaemic control [73], although evidence from randomised clinical trials are inconclusive [74,75]. Obstructive sleep apnoea also results in several co-morbidities that accompany T2DM such as hypertension, atrial fibrillation, depression, erectile dysfunction, and gastro-oesophageal reflux disease. Therefore, identifying and treating OSA may benefit several co-morbidities associated with T2DM. It is of interest that not all CPGs highlight OSA or recommend screening for OSA or provide a clear pathway for OSA assessment for those with T2DM, particularly given its prevalence. Lack of screening recommendations could be related to lack of easy access to sleep testing. However, it is possible to conduct an initial screen in the clinic using questionnaires such as the STOP-BANG questionnaire [76]. Home sleep monitoring devices are increasingly available at low cost obviating the need for laboratory sleep testing to identify those with OSA. Close collaboration between T2DM, sleep, and other related specialties (e.g. respiratory medicine) should facilitate the identification and optimisation of OSA treatment amongst those with T2DM.

Shift work has been associated with both the development of T2DM and poor glycaemic control in those with T2DM. Over time, shift work has become ubiquitous with recent estimates that one fifth of employees in Europe and United States are shift workers [77]. Shift work results in altered timing of sleep and eating and therefore altered circadian rhythms. Previous systematic reviews have identified a requirement to integrate recommendations around glycaemic control and shift work into clinical practice guidelines [78], however, according to this review, there remains a sparsity of such guidance with only 14% of included guidelines including content pertinent to shift work.

The impact of sleep duration and quality on glycaemic control has been noted by several observational studies. However, there are several deficiencies amongst these studies which may impede translation from research to practice. In particular, sleep duration and quality are based on self-report in many studies rather than using objective measures of sleep. Because of this, there is insufficient attention within CPGs for assessing sleep duration and quality. While greater evidence is needed regarding sleep improvement or manipulation to improve glycaemic control, paying attention to sleep duration and quality could highlight several T2DM co-morbidities that are associated with disturbed sleep such as depression, anxiety, and painful neuropathy. Recurrent hypoglycaemia could also disturb sleep and may need further investigation. Quality of life and sleepiness can be improved by identifying those with sleep disturbance related to shift work. Furthermore, assessment and management of sleep is cost-effective, quick and associated with no adverse outcomes. Therefore, there is a need for greater emphasis on the assessment of the impact of sleep duration and quality amongst CPGs.

5. Conclusion

In conclusion, there is some recognition of the impact of sleep duration and quality on diabetes and diabetes associated co-morbidities, but this is less detailed and not covered by many guidelines. While most CPGs recognise OSA as a key T2DM morbidity, this is not recognised by all CPGs and there is insufficient clear guidance regarding screening and treatment of those with diabetes and OSA. There is a need for greater advocacy for the impact of sleep and its disorders on diabetes and diabetes co-morbidities.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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REFERENCES

[1] World Health Organization, Global Report on Diabetes. 2016.
[2] International Diabetes Federation, IDF Diabetes Atlas Ninth Edition 2019. 2019.
[3] World Health Organization. Cardiovascular diseases – Data and Statistics. 2010; Available from: http://www.euro.who.int/en/health-topics/noncommunicable-diseases/cardiovascular-diseases/data-and-statistics.
[4] D'Elia JA et al. Diabetic microvascular complications: possible targets for improved macrovascular outcomes. Int J Nephrology Renovascular Dis 2011;4:1–15.
[5] American Diabetes Association, 4. Lifestyle management. Standards of medical care in diabetes-2018. Diabetes Care 2018, 2018. 41(Suppl. 1): p. S38-S50.
[6] National Institute for Health and Care Excellence, Type 2 diabetes in adults: management. 2015.
[7] Whitehead L, Seaton P. The effectiveness of self-management mobile phone and tablet apps in long-term condition management: a systematic review. J Medical Internet Res 2016;18(5) e97.
[8] Ohkuma T et al. U-shaped association of sleep duration with metabolic syndrome and insulin resistance in patients with type 2 diabetes: the Fukuoka Diabetes Registry. Metabolism 2014;63(4):484–91.
[9] Luyster FS, Dunbar-Jacob J. Sleep quality and quality of life in adults with type 2 diabetes. The Diabetes educator 2011;37 (3):347–55.
[10] Azharuddin M et al. *The impact of sleep duration and sleep quality on glycaemic control in Asian population with type 2 diabetes mellitus: A systematic literature review and meta-analysis of observational studies.* Clinical Epidemiology and Global. Health 2020.
[11] Lee SWH, Ng KY, Chin WK. The impact of sleep amount and sleep quality on glycemic control in type 2 diabetes: A systematic review and meta-analysis. Sleep Med Rev 2017;31:91–101.
[12] Shan Z et al. Sleep Duration and Risk of Type 2 Diabetes: A Meta-analysis of Prospective. Studies. 2015;38 (3):529–37.
[13] Cappuccio FP et al. Sleep duration and all-cause mortality: a systematic review and meta-analysis of prospective studies. Sleep 2010;33(5):585–92.
[14] Zhu B et al. The relationship between sleep disturbance and glycaemic control in adults with type 2 diabetes: An integrative review. J Clin Nurs 2017;26(23–24):4053–64.
[15] Cooper AJM et al. Sleep duration and cardiometabolic risk factors among individuals with type 2 diabetes. Sleep Med 2015;16(1):119–25.
[16] Gan Y et al. Shift work and diabetes mellitus: a meta-analysis of observational studies. 2015;72(1):72–8.
[17] Manodpitipong A et al. Night-shift work is associated with poorer glycaemic control in patients with type 2 diabetes. 2017;26(6):764–72.
[18] Depner CM et al. Ad libitum Weekend Recovery Sleep Fails to Prevent Metabolic Dysregulation during a Repeating Pattern of Insufficient Sleep and Weekend Recovery Sleep. Curr Biol 2019;29(6):957–967.e4.
[19] Soin D et al. Evaluation of obstructive sleep apnea in metabolic syndrome. Journal of Family Medicine and Primary Care 2019;8(5):1580–6.
[20] Leong WB et al. The association between obstructive sleep apnea on diabetic kidney disease: a systematic review and meta-analysis. Sleep 2016;39(2):301–8.
[21] Leong WB et al. Effect of obstructive sleep apnoea on diabetic retinopathy and maculopathy: a systematic review and meta-analysis. Diabet Med 2016;33(2):158–68.
[22] Leong WB et al. The impact of hypoxemia on nephropathy in extremely obese patients with type 2 diabetes mellitus. J Clin Sleep Med 2014;10(07):773–8.
[23] Leong WB et al. Hypoxemia and glycemic control in type 2 diabetes mellitus with extreme obesity. The Journal of Clinical Endocrinology & Metabolism 2014;99(9):E1650–4.
[24] Banerjee D et al. The potential association between obstructive sleep apnea and diabetic retinopathy in severe obesity—the role of hypoxemia. PLoS ONE 2013;8(11).
[25] Briançon-Marjollet A et al. The impact of sleep disorders on glucose metabolism: endocrine and molecular mechanisms. Diabetology & metabolic syndrome 2015;7(1):25.
[26] Stamatakis KA, Punjabi NM. Effects of sleep fragmentation on glucose metabolism in normal subjects. Chest 2010;137 (1):95–101.
[27] Spiegel K et al. Sleep loss: a novel risk factor for insulin resistance and Type 2 diabetes. J Appl Physiol 2005;99 (5):2008–19.
[28] Pallayova M, Banerjee D, Taheri S. Novel insights into metabolic sequelae of obstructive sleep apnoea: a link between hypoxic stress and chronic diabetes complications. Diabetes Res Clin Pract 2014;104(2):197–205.
[29] Perez-Pozuelo I et al. The future of sleep health: a data-driven revolution in sleep science and medicine. npj Digital Med 2020;3(1):1–15.
[30] National Guideline Clearinghouse. NGC and NQMC Inclusion Criteria. 2018; Available from: https://www.ahrq.gov/gam/summaries/inclusion-criteria/index.html.
[31] JBI - Joanna Briggs Institute. Educational interventions to promote oral hypoglycaemic adherence in adults with Type 2 diabetes (Best Practice 15(11)). [Guideline] 2011; Available from: http://connect.jbiconnectplus.org/ViewSourceFile.aspx?0=7122.
[32] JBI - Joanna Briggs Institute. The experiences of, and meaning for, women living and coping with type 2 diabetes (Best Practice 16(10)). [Guideline] 2012; Available from: http://connect.jbiconnectplus.org/ViewSourceFile.aspx?0=9277.
[33] JBI - Joanna Briggs Institute. The effectiveness of nurse-led care in general practice on clinical outcomes in adults with type 2 diabetes (Best Practice 16(1)). [Guideline] 2012; Available from: http://connect.jbiconnectplus.org/ViewSourceFile.aspx?0=9268.
[34] The Royal Australian College of General Practitioners, General practice management of type 2 diabetes: 2016-18. 2016: East Melbourne, Vic:RACGP, 2016.
[35] International Diabetes Federation, Recommendations For Managing Type 2 Diabetes In Primary Care. 2017.
[36] Canadian Agency for Drugs and Technologies in Health, Second-line pharmacotherapy for type 2 diabetes — Update. 2013.
[37] Canadian Agency for Drugs and Technologies in Health. Optimal use recommendations for second- and third-line therapy for patients with type 2 diabetes. Canadian Agency for Drugs and Technologies in Health. NGC:009997.

[Guideline Clearing Report] 2013; CADTH optimal use report; vol3, no. 1d:[Available from: http://www.guideline.gov/content.aspx?id=47068.
[38] Diabetes Canada Clinical Practice Guidelines Expert Committee. Diabetes Canada 2018 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. Can J Diabetes 2018;42(Suppl 1):S1–S325.
[39] Diabetes Association of the Republic of China Executive summary of the DAROC clinical practice guidelines for diabetes care- 2018. Journal of the Formosan Medical Association, 2020. 119, 577-586 DOI: 10.1016/j.jfma.2019.02.016.
[40] Pablo Aschner M et al. Clinical practice guideline for the prevention, early detection, diagnosis, management and follow up of type 2 diabetes mellitus in adults. Colombia Médica 2016;47:109–30.
[41] Ministerio de Salud y Protección Social, Clinical practice guide - For the diagnosis, treatment and follow up of type 2 diabetes mellitus in population over 18 years old. Guide for Health Professionals, 2015.
[42] International Diabetes Federation Guideline Development Group. Global guideline for type 2 diabetes. Diabetes Res Clin Pract 2014;104(1):1.
[43] Bajaj S et al. RSSDI clinical practice recommendations for the management of type 2 diabetes mellitus 2017. International Journal of Diabetes in Developing Countries 2018;38 (S1):1–115.
[44] Diabetes Surgery Summit, Surgical treatment for type 2 diabetes, summary of recommendations and guidelines from the 2nd diabetes surgery summit (DSS-II). 2016.
[45] World Health Organization, Guidelines on second- and third-line medicines and type of insulin for the control of blood glucose levels in non-pregnant adults with diabetes mellitus. 2018.
[46] Haneda M et al. *Japanese Clinical Practice Guideline for Diabetes 2016*. Diabetology International 2019;9(1).
[47] Kim MK et al. 2019 Clinical Practice Guidelines for Type 2 Diabetes Mellitus in Korea. Diabetes Metabolism J 2019;43 (4):398–406.
[48] Ministry of Health Malaysia, Clinical Practice Guidelines Management of Type 2 Diabetes Mellitus. 2015.
[49] Shera AS, Basit A. Pakistan's Recommendations for Optimal Management of Diabetes from Primary to Tertiary care level (PROMPT). Pakistan Journal of Medical Sciences Quarterly 2017;33(5):1279–83.
[50] Araszkiewicz A et al. 2019 Guidelines on the management of diabetic patients. A position of Diabetes Poland. Clinical Diabetology 2019;8:1–95.
[51] Bertoluci MC et al. Portuguese-Brazilian evidence-based guideline on the management of hyperglycemia in type 2 diabetes mellitus. Diabetology & Metabolic Syndrome 2020;12:1–30.
[52] Ministry of Public Health, Clinical Guidelines for the State of Qatar, The diagnosis and management of type 2 diabetes in adults and the elderly. 2016.
[53] Scottish Intercollegiate Guidelines Network (SIGN), Pharmacological management of glycaemic control in people with type 2 diabetes 2017. Edinburgh: SIGN; 2017. (SIGN publication no. 154). [November 2017]. Available from URL: http://www.sign.ac.uk.
[54] Scottish Intercollegiate Guidelines Network (SIGN), Management of diabetes A national clinical guideline. 2017. Edinburgh: SIGN; 2017. (SIGN publication no. 116). [November 2017]. Available from URL: http://www.sign.ac.uk.
[55] Ministry of Health Singapore, Diabetes Mellitus MOH Clinical Practice Guidelines 1/2014. 2014.
[56] The Society for Endocrinology, M.a.D.o.S.A.T.D.G.E.C., The 2017 SEMDSA Guideline for the Management of Type 2 Diabetes Guideline Committee. Journal of Endocrinology, Metabolism and Diabetes of South Africa, 2017. 22(1 (Supplement 1)): p. S1-S196.
[57] American Association of Clinical Endocrinologists and American College Of Endocrinology (AACE/ACE), Clinical Practice Guidelines For Developing A Diabetes Mellitus Comprehensive Care Plan – 2015. Endocr Pract., 2015. 21 (Suppl 1).
[58] ACP - American College of Physicians. Oral Pharmacologic Treatment of Type 2 Diabetes Mellitus: A Clinical Practice Guideline Update from the American College of Physicians. [Guideline] 2017; Available from: http://annals.org/aim/article/2595888/oral-pharmacologic-treatment-type-2-diabetes-mellitus-clinical-practice-guideline.
[59] ACP - American College of Physicians. Hemoglobin A1c Targets for Glycemic Control With Pharmacologic Therapy for Nonpregnant Adults With Type 2 Diabetes Mellitus: A Guidance Statement Update From the American College of Physicians. [Guideline] 2018; Available from: http://annals.org/aim/fullarticle/2674121/hemoglobin-1c-targets-glycemic-control-pharmacologic-therapy-nonpregnant-adults-type.
[60] American Diabetes Association, Standards of Medical Care in Diabetes-2020, in Diabetes Care. 2020.
[61] Redmon, B., et al., Diagnosis and management of type 2 diabetes mellitus in adults. Institute for Clinical Systems Improvement, 2014. 16(7): p. p1-83.
[62] Joslin Diabetes Center & Joslin Clinic, Clinical Guideline for Adults with Diabetes. 2017.
[63] AHRQ - Agency for Healthcare Research + Quality. Management of type 2 diabetes mellitus. University of Michigan Health System. NGC:009416. [Guideline Clearing Report] 2012; Available from: http://www.guideline.gov/content.aspx?id=38618.
[64] The Department of Veterans Affairs and the Department of Defense VA/DoD Clinical Practice Guidelines for the Management of Type 2 Diabetes Mellitus in Primary Care. 2017.
[65] Brouwers MC et al. AGREE II: advancing guideline development, reporting and evaluation in health care. Can Med Assoc J 2010;182(18):839–42.
[66] Lam WMJ et al. Management of type 2 diabetes using non-insulin glucose-lowering therapies: a critical appraisal of clinical practice guidelines with the AGREE II instrument. Diabet Med 2020;37(4):636–47.
[67] Moher D et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Ann Intern Med 2009;151(4):264–9.
[68] Punjabi NM et al. Sleep-disordered breathing, glucose intolerance, and insulin resistance: the Sleep Heart Health Study. Am J Epidemiol 2004;160(6):521–30.
[69] Al-Delaimy WK et al. Snoring as a risk factor for type II diabetes mellitus: a prospective study. Am J Epidemiol 2002;155(5):387–93.
[70] Einhorn D et al. Prevalence of sleep apnea in a population of adults with type 2 diabetes mellitus. Endocrine Practice 2007;13(4):355–62.
[71] Foster GD et al. Obstructive sleep apnea among obese patients with type 2 diabetes. Diabetes Care 2009;32 (6):1017–9.
[72] Qie R et al. Obstructive sleep apnea and risk of type 2 diabetes mellitus: a systematic review and dose-response meta-analysis of cohort studies. J Diabetes 2020;12 (6):455–64.
[73] Guest JF et al. Clinical outcomes and cost-effectiveness of continuous positive airway pressure to manage obstructive sleep apnea in patients with type 2 diabetes in the UK. Diabetes Care 2014;37(5):1263–71.

[74] Labarca G et al. CPAP in patients with obstructive sleep apnea and type 2 diabetes mellitus: Systematic review and meta-analysis. The clinical respiratory journal 2018;12 (8):2361–8.
[75] Zhu B et al. Effect of continuous positive airway pressure on glucose metabolism in adults with type 2 diabetes: a systematic review and meta-analysis of randomized controlled trials. Sleep and Breathing 2018;22(2):287–95.
[76] Toronto Western Hospital. Screening STOP-Bang Questionnaire. 2012; Available from: http://www.stopbang.ca/osa/screening.php.
[77] Messenger, J., Working time and the future of work Future of Work Research Paper Series. 2018, International Labor Office: Geneva, Switzerland. p. 44.
[78] Knutsson A, Kempe A. Shift work and diabetes – A systematic review. Chronobiol Int 2014;31(10):1146–51.