

# Factors associated with missed appointments by adults with type 2 diabetes mellitus: a systematic review

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## ABSTRACT

Keeping regular medical appointments is a key indicator of patient engagement in diabetes care. Nevertheless, a significant proportion of adults with type 2 diabetes mellitus (T2DM) miss their regular medical appointments. In order to prevent and delay diabetes-related complications, it is essential to understand the factors associated with missed appointments among adults with T2DM. We synthesized evidence concerning factors associated with missed appointments among adults with T2DM. Using five electronic databases, including PubMed, Embase, Cumulative Index to Nursing and Allied Health Literature, PsycINFO and Web of Science, a systematic literature search was done to identify studies that describe factors related to missed appointments by adults with T2DM. A total of 18 articles met the inclusion criteria. The majority of studies included in this review were cohort studies using medical records. While more than half of the studies were of high quality, the operational definitions of missed appointments varied greatly across studies. Factors associated with missed appointments were categorized as patient characteristics, healthcare system and provider factors and interpersonal factors with inconsistent findings. Patient characteristics was the most commonly addressed category, followed by health system and provider factors. Only three studies addressed interpersonal factors, two of which were qualitative. An increasing number of people live with one or more chronic conditions which require more careful attention to patient-centered care and support. Future research is warranted to address interpersonal factors from patient perspectives to better understand the underlying causes of missed appointments among adults with T2DM.

## INTRODUCTION

According to the Centers for Diseases Control and Prevention, >34 million people in the USA have diabetes mellitus (DM) with type 2 DM (T2DM) accounting for 90%–95% of all DM cases.<sup>1</sup> DM is disproportionately prevalent among racial/ethnic minorities and people with lower education levels.<sup>1</sup> DM is also economically taxing; the USA spends approximately US\$327 billion annually on DM-related costs.<sup>2</sup>

Persons with T2DM must actively participate in their life-long care to successfully manage their disease.<sup>3</sup> Without adequate

engagement in care, people with T2DM are likely to have higher glucose levels, which may result in severe complications (eg, heart disease, kidney disease).<sup>4</sup> Specifically, persons with T2DM need to perform various self-care activities, including lifestyle management<sup>5</sup> and attending regular medical appointments,<sup>6</sup> to achieve optimal glycemic control. In particular, persons with T2DM should attend medical appointments every 3–6 months to evaluate hemoglobin A1c (HbA1c)<sup>6</sup> and annually to assess microvascular complications.<sup>7</sup> Regular medical appointments that are patient-centered also represent critical opportunities for persons with T2DM to receive individualized education and treatment plans; for the healthcare team to support persons with T2DM in self-care and to review, assess and adjust treatment plans in a timely manner.<sup>6</sup>

Despite its significance, recent statistics show that 12%–36% of persons with T2DM do not keep their regular medical appointments.<sup>8–9</sup> Missed regular medical appointments in T2DM care pose a significant threat to patients' glycemic outcomes. For example, persons with T2DM who missed regular appointments had a 24%–64% greater odds of having poor glycemic outcomes than those who did not,<sup>10–11</sup> and 60% greater odds of rehospitalization.<sup>12</sup> Likewise, missed medical appointments pose a financial burden at the healthcare system level.<sup>13–15</sup> A DM clinic estimated that the average cost of no-show per patient was US\$110 in 2004.<sup>16</sup> Missed DM-related appointments also increase societal costs where the waitlist is longer for other patients to get needed care.<sup>13–14–17</sup>

To improve the quality of T2DM care and to better support those with T2DM in achieving glycemic control, it is essential to understand the factors that are associated with missed regular medical appointments. Few prior systematic reviews addressed some aspects of missed appointments among persons with

DM. For example, one meta-analysis conducted in 2007 (n=47 studies involving children, adolescents or adults with either type of diabetes) examined the effect of depression on various DM self-care activities and found that its effect was the strongest on missed medical appointments compared with overall treatment adherence composite measures, diet, medication, exercise or glucose monitoring.<sup>18</sup> Another review of 50 studies conducted in 2008 targeted uninsured adults with DM revealed that depression or other psychological diagnoses, along with poverty, lack of transportation, personal belief that the appointment did not help, lack of childcare, presence of a sick child and forgetfulness were significantly correlated with missed appointments in the uninsured, low-income samples.<sup>19</sup> A systematic review conducted in 2016 including 24 studies of patients with either DM or hypertension in an outpatient setting worldwide identified 83 factors associated with missed appointments. The authors categorized factors into patient (eg, mental state, demographics, alcohol and tobacco use), disease and medication (eg, poor baseline HbA1c, poor lipid profile) and healthcare provider-related factors (eg, scheduling factors, provider characteristics).<sup>20</sup> Similarly, another systematic review conducted in 2019 with 34 studies of patients with DM across the lifespan summarized factors associated with missed appointments and interventions to minimize missed appointments. The review organized factors associated with missed outpatient appointments into five categories, including patient characteristics (eg, age, gender, duration of DM), socioeconomic factors (eg, financial pressures, smoking/alcohol intake), ethnicity and culture (eg, ethnic minority), illness perceptions and attitudes (eg, dismissive behavior) and other factors (eg, comorbidities, receiving diabetes education).<sup>21</sup>

While these reviews offer some helpful insights, they were either too narrowly focused (eg, the effect of depression on medical visits or uninsured patients only), published >10 years ago,<sup>18 19</sup> included a wide range of age groups,<sup>18 21</sup> or included disease conditions beyond DM.<sup>20</sup> Given that the management of DM in youth is different from adult patients<sup>22</sup> and that the disease progression and treatment plans differ considerably,<sup>23</sup> a systematic review that specifically addresses correlates of missed regular medical appointments among adults with T2DM is warranted. The purpose of this systematic review was to synthesize existing literature to identify factors that are associated with missed appointments by adults with T2DM. In particular, given limited consistency as to how missed appointments (ie, definition and source of data) are operationalized in DM care,<sup>21 24</sup> we attempted to extract the definition of missed appointments and source of data used in each study. To present comprehensive and theoretically relevant factors that are salient to adults with T2DM, we organized factors that are associated with missed appointments by adults with T2DM using the Quality-Caring Model. The Quality-Caring Model uses the structure-process-outcome framework to illustrate how the characteristics of the patient and the provider

(structure) may impact the interpersonal encounter (process), and how the interpersonal process may influence patient outcomes, such as attending regular medical appointments in DM care.<sup>25</sup>

## METHODS

### Search and selection of studies

We prepared this review using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement guideline.<sup>26</sup> A systematic search of peer-reviewed literature on associated factors related to missed medical visits by adults with T2DM was conducted in January 2020 in five databases—PubMed, Embase, Cumulative Index to Nursing and Allied Health Literature, PsycINFO and Web of Science. In consultation with a health science librarian, search terms were identified including Medical Subject Headings (MeSH) ('No-Show Patient' and 'Appointment and Schedules') and non-MeSH search terms (eg, no-show, visit adherence, appointment compliance, or nonattend\*). A variety of terms for diabetes were also identified, such as insulin resistant/resistance, type 2 DM, non-insulin dependent/dependence. Full search logs with specific terms for each database can be found in online supplemental table 1.

Peer-reviewed, full-text original research articles in English were included if they described factors related to missed regular medical appointments by adults with T2DM in primary care or outpatient settings. Non-research articles and systematic review articles were excluded. Articles examining educational program attendance were also excluded. Studies that did not specify the type of diabetes were assessed by the age range of participants, the descriptions of the settings and diabetes treatment to determine its inclusion or exclusion. Studies that did not specify the type of diabetes were included based on the descriptions of the settings if they included only adults and examined oral medications as one of the diabetes treatments. The search comprised research published since 1994.

The results of all searches were exported to a systematic review management tool.<sup>27</sup> Two authors (C-AS and KT) reviewed all manuscript titles and abstracts and assessed for inclusion. Conflicts were resolved through discussion.

### Data extraction

An author (C-AS) extracted relevant data using a standardized extraction table developed for this review. The following data were extracted from the articles included in the review: first author, publication year, country, study design, study setting and study population, definitions of missed appointments used in the study, and factors related to missed appointments.

Factors related to missed appointments from the articles were categorized based on the Quality-Caring Model by Duffy and Hoskins.<sup>25</sup> The Quality-Caring Model emphasizes the importance of interpersonal process in enhancing patient outcomes by using the

structure-process-outcome framework to illustrate the quality of care. Patients, healthcare providers and healthcare systems are the participants in the care process, whose characteristics shape the interaction of the care delivery.<sup>25</sup> The Quality-Caring Model has been used to explain the quality of life and rehospitalizations among older adults with heart failure,<sup>28</sup> as well as among patients with end-stage renal disease.<sup>29</sup> Through constant comparison, the factors were categorized into three groups as patient characteristics, healthcare system and provider factors and interpersonal factors (ie, patient perception or appraisal of the care). Patient characteristics are further grouped into sociodemographic, health status, disease knowledge, behavior or attitudes and risk/protective behavior, social support and others (including transportation, personality, weather).

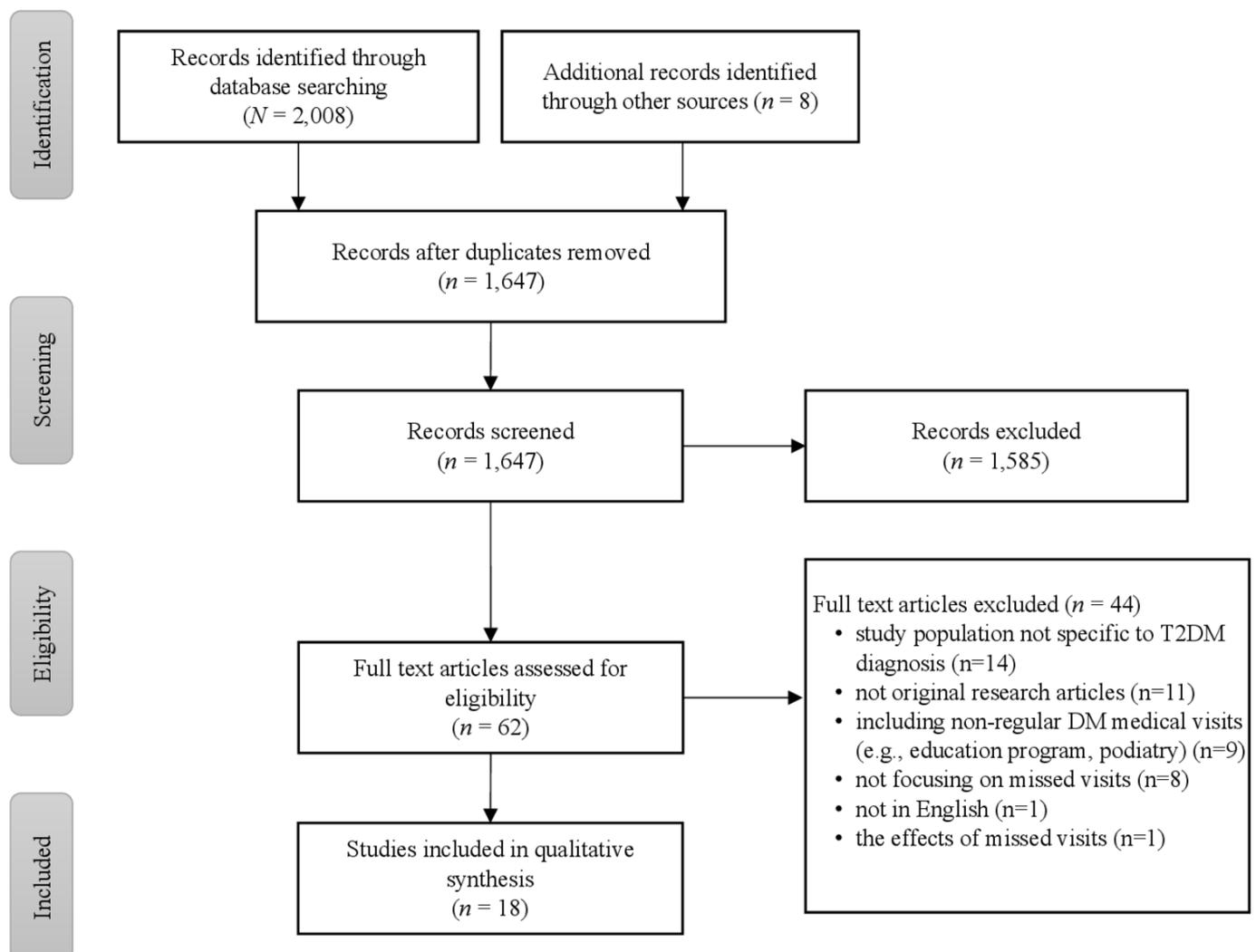
### Quality appraisal

Two reviewers (C-AS and KT) independently assessed the methodological rigor of each included article using the Joanna Briggs Institute (JBI) quality appraisal checklists.<sup>30</sup> According to study design (cohort, cross-sectional, case control and qualitative study), each study's

methodological characteristics were evaluated using the corresponding JBI checklist. Studies were not excluded based on the quality appraisal; rather, the quality appraisal was used to identify and discuss strengths and weaknesses in study methodologies. Studies were rated a zero if they did not report or did not include the component of an item of the checklist, and a one if they did. A total score for each study was then calculated by adding up these ratings. The level of quality for an individual study was calculated as the total score (numerator) divided by the total possible score (denominator). Studies were considered high, medium or low quality if they scored  $\geq 66.7\%$ ,  $33.4\%$ – $66.6\%$  or  $\leq 33.3\%$ , respectively. The inter-rater agreement statistics using per cent agreement ranged from 40% to 100%. All discrepancies were resolved through team discussion.

### RESULTS

Figure 1 shows the process of identifying and including studies. There were 2008 articles retrieved from the database searches. Eight additional articles were identified manually from the systematic review papers in the search.



**Figure 1** Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram. T2DM, type 2 diabetes mellitus.

Two authors (CAS and KT) determined 1585 studies were irrelevant to the review questions and hence excluded and further conducted a full-text review of 62 articles. We included 18 articles for the review.

### Overview of studies

Table 1 summarizes the main characteristics of 18 studies included in this review in chronological order. The majority of the studies used a cohort design (n=12; 8 retrospective and 4 prospective),<sup>31–42</sup> followed by analytical cross-sectional design (n=2),<sup>43 44</sup> qualitative research design (n=2)<sup>45 46</sup> and case-control design (n=1).<sup>47</sup> One study was a mixed-methods study (n=1), in which they used a cohort design and a qualitative research design.<sup>48</sup>

Seven studies recruited participants from DM outpatient clinics,<sup>37–39 42–44 48</sup> five from primary care clinics,<sup>32 36 40 41</sup> two from regional DM registry,<sup>33 46</sup> one from an endocrinology outpatient clinic,<sup>34</sup> one from rural health centers,<sup>45</sup> one from nationally representative sample survey,<sup>35</sup> one from regional household survey<sup>47</sup> and one from either primary care clinic or DM outpatient clinic.<sup>31</sup> Sample sizes ranged from 26<sup>45</sup> to 84 040.<sup>36</sup> Ten studies included only adults with T2DM<sup>31 33 34 39 41 42 44–47</sup> while the other eight studies did not specify the type of diabetes.<sup>32 35–38 40 43 48</sup>

### Quality of the studies

Table 1 includes the summary values of the quality rating for each article and quality assessment scores after consensus can be found in online supplemental table 2. Ten of the studies included in this systematic review were of high quality.<sup>33–36 39–41 45 47 48</sup> Seven of the 12 cohort studies were of high quality,<sup>33–36 39–41</sup> and 5 were of medium quality.<sup>31 32 37 38 42</sup> Common methodological issues observed in the cohort studies were incomplete description of study participant follow-up,<sup>31–33 37–39 41 42</sup> and a lack of identification of confounding variables and accounting for them in statistical analyses.<sup>32 34 35 37 38 42 43</sup> One cross-sectional study was of medium quality,<sup>43</sup> and one was of low quality.<sup>44</sup> Both studies did not address confounding variables and did not use valid measures for outcome variables.<sup>43 44</sup> The case-control study<sup>47</sup> was of high quality. One qualitative study was of high quality,<sup>45</sup> and one was of medium quality.<sup>46</sup> The mixed-methods study<sup>48</sup> was of high quality for its quantitative, cohort methods and of high quality for its qualitative component.

### Definitions of missed appointments

The included studies in the review used a variety of terms for missed appointments (table 1), including appointment/clinic/follow-up non-attendance, failed to attend or missed appointments,<sup>31–38 40 41 43–45</sup> default,<sup>47</sup> lost to follow-up<sup>38 48</sup> and dropout.<sup>39</sup> Ten articles identified missed appointments by using medical records.<sup>33 34 36–41 48</sup> Six articles identified missed appointments through patient self-reported data,<sup>35 43–47</sup> and three articles did not report how they determined the status of an appointment.<sup>31 32 42</sup>

The operational definitions of missed appointments were substantially heterogeneous. The majority of the studies examined the status of appointments in a period of time,<sup>31–36 39–41 43–47</sup> while three studies examined the status of one appointment<sup>37 42 48</sup> and one study examined both the status of one appointment and missed appointments in a period of time.<sup>38</sup> Studies defined missed appointments as appointment no-show,<sup>34 36–38 40–42 48</sup> appointment no-show and cancellation within 24 hours,<sup>32</sup> lost to follow-up (one appointment no-show and subsequent absence from the clinic for 6–12 months)<sup>31 33 39 47</sup> and self-reported experiences of missed appointment.<sup>35 43–46</sup> The self-reported missed appointments included missing annual medical appointments (a foot examination or a cholesterol blood check) in 2 years<sup>35</sup>; and a 5-point Likert scale of missed appointment frequency from ‘never missed’ to ‘always missed appointments’.<sup>43</sup> Three articles used self-reported experiences of missed appointments as inclusion criteria for qualitative inquiry.<sup>44–46</sup> In terms of the level of measurement, missed appointments were operationalized as dichotomous outcome<sup>32 34 37 42 48</sup>; counts of missed appointments in a time period<sup>41</sup> or the percentage of missed appointments among all scheduled appointments.<sup>36 40</sup>

### Factors associated with missed appointments

Based on the Quality-Caring Model,<sup>25</sup> factors associated with missed appointments were grouped into three categories—patient characteristics, healthcare system and provider factors and interpersonal factors. Table 2 summarizes factors examined in each study by all three categories and marked by its results with legend. The majority of studies (n=9) examined factors from one category—patient characteristics.<sup>31 32 34 35 39 41–43 47</sup> Seven studies examined factors in two categories—characteristics and healthcare system and provider factors<sup>33 36–38 44 46</sup> or patient characteristics and interpersonal factors.<sup>40</sup> Only two studies investigated factors in all three categories.<sup>45 48</sup>

### Patient characteristics

Table 3 lists the number of studies examining various patient characteristics and describes results (statistical significance, statistical non-significance, qualitative results or included as factors in a predictive model) from corresponding studies. We include only patient characteristics that have been examined by more than one article in order to improve the readability. A variety of patient characteristics were examined in relation to missed appointments: sociodemographics (including age, sex, race/ethnicity, education, employment, income, insurance type, residential area, health literacy, assets, limited English proficiency), health status (including DM treatment, comorbidity, lipid profile lab values, HbA1c, body mass index, DM duration, DM complications, hospitalization or emergency room visit between visits, blood pressure reading, a diagnosis of depression, fasting plasma glucose levels), DM knowledge and disease belief or attitude (including illness perception, denial of illness),

**Table 1** Main characteristics of the included studies

Study, location	Quality rating by JBI	Study design (Follow-up Period)	Setting/ Sample population	Self-report	Sources of missed appointments		Operationalized definition of the outcome		Factors that were statistically significant or mentioned in the article		
					Chart records	Outcome	One appointment no-show	Missed appointment in a period of time	Sources of associated factors	Patient characteristics	Healthcare system and provider factors
Buyis, 2019, AL, USA <sup>48</sup>	Qual-High; Qual-High	Mixed-Methods (22 months)	A free DM clinic/ n=348, (cohort n=348, interview N=17)	v	v	Lost to follow-up to the most recent appointment	v	Medical records, interview	v	v	v
Garcia Diaz, 2017, Spain <sup>34</sup>	High	Retrospective cohort study (58 months)	An endocrinology clinic/ n=639	v	v	Appointment non-attendance	v	Medical records	v		
Gibson, 2017, USA <sup>35</sup>	High	Retrospective cohort study (24 months)	Medical Expenditure Panel Survey-Household Component and Diabetes Care Survey/ n=3982	v	v	Missed annual DM preventive care services	v	Questionnaire (Diabetes Care Survey)	v		
Heydarabadi, 2017, Iran <sup>45</sup>	High	Qualitative	Health centers/ n=26 (pts N=12, healthcare workers n=9, family n=3)	v	v	Appointment attendance	v	Qualitative interview	v		
Kurasawa, 2016, Japan <sup>37</sup>	Medium	Retrospective cohort study (38 months)	A DM outpatient clinic/ n=879 (16,026 appointments)	v	v	Missed appointment	v	EMR	v	v	
Low, 2016, Singapore <sup>36</sup>	Medium	Retrospective cohort study (19–43 months)	A DM center/ N=1645	v	v	Missed most recent appointment/ Lost to follow-up	v	Medical records	v	v	
Chew, 2015, Malaysia <sup>33</sup>	High	Retrospective cohort study (12 months)	National DM registry from 303 public health centers/ N=57 780	v	v	Follow-up non-attendance	v	Medical records	v	v	
Thongsai, 2015, Thailand <sup>42</sup>	Medium	Prospective cohort study (24 weeks)	DM outpatient clinic/ N=442	Not reported	v	Appointment non-attendance	v	Questionnaire	v		
Parker, 2012, CA, USA <sup>40</sup>	High	Retrospective cohort study (12 months)	Primary care clinics from one health system/ N=12 957	v	v	Poor appointment keeping rate	v	EMR & parent-study survey (DISTANCE)	v	v	v
Bowser, 2009, VA, USA <sup>32</sup>	Medium	Prospective cohort study (12 weeks)	A free clinic/ N=183	Not reported	v	Missed appointment	v	Questionnaires (RAND-36, PHQ-9, ADOOL, DES-SF)	v	v	

Continued

**Table 1** Continued

Study, location	Quality rating by JBI	Study design (Follow-up Period)	Setting/ Sample population	Sources of missed appointments			Operationalized definition of the outcome		Factors that were statistically significant or mentioned in the article			
				Self-report	Chart records	Outcome	One appointment no-show	Missed appointment in a period of time	Sources of associated factors	Patient characteristics	Healthcare system and provider factors	Patient care appraisal factors
Simmons, 2007, New Zealand <sup>47</sup>	High	Case-control	27 419 household in three districts in Auckland/ N=89 (cases n=37; control n=52)	v		Defaulter	Missed three quarterly appointments (not seen in the previous 10 months)	Questionnaire				
Masuda, 2006, Japan <sup>39</sup>	High	Retrospective cohort study (12 months)	A DM clinic/ N=160		v	Dropout	Not visited the clinic > 12 months since their last visit	EMR, qualitative interview				
Ando, 2005, Japan <sup>31</sup>	Medium	Prospective cohort study (24 months)	Unclear/ N=50	Not reported		Clinic attendance	Discontinued for > 6 months during 2 year study period	Medical record, questionnaire (Rorschach, Yatabe-Guilford personality test)				v
Wong, 2005, Torres Straits Island, Australia <sup>46</sup>	Medium	Qualitative	Regional DM registry/ N=67 (11 focus groups n=37, interview n=30)	v		Missed appointment	Ever no-show in the past	Focus group; interview				v
Karter, 2004, CA, USA <sup>36</sup>	High	Retrospective cohort study (12 months)	PCP clinics from one health system/ N=84 040 (DM registry)		v	Missed appointment rate	Number of no-show divided by total number of scheduled in 12 months (0%, 0%–30%, >30%)	EMR				v
Rosen, 2003, CT, USA <sup>41</sup>	High	Retrospective cohort study (24 months)	A VA primary care clinic/ N=79 male		v	Missed appointment	Number of missed PCP appointment in the previous year	Questionnaire (neuropsychological test, MMSE)				v
Khoza, 1995, UK <sup>44</sup>	Low	Cross-sectional	A DM clinic at a rural hospital/ N=30	v		Appointment keeping	Ever no-show in the past	Questionnaire, medical records, observation				v
Belgrave, 1994, DC, USA <sup>43</sup>	Medium	Cross-sectional	A DM outpatient clinic/ N=78 African American	v		Appointment keeping patterns	Self-reported 5-point scale (always keep to never keep)	Questionnaire (measure of social support)				v

(n=7),<sup>32</sup> 35, 36–40, 41, 43–46 Japan (n=3),<sup>31</sup> 37, 39 Australia (n=1),<sup>46</sup> Iran (n=1),<sup>45</sup> Malaysia (n=1),<sup>33</sup> New Zealand (n=1),<sup>47</sup> Singapore (n=1),<sup>38</sup> Spain (n=1),<sup>34</sup> Thailand (n=1),<sup>42</sup> and UK (n=1).<sup>44</sup> ADDOOL, Adult of Diabetes-Dependent Quality of Life; DES-SF, The Diabetes Empowerment Scale-Short Form; DM, diabetes mellitus; EMR, electronic medical record; MMSE, Mini-Mental State Examination; PCP, Primary Care Provider; PHQ-9, Patient Health Questionnaire-9; RAND-36, The RAND-36 Measure of Health-Related Quality of Life; VA, Veterans Affairs.

**Table 2** Summary of the factors examined in each study by three categories

Study, year	Patient characteristics	Healthcare system and provider factor	Interpersonal factor
Buys <i>et al</i> , 2019 <sup>48</sup>	<b>Sociodemographic:</b> age, sex, race/ethnicity <b>Health status:</b> hospitalized or emergency room between appointments <b>Risk/Protective behavior:</b> number of scheduled appointments annually <b>Transportation:</b> no transportation* Other social issues: change phone number constantly*; no permanent address* <b>Others:</b> forgetness*	<b>System:</b> no reminder*; unable to reach a staff via phone*	<b>Staff:</b> rude staff*
Garcia Diaz <i>et al</i> , 2017 <sup>34</sup>	<b>Sociodemographic:</b> younger†, sex <b>Health status:</b> high HbA1c†, insulin users†, fewer DM drugs per day†, high albuminuria†, non-hypothyroidism†, high LDL†, high TG†, T2DM duration, family history of DM, waist circumference <b>Risk/Protective behavior:</b> smoker†, did not attend therapeutic education session†, physical activity		
Gibson, 2017 <sup>35</sup>	<b>Sociodemographic:</b> age, sex, race/ethnicity, education (missing data†), employment, income, reside in deprived area, insurance type, marital status <b>Health status:</b> DM therapy type, DM-related complications (kidney†), hypertension, hyperlipidemia, coronary heart disease, functional limitations, depression, BMI <b>Risk/Protective behavior:</b> smoking status <b>Social support:</b> family size		
Heydarabadi <i>et al</i> , 2017 <sup>45</sup>	<b>Sociodemographic:</b> unemployment*, busy schedule or work-related constraints*, low income*, high healthcare cost# <b>Health status:</b> physical disability*, vision problem* <b>Disease knowledge, belief or attitude:</b> low disease knowledge*, denial of disease* <b>Transportation:</b> no transportation*, long distance* <b>Social support:</b> lack of family support* <b>Others:</b> hot weather*, poor road condition*, local customs (herbal medicine*, women unable to get out alone*)	<b>System:</b> no reminder*, long wait time*, administrative bureaucracy*, lack of resources (no medication*, lack of laboratory*, no proper incentive for healthcare workers*, no communication channels with the clinic*)	<b>Provider:</b> physician lack of respect*, poor communication due to language barrier of providers*
Kurasawa <i>et al</i> , 2016 <sup>37</sup>	<b>Sociodemographic:</b> sex%, age% <b>Health status:</b> HbA1c%, HDL%, LDL%, TG%, T-Cho%, comorbidities%, prescribed medications%, medication dosage and frequency per day%, total amount of medication a day% <b>Risk/Protective behavior:</b> frequency of clinic visits% <b>Transportation:</b> distance and time-distance between home and clinic% <b>Others:</b> weather%	<b>System:</b> interval between scheduling and appointment%, day of the week of the appointment%	
Low <i>et al</i> , 2016 <sup>38</sup>	<b>Sociodemographic:</b> younger†, male†, racial/ethnicity (minority-Indian†, Malay†) <b>Health status:</b> hospitalization/emergency room visit between appointments, referral sources <b>Risk/Protective behavior:</b> less number of scheduled appointments annually†, more missed appointment previously†	<b>System:</b> interval between appointment (61–90 days†), appointment month (January–June†), type of facility (public vs private)	
Chew <i>et al</i> , 2015 <sup>33</sup>	<b>Sociodemographic:</b> older†, male†, foreigner† <b>Health status:</b> high HbA1c†, more DM complications†, longer DM duration†, no hypertension†, lower blood pressure reading†, longer hypertension duration†, no hyperlipidemia†, high LDL†, lower BMI†	<b>System:</b> type of facility† (hospitals with specialists, hospitals without specialists, clinics with specialist, clinics without specialists)	

Continued

Table 2 Continued

Study, year	Patient characteristics	Healthcare system and provider factor	Interpersonal factor
Thongsai, 2015 <sup>42</sup>	<b>Sociodemographic:</b> age, sex, marital status <b>Health status:</b> longer DM duration† <b>Disease belief or attitude:</b> disease cannot be controlled† <b>Social support:</b> family size <b>Others:</b> religion		
Parker <i>et al</i> , 2012 <sup>40</sup>	<b>Sociodemographic:</b> younger*, sex, non-Caucasian†, less educated†, limited English proficiency†, health literacy, unemployment†, fewer assets†, income, live in a deprived area†, higher copay insurance type† <b>Health status:</b> younger when diagnosed with DM†, lower comorbidity score†, high LDL†, higher BP† <b>Risk/Protective behavior:</b> missed appointments previously†, no assigned primary care provider† <b>Social support:</b> social support		<b>Provider:</b> lower trust in physician†
Bowser <i>et al</i> , 2009 <sup>32</sup>	<b>Sociodemographic:</b> age, female†, health literacy, income level <b>Health status:</b> depression <b>Disease knowledge, belief or attitude:</b> low social functioning†, lower self-efficacy†		
Simmons and Clover, 2007 <sup>47</sup>	<b>Sociodemographic:</b> age, sex, race/ethnicity, education, employment, income, not on social benefit†, marital status <b>Health status:</b> HbA1c, on prescribed medication†, DM duration, no severe DM-related retinopathy†, LDL, BMI, BP <b>Disease knowledge, belief or attitude:</b> DM knowledge, emotional and readiness to change <b>Transportation:</b> transportation, distance between home and clinic <b>Social support:</b> social support, family size		
Masuda <i>et al</i> , 2006 <sup>39</sup>	<b>Sociodemographic:</b> younger†, sex, occupation <b>Health status:</b> lower HbA1c†, lower fasting plasma glucose†, DM therapy type (non-medication†), DM diagnosed at other place†, DM complications <b>Risk/Protective behavior:</b> smoking, alcohol use <b>Transportation:</b> distance between home and clinic		
Ando <i>et al</i> , 2005 <sup>31</sup>	<b>Sociodemographic:</b> age, sex, education, marital status <b>Health status:</b> DM therapy type, BMI, fasting plasma glucose <b>Risk/Protective behavior:</b> smokert† <b>Others:</b> Yatabe-Guilford test (lower general activity†, higher depression†), Rorschach (higher negative self-attitude†)		
Wong <i>et al</i> , 2005 <sup>46</sup>	<b>Sociodemographic:</b> older*, work-related constraints* <b>Transportation:</b> no transportation* <b>Others:</b> forgetness*	<b>System:</b> no reminder*, long wait time*	
Karter <i>et al</i> , 2004 <sup>36</sup>	<b>Sociodemographic:</b> middle age†, sex, reside in a poverty area†, higher copay insurance type† <b>Health status:</b> higher HbA1c†, oral medication only†, use of insulin†, lower comorbidity score†, depression, hospitalization/emergency room visit between appointments <b>Risk/Protective behavior:</b> less blood glucose self-monitoring per day†, number of scheduled appointments annually	<b>Provider:</b> type of provider	

Continued

Table 2 Continued

Study, year	Patient characteristics	Healthcare system and provider factor	Interpersonal factor
Rosen <i>et al</i> , 2003 <sup>41</sup>	<b>Sociodemographic:</b> age, sex, non-Caucasian†, education, employment <b>Health status:</b> DM therapy type, lower MMSE†		
Khoza and Kortenbout, 1995 <sup>44</sup>	<b>Sociodemographic:</b> unemployment* <b>Transportation:</b> no transportation* <b>Others:</b> bad weather*	<b>System:</b> long wait time*	
Belgrave and Lewis, 1994 <sup>43</sup>	<b>Social support:</b> less social support†		

\*Qualitative report; %included in the development of a predictive model.

†Statistically significant ( $p < 0.05$ ).

BMI, body mass index; BP, blood pressure; HbA1c, hemoglobin A1c; HDL, high-density lipoprotein; LDL, low-density lipoprotein; MMSE, Mini-Mental State Examination; T-Cho, total cholesterol; T2DM, type 2 diabetes mellitus; TG, triglyceride.

risk/protective behavior (including number of appointments scheduled in a period of time, smoking, previously missed appointments), social support (including family size, social support) and others (including personality, weather, distance between clinic and home and transportation). Sociodemographic factors were the most commonly examined factors: age was examined in 15 articles<sup>31–42 46–48</sup> and sex in 14 articles.<sup>31–42 47 48</sup> Articles operationalized each factor in different ways. For example, when examining DM treatment, some articles compared number of medications per day<sup>34</sup> while others compared prescription medications (oral medication or insulin) with non-medication treatments.<sup>31 34–36 39 41 47</sup> Other details can be found in [tables 2 and 3](#).

The findings were mostly inconsistent as shown in [table 3](#). For example, race/ethnicity were examined in eight articles.<sup>33 33 35 38 40 41 47 48</sup> Only half demonstrated that identification as a racial/ethnic minority (foreigners in Malaysia, Malay or Indian in Singapore, Latino or African American or non-Caucasian in the USA) was associated with missed appointments.<sup>33 38 40 41</sup> Previous missed appointments was the only factor consistently associated with missed appointments in the articles.<sup>38 40</sup>

Regarding factors examined only once across all articles, Parker *et al*<sup>40</sup> found that fewer assets, limited English proficiency, younger age at DM diagnosis and no assigned primary care provider were associated with missed appointments.<sup>40</sup> Other factors that were assessed once and showed significant results included lack of social benefits,<sup>47</sup> less blood glucose self-monitoring,<sup>36</sup> DM diagnosis at other clinics<sup>39</sup> and lower Mini-Mental State Examination score.<sup>41</sup>

#### Healthcare system and provider factors

Healthcare system and healthcare provider factors were addressed in eight articles.<sup>33 36–38 44–46 48</sup> The majority of the results were descriptive in nature: no reminder of the appointment was mentioned by participants,<sup>45 46 48</sup> long wait time<sup>44–46</sup> and lack of resources in healthcare system (eg, lack of resources, no proper incentive for

providers).<sup>45</sup> Other quantitatively measured factors included type of facilities,<sup>33 36</sup> intervals between appointments,<sup>37 38</sup> the time of the appointments (eg, month, day of the week) and type of providers.<sup>36</sup> Chew *et al*<sup>33</sup> found that appointments with specialists in the medical centers were more likely to be missed than appointments with non-specialists in the medical centers, or appointments with specialists or non-specialists in clinics. Low *et al*<sup>38</sup> reported that the intervals between appointments (61–90 days) and appointments scheduled between January and June were associated with missed appointments while Kurasawa *et al*<sup>37</sup> included those factors in developing predictive models and did not report their significance.

#### Interpersonal factors

Of three studies addressing interpersonal factors (ie, patient appraisal of care), two did so qualitatively and reported participants dissatisfied with the care, lack of respect from providers or negative experiences with the clinic as themes relevant to missed appointments.<sup>45 48</sup> One article quantified trust in physicians and found that lower trust was significantly associated with missed appointments.<sup>40</sup>

#### DISCUSSION

To our knowledge, this is the first systematic review that provides a critical appraisal of factors associated with missed appointments among adults with T2DM. There was a great variability in terms of design, setting and sample of the studies included in this review, and most were focused on patient characteristics with inconsistent findings.<sup>31–48</sup> Likewise, the operationalized definitions of the outcomes (missed appointments) varied. Consequently, it is unclear if the influence of factors associated with missed appointments is the same between people who missed several appointments (ie, low engagement in the healthcare) and those who missed once or twice.<sup>49 50</sup>

Based on our analysis of the studies addressing patient characteristics, key sociodemographic factors, such as

**Table 3** Patient characteristics factors examined and their corresponding studies

Patient characteristics: variables	Number of studies examined	Significance	Non-significance/others (qualitative, predictive model)
<b>Sociodemographic</b>			
Age	15	Younger <sup>34 38–40</sup> Middle age <sup>36</sup> Older <sup>33</sup>	31 32 35 41 42 47 48/ Qualitative, <sup>46</sup> Predictive model <sup>37</sup>
Sex	14	Male <sup>33 38</sup> Female <sup>32</sup>	31 34–36 39–42 47 48/ Predictive model <sup>37</sup>
Work	8	Unemployment <sup>40</sup>	35 39 41 47/ Qualitative <sup>44–46</sup>
Race/Ethnicity	7	Minority <sup>33 38 40 41</sup>	35 47 48
Income	5		32 35 40 47/ Qualitative <sup>45</sup>
Education	5	Less educated <sup>40</sup> Missing data <sup>35</sup>	31 41 47
Insurance type	4	High copay <sup>36 40</sup>	35/ Qualitative <sup>45</sup>
Residential area	3	Deprived area <sup>36 40</sup>	35
Health literacy	2		32 40
<b>Health status</b>			
DM treatment	7	On prescription <sup>47</sup> Oral medication only <sup>36</sup> Use of insulin <sup>34 36</sup> Fewer DM medications per day <sup>34</sup> Non-medication <sup>39</sup>	31 35 41
Comorbidities	5	Lower comorbidities score <sup>36 40</sup>	35/ Qualitative, <sup>45</sup> Predictive model <sup>37</sup>
Lipid profile lab value	5	Higher LDL <sup>33 34 40</sup> Higher TG <sup>34</sup> No hyperlipidemia <sup>33</sup>	47/ Predictive model <sup>37</sup>
Number of appointments scheduled	4	Less <sup>38</sup>	36 48/ Predictive model <sup>37</sup>
HbA1c	4	Higher <sup>34 36</sup> Lower <sup>39</sup>	47
BMI	4	Lower <sup>33</sup>	31 35 47
DM duration	4	Longer <sup>33 42</sup>	34 47
DM complications	4	No retinopathy <sup>47</sup> Kidney complication <sup>35</sup> More complications <sup>33</sup>	39
Hospitalized or ER visit	3		36 38 48
Blood pressure reading	3	Higher <sup>40</sup> Lower <sup>33</sup>	47
Depression	3		32 35 36
Fasting plasma glucose	2	Lower <sup>39</sup>	31
<b>Disease knowledge, belief or attitude</b>			
Disease belief or attitude	5	Disease cannot be controlled <sup>42</sup> Lower self-efficacy <sup>32</sup> Low social functioning <sup>32</sup>	Readiness to change <sup>47</sup> / Qualitative <sup>45</sup>
Disease knowledge	2		47/ Qualitative <sup>45</sup>

Continued

**Table 3** Continued

Patient characteristics: variables	Number of studies examined	Significance	Non-significance/others (qualitative, predictive model)
<b>Risk/Protective behavior</b>			
Smoking	4	Smoker <sup>31 34</sup>	35 39
Previously missed appointments	2	38 40	
<b>Social support</b>			
Family size	3		35 39 42
Social support	2	Less social support <sup>43</sup>	40 47/ Qualitative <sup>45</sup>
<b>Others</b>			
Transportation	4		Qualitative <sup>44–46 48</sup>
Distance between clinic and home	4		39 47/Qualitative, <sup>45</sup> Predictive model <sup>37</sup>
Personality	3	Psychological test <sup>31</sup>	Qualitative <sup>46 48</sup>
Weather	3		Qualitative, <sup>44 45</sup> Predictive model <sup>37</sup>

BMI, body mass index; DM, diabetes mellitus; ER, emergency room; HbA1c, hemoglobin A1c; LDL, low-density lipoprotein; TG, triglyceride.

age, sex, race/ethnicity, were not consistent factors related to missed appointments, nor were education, income or insurance. Similar, evidence was either inconsistent or lacking in the relationship between health status of the patient and missed appointments. While American Diabetes Association underscores the substantial influences of social determinants of health in diabetes management,<sup>51</sup> relevant studies included in this review—although mostly qualitative—noted access to reliable transportation as an important factor in appointment keeping behavior among patients with T2DM. According to a recent systematic review,<sup>52</sup> offering transportation services (eg, providing bus passes, taxi/transport vouchers or reimbursement, arranging or connecting participants to transportation) was effective in helping older adults with chronic illnesses use necessary healthcare. Future research is warranted to investigate the effect of social determinants of health as part of patient characteristics, such as transportation, on appointment keeping behavior among patients with T2DM and ways in which transportation barriers can be addressed.

The included articles, although limited in number, demonstrated the influence of healthcare system and provider factors in missed appointments (eg, long intervals between two appointments, or no reminder prior to the scheduled time).<sup>33 36–38 44–46 48</sup> Those factors were examined either quantitatively through using medical records data,<sup>33 36–38</sup> or through qualitative inquiry.<sup>44–46 48</sup> In non-diabetes contexts, health systems have developed and implemented a predictive model of missed appointments to shorten the waitlist while minimizing empty spots in the schedule.<sup>53 54</sup> Additionally, a predictive model of missed appointments may help identify patients with higher risks of missed appointments. An

intervention with targeted reminder phone calls from a patient service coordinator demonstrated significant reduction in missed appointments in a primary care setting,<sup>55</sup> which could resolve a common reported factor related to missed appointments (no reminder prior to the scheduled appointment) in the studies included in this review.<sup>45 46</sup>

Over the last two decades, patient-centered care, in which caring relationships<sup>25</sup> is integral, has taken center stage in discussions of provision of quality healthcare.<sup>56</sup> It is estimated that 45 million Americans live with one or more chronic conditions and this number is projected to increase due to improvement in life expectancy.<sup>57</sup> However, our healthcare system remains focused on the treatment of acute illness, leaving a gap between patient's preferences and experiences of medical care.<sup>58</sup> To this end, patient-centered care has become an important research topic and policy focus, particularly in the context of chronic care and multimorbidity.<sup>59</sup> Further, patient-reported measures of the care delivery have been suggested to become part of the diabetes performance measures to enhance delivery of quality, patient-centered care, and patient support.<sup>60</sup> Nevertheless, we identified only three studies in the review where interpersonal factors (eg, patient trust in health system or providers) were addressed.<sup>40 45 48</sup> Patient engagement is not only a patient behavior but also a process shaped by the therapeutic alliance between providers and patients and the environment in which healthcare delivery takes place.<sup>61</sup> Taken together, future research is warranted to better understand the role of interpersonal relationship between providers and patients and its association with missed appointments among people with T2DM.

To achieve truly patient-centered and quality care delivery, future interventions that promote patient engagement (ie, appointment-keeping behavior) among people with T2DM should be expanded in scope to focus more on strategies to enhance interpersonal processes between providers and patients. In other chronic conditions, better patient-provider relationships have been associated with better health outcomes and less care discontinuity. For example, addressing physicians' communication skills to encourage greater patient engagement in care has successfully improved systolic blood pressure among African-Americans with uncontrolled hypertension.<sup>62</sup> Better interpersonal processes (provider-patient relationship) has been associated with better appointment keeping behavior among patients with HIV.<sup>63</sup>

There are a number of methodological issues to be taken into consideration when interpreting the findings in this review. Although a sample size of thousands were observed in the included studies,<sup>33 35–38 40</sup> some articles had skewed small sample sizes.<sup>31 41 43 44 47</sup> In addition, unaddressed confounding factors in several included studies were subject to threat to internal validity.<sup>32 34 35 37 38 42 43</sup> Last but not least, comparability of the studies was limited due to the variation between studies in terms of the operationalized definitions of missed appointments, independent variables included and differences in the settings.

A number of limitations of this review should be noted. It is possible that we did not include all relevant articles in the literature. We conducted an extensive systematic electronic search in consultation with an experienced health science librarian, in addition to hand searches of references of the identified studies. Besides, we included only articles written in English; therefore, relevant articles may have been excluded. In addition, we included studies that did not specify the type of diabetes in order to expand our results. Although T2DM accounts for 90%–95% of diabetes worldwide,<sup>164</sup> the findings from this review should be interpreted with caution. Likewise, it is important to note that medical records (paper or electronic) were commonly used in the studies included in this review to extract information on the status of appointments and the factors associated with the missed appointments.<sup>31 33 34 36–41 44 48</sup> The regulation on meaningful use of electronic medical records (EMR) has accelerated the adoption of EMR in healthcare settings and expanded the opportunities for conducting research. However, the accuracy of the EMR data can be questionable and EMR data may not tell the complete story of a specific patient.<sup>65</sup> For example, marital status or employment, commonly examined factors in the studies included in this review, might not always be up-to-date depending on the clinical practice. Finally, a missed appointment might not truly mean disengagement from healthcare because a patient might transfer to another healthcare system without notifying the original clinic. Similarly, the characteristics of a patient who eventually reached out to cancel an appointment might vary from the characteristics of a

patient who did not call to cancel nor show up. Given the widely various or unspecified operationalized definitions of missed appointments used in the studies included in the review, we were unable to differentiate the types of missed appointments which could have been useful to identify factors salient to those who are truly at risk of disengagement from diabetes care.

## CONCLUSION

Medical encounters are great opportunities for health-care providers to empower patients to actively participate in their care. This systematic review found a variety of multilevel factors in association with missed appointments among adults with T2DM with inconsistent findings. While the operationalized definitions of missed appointments varied greatly across studies, most of the included studies examined only patient characteristics and overlooked the importance of interpersonal factors. Given that patient should be at the center of diabetes care delivery built on patient-centeredness and approaches aligned with the Chronic Care Model,<sup>51</sup> understanding and assessing patient perspectives of the care process is necessary for understanding and predicting missed appointments. Future research must explore interpersonal factors to better understand the underlying causes of missed appointments to further enhance patient engagement in diabetes care. Mixed-methods research is a good methodological approach to comprehensively understand patient perspectives of the care process and to potentially inform future interventions.

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**Supplemental Table 1: Search terms used in the systematic review**

Database	Search Terms	Results
PubMed Searched on 1/17/2020	<p>("Appointments and Schedules"[Mesh:noexp] OR "No-Show Patients"[Mesh] OR "appointment keeping" OR "keeping appointments" OR "no-show" OR "no show" OR nonattend* [tw] OR "visit adherence" OR "missed visit" OR "missed visits" OR "appointment compliance")</p> <p>AND</p> <p>(diabetes mellitus [mh] OR diabet* [tw] OR IDDM [tw] OR NIDDM [tw] OR MODY [tw] OR "late onset diabetes" OR "maturity onset diabetes" OR "juvenile diabetes" OR hyperinsulin* [tw] OR "insulin sensitivity" OR "insulin sensitive" OR "impaired glucose tolerance" OR "glucose intolerance" OR "glucose intolerant" OR Glucose Intolerance [mh] OR "insulin resistance" OR "insulin resistant" OR "non insulin dependence" OR "non-insulin dependence" OR "non insulin dependent" OR "non-insulin dependent" OR "noninsulin dependent" OR "metabolic syndrome" OR "plurimetabolic syndrome" OR "type 1 diabetes" OR "type 2 diabetes" OR "type 1 diabetic" OR "type 2 diabetic" OR "type I diabetic" OR "type I diabetes" OR "type II diabetic" OR "type II diabetes" OR Insulin Resistance [mh] OR "insulin dependence" OR "insulin dependent")</p>	277 studies
Embase Searched on 1/17/2020	<p>'patient attendance'/exp OR (((keep OR keeps OR keeping OR kept OR compliance) NEAR/3 appointment*):ti,ab) OR 'no-show' OR 'no show' OR nonattend*:ti,ab OR 'visit adherence' OR (((missed OR misses OR missing) NEAR/3 (visit OR visits OR appointment*)):ti,ab)</p> <p>AND</p> <p>'diabetes mellitus'/exp OR 'metabolic syndrome x'/exp OR 'glucose intolerance'/exp OR 'insulin resistance'/exp OR diabet*:ti,ab OR iddm:ti,ab OR niddm:ti,ab OR mody:ti,ab OR (('late onset' OR 'maturity onset' OR juvenile) NEAR/3 diabet*):ti,ab OR hyperinsulin*:ti,ab OR (((insulin OR glucose OR 'non-insulin' OR noninsulin OR 'non insulin') NEAR/3 (sensitive* OR resist* OR depend*)):ti,ab) OR 'metabolic syndrome' OR 'pluri metabolic syndrome' OR 'plurimetabolic syndrome' OR (('type 1' OR 'type i' OR 'type 2' OR 'type ii' OR 'type-1' OR 'type-2') NEAR/3 diabet*):ti,ab)</p>	522 studies
CINAHL Searched on 1/17/2020	<p>MH "Appointments and Schedules+" OR (((keep OR keeps OR keeping OR kept OR compliance) N3 appointment*)) OR 'no-show' OR 'no show' OR nonattend* OR 'visit adherence' OR (((missed OR misses OR missing) N3 (visit OR visits OR appointment*)))</p>	986 studies

	<p>AND</p> <p>(MH "Diabetes Mellitus+") OR (MH "Metabolic Syndrome X+") OR (MH "Insulin Resistance+") OR (MH "Glucose Intolerance") OR diabet* OR iddm OR niddm OR mody</p>	
<p>Psyinfo</p> <p>Searched on 1/17/2020</p>	<p>MH "Appointments and Schedules+") OR (((keep OR keeps OR keeping OR kept OR compliance) N3 appointment*)) OR 'no-show' OR 'no show' OR nonattend* OR 'visit adherence' OR (((missed OR misses OR missing) N3 (visit OR visits OR appointment*)))</p> <p>AND</p> <p>(MH "Diabetes Mellitus+") OR (MH "Metabolic Syndrome X+") OR (MH "Insulin Resistance+") OR (MH "Glucose Intolerance") OR diabet* OR iddm OR niddm OR mody</p>	<p>102 studies</p>
<p>Web of Science</p> <p>Searched on 1/17/2020</p>	<p>("No-Show Patients" OR "appointment keeping" OR "keeping appointments" OR "no-show" OR "no show" OR nonattend* OR "visit adherence" OR "missed visit" OR "missed visits" OR "appointment compliance" OR "appointment adherence")</p> <p>AND</p> <p>(diabet* OR IDDM OR NIDDM OR MODY OR "late onset diabetes" OR "maturity onset diabetes" OR "juvenile diabetes" OR hyperinsulin* OR "insulin sensitivity" OR "insulin sensitive" OR "impaired glucose tolerance" OR "glucose intolerance" OR "glucose intolerant" OR "insulin resistance" OR "insulin resistant" OR "non insulin dependence" OR "non-insulin dependence" OR "non insulin dependent" OR "non-insulin dependent" OR "noninsulin dependent" OR "metabolic syndrome" OR "plurimetabolic syndrome" OR "type 1 diabetes" OR "type 2 diabetes" OR "type 1 diabetic" OR "type 2 diabetic" OR "type I diabetic" OR "type I diabetes" OR "type II diabetic" OR "type II diabetes" OR "insulin dependence" OR "insulin dependent")</p>	<p>121 studies</p>

Supplemental Table 2 Quality Ratings

<b>Cohort Study</b>													
Items	Buys, 2019* [48]	Garcia-Diaz, 2017 [34]	Gibson, 2017 [35]	Kurasawa, 2016 [37]	Low, 2016 [38]	Chew, 2015 [33]	Thongsai, 2015 [42]	Parker, 2012 [40]	Bowser, 2009 [32]	Masuda, 2006 [39]	Ando, 2005 [31]	Rosen, 2003 [41]	Karter, 2004 [36]
1. Were the two groups similar and recruited from the same population?	1	1	1	1	1	1	1	1	1	1	0	1	1
2. Were the exposures measured similarly to assign people to both exposed and unexposed groups?	1	1	1	0	1	1	1	1	1	1	1	1	1
3. Was the exposure measured in a valid and reliable way?	1	1	1	1	1	1	1	1	1	1	1	1	1
4. Were confounding factors identified?	0	0	0	0	0	1	0	1	0	1	0	1	1
5. Were strategies to deal with confounding factors stated?	0	0	0	0	0	1	0	1	0	1	0	1	1
6. Were the groups/participants free of the outcome at the start of the study (or the moment of exposure)?	1	1	1	1	1	1	0	1	1	1	1	0	1
7. Were the outcomes measured in a valid and reliable way?	1	1	0	1	1	1	0	1	0	1	0	1	1
8. Was the follow up time reported and sufficient to be long enough for outcomes to occur?	1	1	1	1	1	1	0	1	0	1	1	1	1
9. Was follow up complete, and if not, were the reasons to loss to follow up described and explored?	1	1	1	0	0	1	0	1	0	1	1	0	1
10. Were reasons to address incomplete follow up utilized?	0	1	1	0	0	0	0	1	0	0	0	0	1
11. Was appropriate statistical analysis used?	1	1	1	1	1	1	1	1	1	0	1	1	1
Total Score	8	9	8	6	7	10	4	11	5	9	6	8	11
Level of Quality	0.73	0.82	0.73	0.55	0.64	0.91	0.36	1.0	0.45	0.82	0.55	0.73	1.0
<b>Cross-Sectional Study</b>													
Items									Khoza, 1995 [44]	Belgrave, 1994 [43]			
1. Were criteria for inclusion in the sample clearly defined?									0	0			
2. Were the study subjects and the setting described in detail?									1	1			
3. Was the exposure measured in a valid and reliable way?									0	1			
4. Were objective, standard criteria used for measurement of the condition?									0	0			
5. Were confounding factors identified?									0	0			
6. Were strategies to deal with confounding factors stated?									0	0			
7. Were the outcomes measured in a valid and reliable way?									0	0			
8. Was appropriate statistical analysis used?									0	1			
Total Score									1	3			
Level of Quality									0.13	0.38			

Supplemental Table 2 (Continued)

Case Control Study			
Items	Simmon, 2007 [47]		
1. Were the groups comparable other than the presence of disease in cases or absence of disease in controls?	0		
2. Were cases and controls matched appropriately?	1		
3. Were the same criteria used for identification of cases and controls?	1		
4. Was exposure measured in a standard, valid, and reliable way?	0		
5. Was exposure measured in the same way for cases and controls?	1		
6. Were confounding factors identified?	1		
7. Were strategies to deal with confounding factors identified?	1		
8. Were outcomes assessed in a standard, valid and reliable way for cases and controls?	0		
9. Was the exposure period of interest long enough to be meaningful?	1		
10. Was appropriate statistical analysis used?	1		
Total Score	7		
Level of Quality	0.7		
Qualitative Study			
Items	Buy, 2019 * [48]	Heydarabadi, 2017 [45]	Wong, 2005 [46]
1. Is there congruity between the stated philosophical perspective and the research methodology?	1	0	0
2. Is there congruity between the research methodology and the research question or objectives?	1	1	1
3. Is there congruity between the research methodology and the methods used to collect data?	1	1	1
4. Is there congruity between the research methodology and the interpretation of results?	1	1	1
5. Is there congruity between the research methodology and the interpretation of results?	1	1	1
6. Is there a statement locating the researcher culturally or theoretically?	0	0	0
7. Is the influence of the research on the research, and vice-versa, addressed?	0	0	0
8. Are participants, and their voices, adequately represented?	0	1	0
9. Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body?	1	1	1
10. Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?	1	1	1
Total Score	7	7	6
Level of Quality	0.7	0.7	0.6

\*Mixed methods study

