




Knowledge, attitude, and practice toward pre-diabetes among the public, patients with pre-diabetes and healthcare professionals: a systematic review

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ABSTRACT

The prevalence of pre-diabetes is increasing globally, affecting an estimated 552 million people by 2030. While lifestyle interventions are the first line of defense against progression toward diabetes, information on barriers toward pre-diabetes management and how to overcome these barriers are scarce. This systematic review describes the public's and healthcare professionals' knowledge, attitude and practice (KAP) toward pre-diabetes and determines the barriers toward pre-diabetes management. A systematic search for studies examining KAP towards pre-diabetes was conducted in six databases from inception to September 2022. Studies that quantitatively assessed at least two KAP elements using questionnaires were included. The quality of studies was assessed using the NIH Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies. Barriers and enablers were identified and mapped onto the Capability, Motivation, and Behaviour model to identify factors that influence behavior change. Twenty-one articles that surveyed 8876 participants were included in this review. Most of the reviews (n=13) were directed to healthcare professionals. Overall, positive attitudes toward diabetes prevention efforts were observed, although there were still knowledge deficits and poor behavior toward pre-diabetes management. Barriers and enablers were detected at patients (eg, goals and intention), healthcare professionals (eg, clinical judgement) and system (eg, access and resources) levels. The use of different survey instruments to assess KAP prevented a head-to-head comparison between studies. Most studies conducted among patients were from middle-income countries, while among healthcare professionals (HCPs) were from high-income countries, which may produce some biasness. Nevertheless, the development of pre-diabetes intervention should focus on: (1) increasing knowledge on pre-diabetes and its management; (2) imparting practical skills to manage pre-diabetes; (3) providing resources for lifestyle management; (4) improving the accessibility of lifestyle management programs; and (5) other HCPs and human support to pre-diabetes management.

INTRODUCTION

Pre-diabetes refers to the clinical situation in which blood glucose levels are elevated but do not meet the threshold for diabetes. This includes people with impaired fasting glucose and impaired glucose tolerance.^{1,2} While

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ While lifestyle interventions are the first line of defense against progression toward diabetes, information on barriers toward pre-diabetes management and how to overcome these barriers are scarce.

WHAT THIS STUDY ADDS

⇒ By consolidating KAP levels from included studies, this systematic review adds on to existing evidence on approaches to improve diabetes prevention and pre-diabetes management.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OF POLICY

⇒ This study suggests key components of pre-diabetes interventions to researchers and healthcare providers, which can be included in the development diabetes prevention programs.

diagnostic criteria vary, it can broadly be defined as a fasting plasma glucose of 5.6–6.9 mmol/L, glycated hemoglobin (HbA1c) of 5.7%–6.4%, or 2-hour plasma glucose of 7.8–11.0 mmol/L.^{3,4} Studies suggest that people with pre-diabetes are at a higher risk of developing complications of diabetes, including cardiovascular diseases, nephropathy and neuropathy.¹

Currently, 5%–10% of people with pre-diabetes will meet the clinical criteria for diabetes annually, with up to 70% progressing to diabetes within their lifetime.^{5,6} The high prevalence of pre-diabetes is worrying, as these are potential seedbeds for type 2 diabetes mellitus in the coming years. However, there is still a silver lining for those who have pre-diabetes. Current evidence shows that lifestyle interventions to combat obesity and physical inactivity can effectively reduce the risk of progression from pre-diabetes to type 2 diabetes mellitus by up to 58%.^{5,7,8} In many of these lifestyle intervention programs,

patients were routinely trained and monitored by lifestyle ‘coaches’ to perform intensive diet and exercise regimes to achieve weight loss.^{5,9,10} These interventions also found an increased life expectancy and protection from the detrimental repercussions of diabetes-related complications such as microvascular and macrovascular diseases,¹¹ which may persist for up to 10 years.¹²

To successfully implement lifestyle intervention programs, it is essential to understand the public readiness for behavioral change. This can be done using several ways, such as qualitative interviews and focus groups or through knowledge, attitude and practice (KAP) surveys of individuals with pre-diabetes, and that of healthcare providers managing patients with pre-diabetes.^{13–34} In the latter, the model assumes that the KAP elements are interrelated, where good knowledge would positively affect the attitude and practice, triggering preventive behavior.^{35, 36} This model helps detect barriers toward preventive behavior and gaps between each component.³⁷ Various studies have examined the KAP toward pre-diabetes among patients and healthcare professionals. For example, Hyder *et al* showed that the people newly diagnosed with pre-diabetes from India had poor knowledge and practice toward lifestyle modifications, but there was a mixed response on their attitude toward pre-diabetes.^{16, 17} Among the healthcare professionals, Keck *et al* and Tseng *et al* suggested that their knowledge gap contributed to inadequate pre-diabetes diagnosis and referrals to diabetes prevention programs.^{24, 26} These studies found gaps in the KAP toward pre-diabetes; however, none have demonstrated the common barriers toward pre-diabetes and how to address them.

As such, investigating specific influencing factors that can overcome the barriers identified from the KAP model provides a foundation for diabetes prevention strategies.³⁸ This helps researchers make informed decisions and select the most effective interventions for diabetes prevention.

This systematic review aimed to investigate the KAP level toward pre-diabetes among the general population and healthcare professionals (HCPs). In addition, we aim to determine the barriers and enablers toward pre-diabetes management. By consolidating KAP levels from included studies, this systematic review adds on to existing evidence on approaches to improve diabetes prevention and pre-diabetes management.

METHODS

This study was performed in accordance with the recommendations of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (online supplemental figure 1, online supplemental table S1). The study was registered in PROSPERO (CRD42021271768).

Search strategy

Studies were identified through a systematic search of CINAHL, PsycINFO, PubMed, Embase, CNKI, and

LILACS from database inception to 1 September 2022. A combination of keywords and Medical Subject Headings (MeSH) related to pre-diabetes, survey, knowledge, attitude, and practice were used without language restriction (online supplemental figure S2). This was supplemented with manual searches on the reference lists of the included studies for potentially relevant publications.

Study eligibility

Studies were eligible for inclusion if they fulfilled the following criteria: (1) included adults aged 18 years and above; (2) examined perceptions of the general population, patients with pre-diabetes, and/or healthcare professionals; and (3) quantitatively assessed two or more KAP elements toward pre-diabetes using questionnaires. In order to draw comparisons between the KAP elements, only studies with at least two KAP elements were included. We excluded qualitative studies, conference abstracts, letters, editorials, and comments.

All retrieved studies were exported into Endnote X9 (Thomson Reuters, London) and deduplicated. Two authors (KWT and SL) independently screened the titles and abstracts for eligibility. Six authors (KWT, CMN, CWC, SB, MWLC and SL) independently reviewed full texts of eligible articles to determine their eligibility. Any disagreement was discussed and resolved between the two authors.

Data extraction, coding, and critical appraisal

Data from the included articles were extracted independently using a standardized extraction form. Extracted data included study demographic, questionnaire characteristics, and questionnaire responses. Subsequently, we mapped each question to be a barrier and enabler for behavioral change from each questionnaire item.

As intervention strategies that target behavior changes are often more effective when an implementation theory was used, we further mapped each of these barriers or enablers to the Capability, Motivation, and Behaviour (COM-B) model, more commonly known as a part of the behavior change wheel. The COM-B model classifies target behavior (B) into three distinct yet interacting components- ‘capability’ (C), ‘opportunity’ (O) and ‘motivation’ (M). Each component can be further stratified into their subcomponents (table 1).

This model contextualizes individual-level change, and the underlying determinants needed to achieve organizational change.³⁸ This was supplemented with a mapping to the Theoretical Domains Framework (TDF) that builds on the COM-B model to uncover the underlying barriers and facilitators for change.³⁹ We then used the barriers to guide potential intervention functions (based on the Behaviour Change Wheel) and Behaviour Change Techniques (BCTs) that can shape behavior change.⁴⁰

Two team members mapped the questions independently, and any disagreement was resolved by consensus. To assess the quality of studies, two authors used the National Institutes of Health (NIH) Quality

**Table 1** Definition of COM-B and its subcomponents

Component	Subcomponent
Capability (C) <i>Ability to undertake an action for behavior change</i>	Physical <i>Physical skills and strength</i>
	Psychological <i>Knowledge, psychological skills, comprehension and reasoning</i>
Opportunity (O) <i>External factors that encourage behavior</i>	Physical <i>Opportunity provided by environment</i>
	Social <i>Social cues, cultural norms, interpersonal influences</i>
Motivation (M) <i>Cognitive processes that trigger behavior</i>	Reflective <i>Plans and evaluations</i>
	Automatic <i>Emotional reactions, desires, reflexes, impulses</i>

Assessment Tool for Observational Cohort and Cross-Sectional Studies.⁴¹ The tool assessed the studies based on several criteria namely: (1) research objective; (2) study population and recruitment; (3) exposure measurement and assessment; and (4) statistical analyses methods. Two authors independently assessed the quality of the included studies, with any disagreements resolved through discussion and consensus. All data were subsequently summarized narratively.

RESULTS

Study characteristics

The search identified 4698 potentially relevant articles, and 4332 were screened by title and abstract after removing duplicates. Full texts of 45 articles were reviewed, and 22 articles describing 21 unique studies

were included (online supplemental figure S3). The studies were conducted in Asia (n=8),^{13–17 19 20 34} North America (n=8),^{18 21 24–26 29 30 33} South America (n=1),³² Africa (n=2)^{22 31} and Europe (n=2).^{27 28} These were cross-sectional studies that examined the KAP toward pre-diabetes among the general public (n=1),²⁰ patients with pre-diabetes (n=7)^{13–19} and HCPs (n=13) (tables 2 and 3).^{21–34}

The studies surveyed a total of 8876 participants, including 303 participants from the general public, 2007 participants with pre-diabetes, and 6258 healthcare providers, with response rates ranging between 11.6% and 100%. The sample size of the studies varied, ranging from 54 to 1248 participants. The mean age of participants was 45.1 years old, with 52.5% females. Based on the NIH quality assessment tool, most studies were rated to have a poor to fair internal validity (online supplemental table S2 and figure S4).

KAP questionnaires

Various questionnaires were used to assess the KAP elements (tables 2 and 3, and online supplemental file 1). Sixteen studies evaluated all KAP elements, while the remaining five assessed at least two KAP elements. Of the 21 studies, 16 used validated questionnaire, with five describing the questionnaire development.

Knowledge

Patients

Six studies investigated the patients' knowledge toward pre-diabetes.^{13 14 16 17 19 20} Studies reported that up to 93.7% of the individuals were unfamiliar with the terms 'prediabetes', 'impaired fasting glucose', 'impaired glucose tolerance', or 'borderline diabetes'.^{14 19} However, patients' understanding of the risk factors and consequences of pre-diabetes were heterogeneous. Studies

Table 2 Characteristics of included studies that examined KAP toward pre-diabetes among the public and patients with pre-diabetes

First author	Study setting and collection period	Mean age (SD)	Sample size	Women, n (%)	KAP element reported (K/A/P)	Response rate
Chen, 2015 ¹³ (Taiwan)	Health examination centres of two hospitals; January–August 2013	58.64 (10.99)	200	136 (68)	K/P	95.20%
Zhuang, 2015 ¹⁴ (China)	Community-dwelling adults; January 2012–May 2013	52.15 (6.29)	148	82 (55.4)	K/P	100%
Rahmati-Najarkolaei, 2017 ¹⁵ (Iran)	Health centres; November 2014–April 2015	52.9 (11.5)	303	86 (28.4)	A/P	86.60%
Hyder, 2020 ¹⁶ Hyder, 2021 ¹⁷ (India)	Screening camps; September 2017–October 2019	46–50 (range)	308	150 (48.7)	K/A/P	98%
Kolb, 2014 ¹⁸ (USA)	Urban academic primary care practices	45.7 (10.9)	54	44 (81.5)	K/A/P	85.70%
Dong, 2014 ¹⁹ (China)	Community-dwelling adults; May 2013–June 2013	45–59 (range)	994	588 (59.15)	K/A/P	ND
Zhao, 2011 ²⁰ (China)	Community-dwelling adults; October 2010–February 2011	20.95 (2.13)	303	180 (59.4)	K/P	K: 86.5% P: CD

A, attitude; CD, cannot determine; K, knowledge; ND, no data; P, practice.

Table 3 Characteristics of included studies that examined KAP toward pre-diabetes among healthcare providers

First author	Study setting and collection period	Mean age (SD)	Sample size	Women, n (%)	KAP element reported (K/A/P)	Response rate
Tseng, 2017 ²¹ (USA)	Academic medical center (doctors, nurses, and doctors' assistants), 2015	ND	140	99 (72.8)	K/A/P	89.7%
Inaku, 2021 ²² (Nigeria)	Four government-owned tertiary hospitals (doctors), ND	ND	358	130 (36.3)	K/A/P	87.3%
Basavareddy, 2015 ²³ (India)	Academic practice, primary care, and secondary care (doctors), April 2014–August 2014	ND	122	ND	K/A/P	81.30%
Keck, 2019 ²⁴ (USA)	Academic family medicine clinic (doctors and nurses), February 2018	ND	31	19 (61.3)	K/A/P	67.39%
Mainous III, 2016 ²⁵ (USA)	Physicians from Council of Academic Family Medicine Educational Research Alliance (doctors), February 2016–March 2016	40–49 (range)	1248	619 (49.6)	A/P	34.65%
Tseng, 2018 ²⁶ (USA)	Primary care providers from American Medical Association (doctors), October 2017–January 2018	above 60 years old (n=99)	298	29 (30.2)	K/A/P	33.56%
Franch-Nadal, 2020 ²⁷ (Spain)	Primary care providers (doctors and pharmacists)	Physicians: 23.4 (8.32) Pharmacists: 45.26 (10.26)	803 Physicians: 410 Pharmacists: 393	419 (52.2%)	K/A/P	89.72%
Montee, 2021 ²⁸ (France)	Primary care providers (doctors)	49 (11)	121	57 (47.1%)	K/A/P	18.10%
Hulbert, 2021 ²⁹ (USA)	Providers from individual, group, or hospital practice (nurses, doctors, pharmacists, and internists)	45–54 (range)	1503	682 (45.4%)	K/A/P	43.38%
Shimpi, 2021 ³⁰ (USA)	Primary care providers (dentists)	50.1 (12)	854	593 (69.4%)	K/A/P	11.61%
Saleh, 2021 ³¹ (Sudan)	Primary care providers (doctors)	34 (median)	189	149 (79%)	K/A/P	94.5%
Montee, 2021 ²⁸ (France)	Primary care providers (doctors)	49 (11)	121	57 (47.1%)	K/A/P	18.10%
Ross, 2021 ³³ (USA)	Primary care providers (physical therapists)	52.8 (11.5) range 26–75	63	29 (47)	K/A/P	6.30%
Aljehani, 2022 ³⁴ (Saudi Arabia)	Primary care providers (doctors)	ND	155	79 (51)	K/A/P	ND

K, Knowledge; A, Attitude; P, Practice; ND, no data.

from middle-income countries generally reported that one in three patients (range 19.7%–37.5%) understood the risk factors and consequences of pre-diabetes.^{14 16 17 19} Conversely, more than half of patients from high-income countries (range 63%–88%) knew about the risk factors and consequences of pre-diabetes.^{13 18}

Most patients could not correctly identify pre-diabetes diagnostic criteria and screening methods.^{13 16 17 20} Misinformation on pre-diabetes remains widespread; up to 90% of patients thought that pre-diabetes would present symptoms similar to diabetes.¹³ While more than half of the individuals were aware that pre-diabetes could be treated through lifestyle management,^{13 19 20} many were unaware of what these modifications entailed, in terms of dietary changes and recommended duration of physical activities.^{16 17 20} Interestingly, only 18.2% understood that weight reduction could help with reversing pre-diabetes, and up to 43% of the individuals believed that pre-diabetes could only be treated with medications.^{16 17 20}

Healthcare providers

Most healthcare providers had poor knowledge about pre-diabetes, where only 2.8%–42% correctly identified the diagnostic criteria and risk factors for pre-diabetes.^{21 22 24 26–28 32–34} Less than half of the healthcare providers could identify recommended lifestyle changes, clinical targets, and pharmacological therapies for patients with pre-diabetes.^{21 23 24 26 32–34}

Attitude Patients

Four studies described the patients' views and perceptions toward pre-diabetes, with mixed levels of attitudes.^{15–18 20} For example, a study from India reported that half of the patients believed they could manage living life with pre-diabetes but were concerned it would eventually lead to complications such as developing diabetes, ischemic heart disease or stroke.^{16 17}

Studies from high-income countries found that patients were more willing to change and lead a healthier lifestyle ($\geq 94\%$) if diagnosed with pre-diabetes, compared with only 30%–40% among those living in middle-income countries.^{14 18} A similar trend was found for the stages of change, where up to 54% of individuals in high-income countries were taking actions for weight control, compared with less than one-third (range 8%–36%) of those living in middle-income countries.^{18–20}

Most patients (up to 80%) appeared receptive to public health measures, such as health promotion and education to prevent diabetes.^{16 17 19} The patients were reportedly agreed to participate in lifestyle management programs, such as weight control, healthy eating, and regular physical activities to build a healthier lifestyle.^{15–18}

Healthcare providers

Up to 93.5% of the healthcare providers agreed that pre-diabetes is a major public health issue that causes significant economic burden.^{23 24 27} As such, most felt that population-based screening and lifestyle change programs were important to manage pre-diabetes and other comorbidities.^{21 22 24 27–34} Despite patient's positive attitudes toward lifestyle management programs, HCPs felt that their patients perceived lifestyle modifications as unimportant.^{21 22 26 32–34} HCPs favored lifestyle management (68.8%–100%) compared with using medications (15%–86.4%) or complementary alternative medicines (9%–23.9%).^{21 22 24 26 27 29 32–34 42}

Practice

Patients

All the included studies examined the practice element, which mostly showed poor practice level. Most participants had poor dietary habits, such as meal skipping, distracted eating, inadequate fiber intake, excessive fats and sweetened food consumption.^{16–18 20} Poor sleep hygiene and poor sleep quality were found, with less than half of the participants reported having enough sleep (≥ 6 hours of sleep daily).^{16 17 20}

Most participants had sedentary lifestyles, with nearly three in four had screen time of more than 4 hours a day.¹⁸ A study from Iran reported that men were more likely to exercise than women, suggesting that gender may be an influential factor.¹⁵

Poor health-seeking behaviors were reported, with less than one-third of the participants declared recent health check-ups.^{16 17 20} Up to 68% of university students reported never having done a blood glucose test²⁰; however, most of these students expressed that they would take the necessary actions if their blood glucose were higher than normal.²⁰

Healthcare providers

While most HCPs educate patients on lifestyle changes, the content of their advice could vary. Some would only talk about dietary management (67.7%–97.9%), while others provided advice on diet and exercises (21.8%–98.6%).

Some HCPs would also provide specific advice on diabetes (45.4%) or cardiovascular diseases prevention (37.6%).^{21–23 25 26 28 31 32 34} Up to 41.3% would refer their patients to nutritionists.^{21 22 26 28} Only less than 36% of the healthcare providers, however, would consider referring their patients to diabetes prevention programs, resulting in the low uptake of these programs.^{21 22 24 26 29 32–34}

Most HCPs would screen for pre-diabetes using fasting blood glucose or HbA1c tests (52.1%–92.7%) and less commonly oral glucose tolerance tests (8%–57%).^{21–23 25–28 34} However, some providers (27%–34.1%) used non-fasting blood glucose to detect pre-diabetes, although the diagnostic criteria are currently non-existent.^{22 26 34} Unsurprisingly, 12.3%–76.8% of providers were either unfamiliar with or did not adhere to clinical guidelines in their practice.^{21 22 25 26 28 33} Blood screening was repeated at different intervals, ranging from 3-monthly to every 4 years.^{21–23 26–28 32 34}

COM-B and TDF analysis

Twenty-nine potential barriers and enablers were identified and categorized as patient, HCP, or health system level (figures 1 and 2). A detailed summary of potential intervention functions and BCTs associated with these barriers and enablers can be found in online supplemental table S5.

Barriers and enablers

Psychological and physical capability

At patient, HCPs and system levels, barriers and enablers were mainly related to the 'knowledge about pre-diabetes and lifestyle management'.^{13–26} 'Breaking lifestyle habits' and a 'lack of lifestyle management skills/abilities', such as the ability to make healthy food choices, were barriers to pre-diabetes management among patients.^{16 20 25 31} These barriers suggest a lack of knowledge and skills necessary for pre-diabetes management for both patients and HCPs and can potentially be addressed by providing 'Training and Education'.^{21 22 26 32–34}

Social and physical opportunity

Having a social support network, such as friends and family can improve pre-diabetes management among patients.^{16–18 27} Key barriers reported was the lack of societal attention on pre-diabetes and stigma related to pre-diabetes, which was perceived as 'bad luck' by some communities from the low-income countries.^{16 17}

Results suggest that there is a need for a comprehensive health system to address issues related to 'Environmental Context and Resources'. Nutrition and weight management resources were lacking, highlighting areas for improvement.^{16 17 21 26 32–34} In addition, there is a lack of healthcare financing for those with pre-diabetes.^{21 22 25 26 30 31}

At the HCPs and system level, guidelines and clinical decision support tools were found to be useful,^{22 24 26–28 31} although guideline complexity was identified as an area for improvement.^{21 28} Healthcare providers identified the



Figure 1 Barriers toward pre-diabetes management at patient, HCPs and system levels. HCPs, healthcare professionals.

time required to advise patients with pre-diabetes as a potential challenge and could hinder effective management. There is a need for a quick yet effective diabetes prevention program for patients to follow and for HCPs to manage in their respective practices.^{25–28 30–34} Some recommendations were identified from the studies, including increasing screening rates, development of a

multidisciplinary effort, and task shifting to nurses, pharmacists, dentists, and nutritionists.^{26 27 30}

Reflective motivation

‘Reflective motivation’ was the most identified component within the COM-B model, with factors mapped to TDF domains such as ‘social/professional role and



Figure 2 Enablers toward pre-diabetes management at patient, HCPs and system levels.



identity', 'beliefs about capabilities', 'beliefs about consequences', 'optimism', 'goals' and 'intentions'. This indicates that an individual's experience, reflective processes, and evaluations significantly determine their behavioral change.

'Goals and intention to make lifestyle changes', 'potential side effects and contraindications' of medications, and 'emotions' were identified as barriers and enablers among patients. These factors could affect adherence to lifestyle interventions and medication.^{21 22 25 26 28 31 32 34}

'Prescriber's clinical judgement' could be an influential factor, as HCPs have different practices with regard to the types of laboratory tests used, follow-up intervals, and decision to prescribe oral antidiabetics.^{21-23 26-28 31 32 34}

'Existing HCP practices' could also be a barrier or enabler, as changing current practices requires a combined effort from both HCPs and the health system.^{21 22 24-27 29 30 32-34}

Three barriers or enablers were found at the patient and HCP level; these were 'perception toward pre-diabetes and its management',^{15-18 20} 'risk perception' toward developing diabetes and its complications¹⁸ and 'treatment failure/success with lifestyle management'.^{21 23 26}

Confidence plays a vital role in facilitating one's behavior at the patient and HCPs level; for example, patients' 'self-confidence in making lifestyle changes',^{16 17} 'patients' trust toward hcp's¹⁸ and 'HCPs' self-confidence^{24 27} in managing their patients with pre-diabetes.

Automatic motivation

Four TDF domains that determined the behaviors were 'emotion', 'optimism', 'social/professional role and identity' and 'reinforcement'. 'Patient's preference' may be a barrier to those prescribed oral antidiabetics, as studies described that most patients disliked taking medications. However, this dislike for medications may be an enabler for introducing lifestyle interventions to these patients.^{21 22 26 32 34} Mental and emotional health (eg, stress, anxiety, and optimism) were factors for better pre-diabetes management.^{16-18 26 28} Similar to reflective motivation, 'Patients' trust toward HCPs' and 'HCPs' self-confidence' were both important enablers for pre-diabetes management.^{18 24 27}

DISCUSSION

To our best knowledge, this is the first systematic review that critically evaluated KAP toward pre-diabetes among patients and healthcare providers. We noted that there were knowledge deficits around pre-diabetes among patients, such as misinformation around pre-diabetes among patients and cultural misconception, especially within low-income and middle-income countries. This may also be related to their reluctance to change lifestyle behaviors as observed from the results. The relationship between socioeconomic level, health literacy, and health seeking behavior are usually intertwined. Studies have found that people from low socioeconomic backgrounds have lower health literacy and are less likely to participate

in preventive measures. They tend to only seek for medical care when a condition has become severe.^{43 44}

Cultural sensitivities, stigma, and gender norms may also discourage positive lifestyle behavior in some regions. For example, women were expected to dress conservatively, which makes it less suitable for physical activity. They often also have limited accessibility to public spaces and could only be in public areas with a companion.⁴⁵ Similarly, in some cultures in the Middle East, unhealthy lifestyle were perceived as positive, where obese individuals often were associated with beauty.⁴⁶ Pre-diabetes interventions therefore must be designed to take into consideration the specific regional context and consider how each cultural influencing factors and barriers.

Factors associated with pre-diabetes behavior change identified were often internal, such as personal beliefs, knowledge levels, and emotions. Nonetheless, the contribution of external factors, although lower, was reported. As such, interventions such as providing education to patients and HCPs should address misconceptions and information deficits.⁴⁷ Emphasis should be placed on highlighting reversibility of pre-diabetes, consequences of pre-diabetes, diagnosis, and evidence-based information for performing lifestyle changes. Education should be supplemented with training to impart hands-on skills to execute lifestyle changes.⁴⁷⁻⁴⁹ These should focus on techniques to instill a new habit or reverse an unwanted practice, coupled with self-monitoring and graded tasks (eg, setting easy tasks and slowly increasing their difficulty).^{40 48-50}

While knowledge about pre-diabetes is essential, meaningful behavior change is likely linked to patients' perceived susceptibility toward the condition, the severity of the disease, the benefits of health behavior, and their capabilities in carrying out the behavior change.^{51 52} To address this, BCTs such as providing credible sources on lifestyle modification, learning to self-talk about own capabilities, and focusing on past successes should be imparted to patients, especially when hit by setbacks.

Many HCPs were unfamiliar with the recommended lifestyle modification and clinical targets for their patients. Although HCPs provided advice to their patients with pre-diabetes, few HCPs were aware of or adhered to existing guidelines.^{21 22 26 28 32 34} This is an essential factor that needs to be addressed as adherence to guidelines can improve patient outcomes.⁵³ Our findings also noted that referrals to a lifestyle modification program were rare, suggesting the need to increase awareness further.^{21 22 24 26 32-34} Consultations with carers and patients can be complemented with clinical support tools such as patient decision aids,⁴² where HCPs work together with patients to plan their actions for behavior change (eg, when and what kinds of exercises). Realistic goals for achieving a behavior (eg, how much time to spend on exercising a day) or an outcome (eg, weight loss) should be set.⁵⁴ Pre-diabetes management is not a 'one size fits all' method, as it should be individualized into practices that can be incorporated into patients' daily lives.

Patients and HCPs were receptive to health promotion and diabetes prevention efforts, showing readiness to provide and receive help in managing pre-diabetes in both groups.^{16 17 19 21 22 24 25 27–31 33 34} However, patients' negative outlook toward living a life with pre-diabetes, mainly due to the concern of developing diabetes and its complication, should be highlighted and addressed while developing pre-diabetes intervention.^{18 26}

The studies described time and resources as common barriers that contributed to the poor practices among patients and HCPs.^{16 17 21 22 25–28 30–34} Environmental restructuring could address these barriers, especially on improving access and resources for lifestyle modifications. At the HCPs level, the load of delivering care for patients with pre-diabetes can be shared across disciplines and involve other healthcare professionals such as pharmacists, nutritionists, and nurses.^{26 27 30} To improve adherence to evidence-based guidelines, prediabetes-specific guidelines can be incorporated into local protocols of the healthcare settings.⁵³

Streamlining the referral processes to a diabetes prevention program is necessary to help promote referrals. Among some approaches reported by Centers for Disease Control and Prevention (CDC) are forming partnerships with HCPs, providing technical assistance on allocating time and resources for lifestyle programs, and developing a sustainable pricing structure for the program.⁵⁵

As social environment plays a role in patients' dietary and lifestyle habits, friends and families could be looped into pre-diabetes management process, to gain an understanding of the condition and to be a valuable support for the patient.^{16–18 27} Engaging stakeholders for system-level interventions, such as restructuring the physical environment of the community, is necessary, by providing more healthy and affordable food options and infrastructures for physical activities.

Implication

This study revealed the existing beliefs and practices among HCPs and patients and the potential influencing factors that can be reinforced or changed. The review formulates key components of pre-diabetes intervention: (1) increasing knowledge and skills on pre-diabetes and its management; (2) imparting practical skills to manage pre-diabetes; (3) providing resources for lifestyle management; (4) improving the accessibility of lifestyle management programs; and (5) training of other HCPs and human support to pre-diabetes management. Undoubtedly, multifaceted efforts are needed for diabetes prevention.

Limitation

This review included quantitative studies in which two or more KAP elements were discussed and did not include qualitative KAP studies; this may have reduced the number of data retrieved. Not all studies included in the review described the use of validated questionnaires, and

it was not possible to determine the psychometric properties of these questionnaires. We also did not include qualitative studies in our review, which may have limited the study applicability and findings. The included studies were heterogenous, in terms of their aims. Most studies conducted among patients were from middle-income countries, while among HCPs were from high-income countries, which may produce some biasness. Most studies among patients were carried out in Asia, while among HCPs were in the North America, which gave us a better insight into the KAP within these continents. However, this may also mean that population from the other continents from the other continents (eg, the Hispanic population) may be under-represented in this review. Most studies did not specify if their studies were conducted in rural or urban areas. Exploring possible rural and urban differences may be an area of interest for future pre-diabetes research, given that the information can be used to develop suitable targeted interventions that may address health disparity. Finally, as this review only included published studies, the review may have inherently missed some relevant studies. However, we believe this may be minimal as we have searched through six databases and included studies in the Chinese language.

CONCLUSION

We found that KAP levels among patients and HCPs were generally unsatisfactory, and future research should identify targeted diabetes prevention interventions at patient, HCP, and system levels considering the factors and behavior strategies we identified.

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