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SCOPING REVIEW: DIET FOR PREDIABETES AND ITS EFFECTS ON GLYCAEMIC CONTROL

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ABSTRACT

Background: Prediabetes is a global health problem among the non-communicable diseases and much effort has been exerted in the past in response to the increased prevalence of prediabetes. The objective of this scoping review is to describe evidences on the types of prediabetes diet and intervention studies available for prediabetes and its effects on glycaemic control.

Materials and Methods: The scoping review was conducted based on the framework by Arksey and O'Malley. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) diagram was used as a guide to record the review process. Articles from years 1995 until 2020 on prediabetes diet among adults aged 18 years and above were retrieved based on the keywords using electronic databases (Ovid, PubMed, Cochrane Library and Google Scholar). Virtual library databases were also included in the searches.

Result: A total of 652 articles were identified through database searches and 20 records were identified through manual search. A total of 205 duplicate records were removed and subsequently, the titles and abstracts of 467 records were screened for inclusion. The full texts of 223 articles were reviewed for eligibility, and finally, 78 studies were included in the review.

Conclusion: The prediabetes state is reversible and provides an opportunity for treatment. Therefore, the focus on nutrition must be included in diabetes prevention strategies. Currently, a diet low in fat intake, rich in fiber, whole grains, and fruits and vegetables, as well as a Mediterranean-type diet, may be recommended for the prevention of diabetes in prediabetes.

Keywords: prediabetes diet, impaired glucose tolerance, impaired fasting glucose, diabetes prevention, dietary intervention

1.0 Introduction

Prediabetes is defined as a state of abnormal glucose homeostasis characterized by impaired fasting glucose (IFG), impaired glucose tolerance (IGT), or both (1). Plasma glucose levels in this range increase the risk of developing confirmed diabetes, defined as fasting glucose level ≥ 126 mg/dL (7.0 mmol/dL) or 2-hour prandial glucose ≥ 200 mg/Dl (11.1 mmol/dL) (1). Microvascular and macro vascular damage starts during prediabetes and is associated with an increased risk of cardiovascular disease early in the progression to Type 2 diabetes mellitus (1,2,3). Elevated glucose levels will damage endothelial cells, which can lead to microvascular disease (1,2,3).

Prediabetes prevalence in Malaysia was 4.7% in 2015 based on Malaysian National and Morbidity Survey (NHMS) 2015 (4). It has remained stable from 4.2% (NHMS 2006) and 4.9% (NHMS 2011) (5). By ethnicity, Indian had the highest prevalence in Malaysia at 7.7% (4). It is estimated that the number of prediabetes cases will increase to 470 million in 2030 and this is understandably a worrying trend (1). Prediabetes is seen as the critical phase, because studies have shown that at this stage, the condition is reversible and could serve as a potential route to combat diabetes (1,2). A total of 37% of prediabetes patients who leave their condition untreated may see themselves develop diabetes in 4 years (1,3).

Previously, diet for prediabetes and its effects have been recorded in The Da Qing IGT and Diabetes Study 1986, The Finnish Diabetes Prevention Study (DPS) 2003 and Diabetes Prevention Program 2002 (6,7,8) which are a few studies that used dietary intervention as their main component of reversing prediabetes state to normal glucose tolerance. All three studies showed that dietary intervention was effective in decreasing the incidents of diabetes (6,7,8). A report by Nutrition Therapy for Adults with Diabetes and Prediabetes: A Consensus Report 2019 by American Diabetes Association (ADA) highlighted 9 types of diet / eating pattern that are reported by systematic reviews and journals (9). The ATTICA Study follow up showed the protective effect of the Mediterranean Diet on prediabetes patients (10).

Studies have shown that 1.5% – 7.4% of individuals with prediabetes developed type 2 diabetes annually (1,2,3). After three to five years of follow up, a quarter of these patients developed diabetes (11). A systematic review with meta-analyses (2012) results showed better glycaemic control by adhering to Mediterranean diet (12). Another meta-analysis of two long-term RCTs showed a 49% increase probability of remission from the metabolic syndrome (14). Two meta-analyses demonstrated that higher adherence to the Mediterranean diet reduced the risk of future diabetes by 19 – 23% (12,15).

The World Health Organization (WHO 2019) makes the following five recommendations with respect to both individuals and populations i) Consume 400 g of fruits and vegetable or above per day (cassava, potatoes, sweet potatoes, and other starchy root crops are not included). A healthy diet also contains legumes (for example, beans, lentils), whole grains and nuts, ii) limit intake of fats, less than 30% of total calories should come from fat, preferably unsaturated fats to saturated fats and eliminate trans fats, iii) limit the intake of the simple sugars to below 10% of calories (below 25 grams or below 5% of calories per day may even be better), iv) limit sodium and salt

intake from all sources and ensure that the salt is iodized. Intake of salt below 5 g per day have been shown to reduce the risks of cardiovascular diseases, v) maintain healthy weight by consuming approximately the same number of calories the body uses (2).

The Dietary Interventions for the Prevention of Type 2 Diabetes in High-Risk Groups: Current State of Evidence and Future Research Needs study showed the dietary intervention used in the study has been tested in multiple populations, ethnicities and settings, and represents the strongest evidence base currently available (16). To date, there are many dietary interventions proposed by international studies to control and treat prediabetes with hope of reversing the condition to normal glucose tolerance.

Objectives

The main objective of this scoping review is:

i) To describe evidences on the types of prediabetes diet and intervention studies available for prediabetes.

The specific objectives of scoping review are:

i) To provide available evidence of types of prediabetes diet on glycaemic control.
ii) To provide available evidence of intervention studies on prevention of diabetes

2.0 Materials and Methods

A 6-stages structured scoping review framework proposed by Arksey and O'Malley was followed (17).

Stage 1: Identifying the research questions

Based on the literatures two review questions were developed:

1. What are the types of dietary intervention available for prediabetes patients?
2. What are effects of dietary intervention on prediabetes patients' glycaemic control? (Improvement in fasting blood sugar, HbA1C and transition of prediabetes state to normal glucose tolerance or confirmed diabetes)

Stage 2: Identifying relevant studies

Following the framework of Arksey and O'Malley, 2005 (17) the second stage of the scoping review process aimed to identify the criteria that was used to select the studies for inclusion in the review. Although a scoping review is designed to cover a broad spectrum of literature, these criteria will guide the search and help filter for relevant sources.

A comprehensive search strategy was performed by a team of researchers, includes published scientific journals, unpublished work, grey literature and annual reports as below:

(i) Electronic databases of PubMed, Cochrane Library, Google Scholar
(ii) Relevant research websites such as World Health Organization (WHO), Virtual Library Ministry of Health (MOH), Malaysia

Systematic approach to searching, screening, reviewing and data extraction will be applied based on PRISMA (Preferred method in reporting systematic review and meta-analysis). Titles, abstract, keywords for eligibility will be examined independently by researchers. Keywords and search terms for related articles' search is attached (Appendix 1). The search was conducted with medical subject headings (MeSH) terms, including "prediabetes adults", "diabetes prevention", "dietary intervention", "prediabetes diet", "lifestyle changes", "impaired fasting glucose", "impaired glucose tolerance", "diabetes diet". Microsoft Excel programs was used to manage the references and to remove duplications.

The inclusion and exclusion criteria for this scoping review are:

- Inclusion criteria:

Search articles published from January 1995 up to and May 2020 among adults' respondents

- Exclusion criteria:

Non-dietary interventions involved in prediabetes management (surgery, oral hypoglycaemic agents (OHA), insulin) and articles related to diabetes mellitus type 1, type 2 and gestational diabetes.

Stage 3: Study selection

The study selection was based on the objectives of this review. A team of researchers screened the titles and abstracts. Abstracts which did not meet the scope of the review were excluded. Full articles were obtained for the remaining potentially relevant abstracts. The team consolidated the results of the searches, run them on the different databases and removed duplicates. These full articles were checked for their ability to meet the research questions of this study. Selected full articles were read by the researchers to finally select the final full articles for this study. Two review authors independently screened for potentially eligible articles by inspecting the titles and abstract to generate a shortlist. Any disagreement was resolved with the review of a third author.

Stage 4: Charting the data

The extracted data from the articles was charted in table of evidence by authors/year, type of publication, objective, design and glycaemic outcome (Table 1). Non-English language articles were excluded as the translation was not practical. Questions arising when piloting the framework were discussed by the team and possible disagreement was resolved through consultations. Discrepancies in extracted data were discussed between reviewers until consensus is reached or by arbitration of a third reviewer, if required.

Stage 5: Collating, summarizing and reporting the results

The analysis of the data collected using the data extraction framework provided information on the body of research that has been conducted on interventions on prediabetes prevention. Areas that have been under researched and may require further investigation was shown. The characteristics of the outcome from the selected articles was described based on the types of diet and glycaemic outcome of the diet (types of diet for prediabetes patients, improvement in fasting blood sugar, HbA1C and transition of prediabetes state to normal glucose tolerance or confirmed diabetes. The findings of this review were presented as table of evidence and summary table.

Stage 6: Consultation with stake holders, experts and dissemination

The findings were shared and discussed with the relevant authorities, stake holders and experts in pre-diabetes management. The results of scoping review is anticipated to provide a comprehensive overview of the evidence based on intervention diets to prevent prediabetes and to highlight areas where evidence is controversial or missing. The review also provided key information to policy makers and health professionals interested in planning, funding and delivering evidenced based and effective intervention diet to prevent prediabetes. For this reason, the results also will be disseminated as part of future workshops with professionals involved in prediabetes prevention.

Ethnical Approval

Ethical approval was not required from the Medical Research and Ethics Committee, Ministry of Health Malaysia since this is a scoping review and does not involve human respondents; however, this scoping review was registered at the National Medical Research Register (NMRR), bearing the number **NMRR-20-1233-55448** dated 23 July 2020.

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3.0 Result

PRISMA Flow Diagram

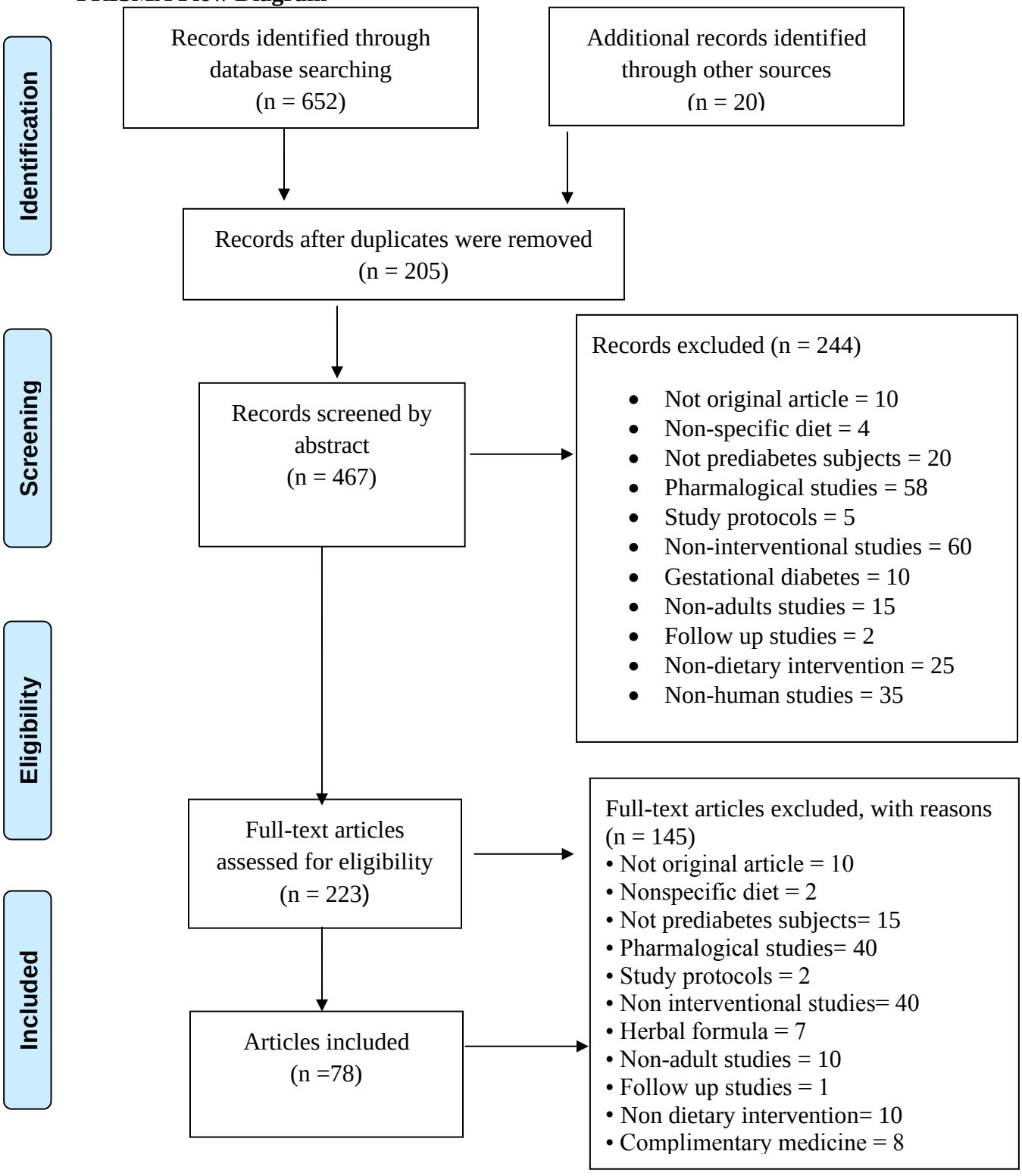

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Table 1: Description of types of Prediabetes Diet and glycemic outcome

Types of Prediabetes Diet	Description of diet	Glycemic outcome
Mediterranean Diet (1-2,9-16,18-25)	Consists of plant-based food (vegetables, beans, nuts and seeds, fruits, and whole intact grains); fish and other seafood; olive oil as source of dietary fat; dairy products (mainly yogurt and cheese) in low to moderate amounts; fewer than 4 eggs/week; red meat in low frequency and amounts; wine in low to moderate amount, sugars or honey rarely.	Reduced risk of diabetes. Remission of metabolic syndrome from 19%-43%. There were 8 meta-analyses and 5 randomized controlled trials (RCTs) that have strong evidence on adhering this diet for metabolic parameters. The ATTICA Study conducted using Mediterranean Diet showed that adhering to this diet showed low risk of developing diabetes among prediabetes patients. This study showed a reduction of between 75%-85% risk of developing diabetes.
Vegetarian / Vegan Diet (26-35)	Plant-based vegetarian eating devoid of all flesh foods but include egg (ovo) and/or dairy (lacto) products, or vegan eating devoid of all flesh foods and animal-derived products.	Mixed results on glycemic outcome but can reduce HbA1C. Results of 2 meta-analyses showed that this diet can reduce HbA1c levels of 0.3-0.4%. Other meta-analyses showed no effects on fasting insulin. Mostly all meta-analyses on vegetarian diet showed weight reduction.
Low fat diet (36-45)	Incorporates vegetables, fruits, starches (e.g., breads/ crackers, pasta, whole intact grains, starchy vegetables), lean protein sources (including beans), and low-fat dairy products. Total fat intake < 30% of total calories and saturated fat intake < 10%.	Restricting fats intake within the recommended limit is required for healthy living and managing diabetes. May reduce the risk of diabetes but evidence on systematic reviews does not provide consistent glycemic results but more towards weight loss.

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Very low fat diet (46-48)	Includes fiber-rich vegetables, beans, fruits, whole intact grains, nonfat dairy, fish, and egg whites and comprises 70–77% carbohydrate (including 30–60 g fiber), 10% fat, 13–20% protein.	May reduce risk of diabetes. Three nonrandomized single-arm studies with 69 to 652 participants lasting between 3 weeks and 2–3 years show that these multicomponent lifestyle intervention programs may improve glucose level.
Low carbohydrate diet (46-51)	Emphasizes vegetables low in carbohydrate (such as salad greens, broccoli, cauliflower, cucumber, cabbage, and others); fat from animal foods, oils, butter, and avocado; and protein in the form of meat, poultry, fish, shellfish, eggs, cheese, nuts, and seeds. Some plans include fruit (e.g., berries) and a greater array of non-starchy vegetables. Avoids starchy and sugary foods such as pasta, rice, potatoes, bread, and sweets. There is no consistent definition of "low" carbohydrate. A low-carbohydrate eating pattern is defined as reducing carbohydrates to 26–45% of total calories.	A low-carbohydrate diet reduces body exposure to high glucose levels, leads to weight loss, decrease the risk of obesity, and prevent or control diabetes, and other related metabolic imbalance. Reduced risk of diabetes. Reduction in HbA1C levels.
Very low carbohydrate diet / ketogenic diet (49-56)	Similar to low-carbohydrate pattern but further limits carbohydrate-containing foods, and meals typically derive more than half of calories from fat. Often has a goal of 20–50 g of non-fiber carbohydrate per day to induce nutritional ketosis. In this review a VLC eating pattern is defined as reducing carbohydrate to 26% of total calories.	The ketogenic diet may improve blood glucose level while at the same time reducing the requirement for insulin in diabetic people. Reduced risk of diabetes. Reduction in HbA1C levels but most research was not done for a longer period of 12 months.
Dietary Approach to Stop Hypertension (DASH) Diet (57-62)	Emphasizes vegetables, fruits, and low-fat dairy products; includes whole intact grains, poultry, fish, and nuts; reduced in saturated fat, red meat, sweets,	The DASH dietary pattern may lead to an improvement in insulin sensitivity independent of weight loss or physical activity. Dietary fiber, iso-flavone, and phytoestrogen intake

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	and sugar-containing beverages. May also be reduced in sodium.	due to higher fruit and vegetable consumption might be responsible for these effects Reduced risk of diabetes. Positive outcome on weight and blood pressure.
Paleo Diet (63-65)	Emphasizes foods theoretically eaten regularly during early human evolution, such as lean meat, fish, shellfish, vegetables, eggs, nuts, and berries. Avoids grains, dairy, salt, refined fats, and sugar.	Mixed results. Inconclusive evidence. Most randomized control trials (RCTs) were done on diabetic patients and not prediabetes. As of 2016 there are limited information on the metabolic effects on the humans eating a paleo diet, but data are based on the clinical trials which have not been enough to have a sufficient statistical significance to allow the call for generalizations.
Low calorie Diet (66-71)	Moderate-fat (total fat<30% of energy [E%], saturated fat<10 E%), high-fiber (>15 g/1,000 kcal) diet,	Reduced risk of diabetes. Reduction in plasma glucose and HbA1C levels. All general eating guidelines incorporates low calorie diet for prediabetes patients.
Low Glycemic Index Diet (72-82)	Low glycemic index load diet intake with modified carbohydrate intake.	Several studies have reported that both glycemic index (GI) and glycemic load (GL) are positively associated with diabetes risk. Reduced risk of diabetes. A low glycemic load diet increased the incidence of reaching normal glucose tolerance.
Intermittent Fasting (IF) (83-91)	IF is an eating pattern where the individual alternates between periods of eating and a defined phase of prolonged fasting. IF plans include fasting for several hours to days and can be continuous or interrupted,	3% to 6% decrease in fasting glucose was observed in patients with prediabetes. Reduced risk of diabetes. Improved insulin sensitivity. The IF diet might be more beneficial to

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	and the calorie intake during the non-fasting periods may be normal or reduced.	patients with high insulin resistance who are likely to progress to DM
High wholegrain and fiber diet (92-98)	Dietary fiber should be increased between 15g to 35g/d. Replace refined grain products with whole grain food.	Reduced risk of diabetes. Fasting plasma glucose improved with increased of fiber in diet. Soluble and insoluble dietary fiber intakes were inversely associated with the risk of type 2 diabetes. The beneficial effect of soluble fiber may be mediated through the slow absorption and digestion of carbohydrates that lead to a reduced demand for insulin
Very Low-Calorie Diet (VLCD) (99-102)	A Very Low-Calorie Diet (VLCD) is a diet of less than 800 kilocalories (kcal) daily. The very low intake of fat and carbohydrates, but normal amount of proteins (0.8 g/kg ideal bodyweight per day. The most commonly used VLCD's are commercially available mixed-formula diets, containing various amounts of carbohydrate, fat and high-quality protein.	Reduced risk of diabetes. Not recommended for long term use without close supervision. Energy restriction has shown to improve metabolic parameter including insulin sensitivity. VLCD have also been associated with improvement in HbA1c.
High Protein and energy restricted Diet (103-109)	35% of total calories comes from protein, 35% carbohydrates, and 30% fat and energy restricted diet.	Reduced risk of diabetes. Leads to greater glucose metabolism but, trials conducted using this diet had some limitations such as small sample sizes and self-reported diet recall.

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Table 2: Summary of major intervention studies on prevention of diabetes

Study Title	Intervention strategies	Outcome of study
The Da-Qing Impaired Glucose Tolerance (IGT) and Diabetes Study 1986–1992 (6)	Aim: achieve BMI of 23 kg/m^2 (if > 25 kg/m^2) • High-carbohydrate diet • Low-fat diet • Increase physical activity by 12 units/day	Diet and/or exercise interventions reduced the incidence of diabetes in Chinese participants with Impaired Glucose Tolerance (IGT). Interventions were associated with 31%, 46%, and 42% reduction in risk of developing diabetes, respectively.
Japanese Diabetes Prevention Trial 1993–1996 (110)	Aim: maintain BMI < 22.0 kg/m^2 • Individualized dietary advice • Decrease fat intake (<50 g/day), portion size, alcohol intake and eating out, physical activity: 20–40 min/day	Lifestyle intervention successfully reduced body weight and the 4-year cumulative incidence of diabetes in Japanese males with IGT. Risk reduction of 65% for diabetes.
The Finnish Diabetes Prevention Study (FDPS) 1993–2002 (111)	Aim: 5% weight loss • Fat < 30% of total energy • Saturated fat < 10% of total energy • Fiber > 15 g per 1000 kcal • Physical activity: 30 min/day	Body weight and diabetes risk were significantly reduced by lifestyle changes in overweight participants with IGT, reducing the risk of diabetes by 58% in the intervention group. Risk reduction of 58% for diabetes. Risk reduction of 58% for diabetes.
U.S. Diabetes Prevention Program (DPP)1996–1999 (112)	Aim: 7% weight loss • Fat < 25% of total energy • Physical activity: 150 min/week	Lifestyle intervention and metformin significantly decreased the incidence of T2DM in prediabetes participants, with more notable reductions in the former. The incidence of diabetes was 11.0, 7.8, and 4.8 cases per 100 person-years.

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Indian Diabetes Prevention Study 2002–2005 (113)	• Avoid simple sugar and refined carbohydrate • Fat < 20 g/day • Increase fiber intake • Physical activity: 30 min/day	Incidence of T2DM in Asian Indians was significantly reduced in the lifestyle modification and metformin groups, with no additional benefits in the combined group.
ATTICA Study 2002-2012 (10)	• Using Mediterranean Diet	The study showed a reduction of the 10-year diabetes risk by almost 70% with medium adherence to the Mediterranean pattern, and a greater than 85% reduction with high adherence.
PREVIEW Study 2013-2015 (114)	• Using a low energy drink formula for 8 weeks. • Second phase involves PA, diet and lifestyle modification	More than 35% of the men and women with IFG at screening reverted to normal-glycaemia
SLIM Study 1999-2001 (115)	• Dutch guidelines for a healthy diet (Dutch Nutrition Council), and consisted of carbohydrate intake of at least 55% of total energy intake, a reduction in fat intake of to 30e35% of total energy intake, and increased intake of dietary fiber (>3 g/MJ/day), increase physical activity to at least 30 min a day for at least 5 days a week	Combined diet-and-exercise SLIM intervention program not only prevented type 2 diabetes (47% reduction), but also reduced metabolic syndrome prevalence at the end of active intervention and prevented development of new metabolic syndrome cases in the intervention group.
Rotterdam Study 1989-1993, 2000-2001, 2006-2008 (116)	• Plant based dietary index	A diet higher in plant-based foods and lower in animal-based foods was associated with lower insulin resistance, and a lower risk of prediabetes

		and type 2 diabetes (T2D), suggesting a protective role of a more plant-based opposed to a more animal-based diet in the development to T2D, beyond strict adherence to a vegetarian or vegan diet.
EDIPS STUDY 2000-2007 (117)	• An individual plan for behavior change, with the aim of achieving: >50% total dietary energy intake from carbohydrate, reduced total and saturated fat intake with <30% total dietary energy from fat, increased fiber intake, and weight loss to achieve BMI <25 kgm^2	55% of reduction in the incidence of diabetes. The results contribute to the evidence that T2D can be prevented by lifestyle changes in adults with IGT.

Results: Study Selection and Characteristics

The literature search and study selection process are summarized in Figure 1. Table 1 further described the types of prediabetes diet and their glycemic outcome. Table 2 described major intervention studies on diabetes prevention and their outcomes.

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4.0 Discussion

This scoping review identified that most trials and studies used American Diabetes Association (ADA) and WHO guidelines for the definition of Impaired Fasting Glucose (IFT), Impaired Glucose Fasting (IGF) and prediabetes state (1-4). Prediabetes studies and condition showed it has been studied worldwide and importance on its improvement has been emphasized in many studies due to its medical cost savings or burden towards economic growth of the country (6,10,110-117).

There were many guidelines that were also used for diabetes prevention. In Malaysia, two major guidelines which are available are Malaysian Clinical Practice Guidelines for Diabetes 2018 and WHO Guidelines on Diabetes Prevention 2006 (2,4,5). The new Diabetes Prevention Guidelines on Diabetes 2019 by WHO is the latest guidelines available worldwide (3). The guidelines followed by most of the trials were adapted from WHO 2006 and American Diabetic Association (ADA) (1,2). The WHO Guidelines have seen amendments from 1996-2019 (2,3,119). These amendments were however based on evidence and updated accordingly (2,3,119).

General healthy eating guidelines have been the corner stone of American Diabetes Association and WHO guidelines for prevention of diabetes (1,2). Energy reduction or low-calorie diet coupled with lifestyle modification has been emphasized in nearly all major studies and guidelines available (1,2,9). Many studies used different approach of diet to provide a gold standard diet for diabetes prevention or probably remission of prediabetes to normal glucose tolerance (6,10,110-117). Based on ADA Consensus Report 2020 intervention trials, a variety of eating patterns may be appropriate for patients with prediabetes, including Mediterranean diet, low calorie diet, and low-fat eating patterns (9An eating pattern represents the totality of all foods and beverages consumed. In addition, evidence suggests that the overall quality of food consumed (as measured by the Healthy Eating Index, Alternative Healthy Eating Index, and Dietary Approaches to Stop Hypertension [DASH] score), with an emphasis on whole grains, legumes, nuts, fruits and vegetables and minimal refined and processed foods, is also important (57-62).

Malaysian Clinical Practice Guidelines (CPG) for diabetes recommends that medical nutritional therapy is the mainstay of prevention and treatment of T2DM (4). For obese and overweight patients, weight loss of 5–10% of initial body weight over a 6-month period is recommended to prevent T2DM. A balanced diet consisting of 45–60% energy from carbohydrate, 15% – 20% energy from protein and 25% – 35% energy from fats is encouraged. Substituting high Glycaemic Index (GI) foods with lower Glycaemic Index (GI) foods at mealtime reduces postprandial blood glucose (4).

Weight loss is considered the cornerstone of good glycaemic control. Most of the clinical trials recorded weight loss which is beneficial for good glycaemic outcome. Larger weight loss has positive impact on long term prevention of diabetes and glucose metabolism. Losing 5% to 10% of body weight is effective in preventing and treating diabetes. Weight loss was reported in all major diabetes prevention trials (6,10,110-117).

Medical nutrition therapy (MNT) is an effective and affordable method to prevent diabetes. The goals of MNT are to promote and support healthful eating patterns, emphasizing a variety of nutrient-dense foods in appropriate portion sizes, in order to improve overall health and specifically to improve HbA1C, blood pressure, and cholesterol levels (goals differ for individuals based on age, duration of diabetes, health history, and other present health conditions),. It also aims to achieve and maintain body weight goals and to delay or prevent complications of diabetes (118-119).

It was found that there was no gold standard for prediabetes diet for the prevention of diabetes. However, based on the scoping review findings, it can be recommended that a diet low in fat intake, rich in fiber, whole grains, and fruit and vegetables, as well as a Mediterranean-type diet, may prevent diabetes in prediabetes patients.

This scoping review has some strengths. First, this review included a large number of RCTs and systematic reviews which validates the evidence presented. The sample size in this review paper was large. Studies were not limited but extended for previous 25 years (1995–2020) to facilitate the provision of up-to-date information. Most studies discussed in this review were able to provide prediabetes diet that were relatively simple to implement, practice and prescribe to prediabetes patients.

This scoping review has few limitations. One limitation is that nutrition strategies that include other elements of glycaemic control were not included as part of this review such as physical activity and medication. There was no emphasis on other metabolic parameters such as fasting lipid profile and weight changes. Search method of this review was limited to electronic databases only, possibly resulting in fewer studies considered in this review than would otherwise be the case if other search strategies were also employed. Most studies rejected in the first screening were cohort, case-control, epidemiological and animal studies, whereby some may be of relevance or significance.

The most successful nutritional strategy for both prevention and treatment of diabetes is one that the patient can adapt and follow permanently. Therefore, any extreme weight reduction diet, which may be difficult to follow in the long term or which safety has not been well documented, may not be suitable for prevention of diabetes. Diets that differ much from habitual food patterns in the proportion of macronutrients also cannot be recommended for chronic disease prevention in terms of safety, but especially because of low long-term compliance. Currently, a diet low in fat intake, rich in fiber, whole grains, and fruit and vegetables, as well as a Mediterranean-type diet, may be recommended for the prevention of diabetes in prediabetes.

However, more research is needed to further prove the effectiveness of any types of diet. A combination of nutritional strategy consisting of physical activity and healthy lifestyle must be incorporated for achieving the best results in preventing non-communicable diseases such as diabetes. A multinational study involving the collaboration of many developing countries can be considered since genetic variations and different ethnicity need to be considered to provide evidence for nutritional interventions that are valid, reliable and generalizable.

The prediabetes state is reversible and provides an opportunity for treatment. Therefore, the focus on nutrition is evitable and must be included in diabetes prevention strategies interventions. Prediabetes diet is simple to follow and is a cost saving option for prediabetes management.

5.0 Conclusion and recommendation

In conclusion, it is highly suggested that a diet low in fat intake, rich in fiber, whole grains, and fruit and vegetables, as well as a Mediterranean-type diet, may be recommended for the prevention of diabetes in prediabetes patients. Special consideration and adjustments should also be given to the multi- cultural population of Malaysian if this type of dietary recommendation is to be suggested for Malaysians. A summary of evidence by this review could provide useful information to healthcare providers in making decisions in prediabetes patient management. It is hoped this review may direct future studies to the prospects of prediabetes diet for prediabetes patients.

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Declaration

These authors declare that there is no conflict of interest in any form. There is no conflict of interest with the funder; no influence in the design, data collection, data analysis or the manuscript writing.

Author's contribution

Author 1: Literature review, Author 2: Analysis, Author 3: Write up, Author 4: Write up and Author 5: Proof read and referencing

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