OPEN ACCESS

Saudi Journal of Medicine
Abbreviated Key Title: Saudi J Med
ISSN 2518-3389 (Print) | ISSN 2518-3397 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Review Article

Saudi Consensus on Medical Nutrition Therapy for Type 2 Diabetes Mellitus

Abdulrahman Alsheikh[1], Mahmoud M. A. Abulmeaty[2], Abdulaziz Alothman[3], Nahla Bawazeer[4], Ossama Hamdy[5], Saud Alsifri[6], Emad R. Issak[7*]

[1]King Abdulaziz University Hospital, Jeddah, Saudi Arabia
[2]Clinical nutrition program, Department of Community Health Sciences, College of Applied Medical Sciences, King Saud University, Riyadh, Saudi Arabia
[3]Saudi Society of Clinical Nutrition, Riyadh, Saudi Arabia
[4]Department of Health Sciences, College of Health and Rehabilitation Sciences, Princes Nourah Bint Abdulrahman University, Riyadh, Saudi Arabia
[5]Harvard Medical School, Joslin Diabetes Center, Greater Boston, USA
[6]Alhada Armed Forces Hospital, Taif, Saudi Arabia
[7]Internal Medicine Department, Ain Shams University, Cairo, Egypt

DOI: 10.36348/sjm.2023.v08i12.001 | **Received:** 24.10.2023 | **Accepted:** 01.12.2023 | **Published:** 05.12.2023

***Corresponding Author:** Emad R. Issak
Internal Medicine Department, Ain Shams University, Cairo, Egypt

Abstract

The burden of diabetes mellitus (DM) is a major challenge worldwide. This health problem has drawn attention, especially in Saudi Arabia, which is expected to be among the top five countries in 2030. The socioeconomic changes in KSA in recent decades resulted in changes in eating habits and lifestyle patterns. Diet is a modifiable factor that can prevent or delay the incidence of T2DM. Therefore, the relationship between diet and DM is crucial to deliver recommendations. Treatment of DM can only be effective if adequate attention is given to appropriate nutrition. Therefore, the Saudi Diabetes Clinical Practice Guidelines (SDCPG) (2021) recommended developing a nutrition therapy plan for each patient to achieve the treatment goals registered nutritionists provide for all individuals with DM. That is why a panel of 6 experts, a Saudi task force, gathered to develop an explicit, evidence-based consensus for nutrition therapy for T2DM people. An initial concept proposal was obtained. The proposal was divided into several topics discussed in September 2022. A literature review was carried out. The literature search was completed in March 2023. A drafted report was distributed to the entire panel. Approval of the recommendations required consensus, defined as a majority approval (i.e., above 80%). The recommendations were revised to accommodate any differences of opinion until a consensus was reached. Recommendations were finally formulated in June 2023. Subsequently, the panel reviewed and discussed the supporting rationale of the revised recommendations. This article presents these practical recommendations.

Keywords: Diabetes mellitus; nutrition therapy; life style modifications; diet; nutrients.

INTRODUCTION

The burden of diabetes mellitus (DM) is a major challenge worldwide. This health problem has drawn attention, especially in Saudi Arabia (KSA), which is among the top ten countries with the highest prevalence of DM (expected to be among the top five in 2030) [1]. Type 2 DM (T2DM) prevalence in KSA was 24% in Al Nozah *et al*., (2004), which increased 10-fold compared to 2.5% in 1982 [1-3]. Furthermore, in 2019, KSA had 4.3 million people with DM, the fourth highest among the Middle East and North Africa region (MENA) countries. Also, the estimated age-adjusted prevalence of DM in KSA was 15.8%, with a total medical cost of 5,012,600 USD. The projected prevalence of DM in 2030 and 2045 is 17.2% and 17.8%, respectively [4-7].

KSA has undergone socioeconomic changes in recent decades, which have resulted in changes in eating habits and lifestyle patterns [8]. Diet is a modifiable factor that can prevent or delay the incidence of T2DM [5, 9]. Therefore, the relationship between diet and DM is crucial to deliver recommendations [9].

Lifestyle management is a fundamental aspect of care for T2DM, and it should be developed in collaboration with the patient and modified regularly starting from the patient's first visit. It includes diabetes self-management education and support, nutritional therapy, physical activity, sleep health, smoking and alcohol cessation counseling, and psychosocial care [10]. Diet is a fundamental part of management in all individuals with DM. Treatment can only be effective if adequate attention is given to appropriate nutrition [11]. Diet treatment should ensure weight control, provide nutritional requirements, allow reasonable glycemic control, and correct any associated blood lipid abnormalities [11-14]. Weight loss (> 5%) can benefit obese or overweight adults with T2DM and those with prediabetes, which may be achievable through caloric restriction and lifestyle modification [15].

Therefore, the Saudi Diabetes Clinical Practice Guidelines (SDCPG) (2021) recommended the development of a nutrition therapy plan for each patient to achieve treatment goals provided by a registered nutritionist for individuals with DM [10]. That is why we, a Saudi task force, gathered to develop an explicit, evidence-based consensus for nutrition therapy for T2DM people. This article has the recommendations of this expert panel.

Methods of Consensus Development

A panel of 6 experts (endocrinologists, diabetologists and registered nutritionists) formed a Saudi task force that gathered to develop an explicit, evidence-based consensus for nutrition therapy for T2DM people. An initial concept proposal was obtained. The proposal was divided into several topics discussed in September 2022. A literature review was carried out. The literature search was completed in March 2023. A drafted report was distributed to the entire panel. Approval of the recommendations required consensus, defined as a majority approval (i.e., above 80%). The recommendations were revised to accommodate any differences of opinion until a consensus was reached. Recommendations were finally formulated in June 2023. Subsequently, the panel reviewed and discussed the supporting rationale of the revised recommendations.

1. Dietary patterns among people with T2DM in KSA

Diet is a cornerstone in the management of T2DM. Substantial evidence from prospective and randomized studies highlights the vital role of healthy dietary patterns in preventing and managing T2DM. The recommended dietary patterns' common characteristics include consuming fruit, vegetables, and other plant-based foods and avoiding or moderately consuming animal-based products [16-18].

In 2022, Aljahdali and Bawazeer conducted the first exploratory study to identify common dietary patterns among adults with T2DM in KSA. Five dietary patterns emerged in food intake. The “Vegetables and olive oil” pattern accounted for the highest variance, followed by the “Refined grains and sweets,” “Dairy products and legumes,” “Dates and beverages,” and “Fruit” patterns. The labeling explained the correlations between the nutritional compositions of the identified dietary patterns. Two of the five identified patterns encompassed the recommendations mentioned in the previous section: the “Vegetables and olive oil” and “Fruit” patterns. Similar dietary patterns have emerged in other studies [19-21].

The “Vegetables and olive oil” and “Fruit” patterns were positively associated with fiber, vitamin, and mineral intake, which is consistent with the high contents of these nutrients in fruit and vegetables [19, 22]. Conversely, this study's high olive oil consumption is inconsistent with the low olive oil consumption reported in a previous cross-sectional study involving Saudi male adults (N = 80) with and without cardiovascular diseases [19, 23]. The difference between the two study populations may be a reason for this discrepancy [19].

About 70% of the sample in the study of Aljahdali & Bawazeer (2022) received nutrition education for T2DM management; they were more likely to receive emphasis on the benefits of consuming olive oil. The importance of olive oil consumption might be more strongly emphasized in dietary recommendations for adults with T2DM, given that it has been associated with improved glucose homeostasis [19, 24-26].

A substantial body of evidence suggests the protective role of whole grains in glycemic control and the prevention of T2DM as they are rich in fibers, vitamins, and minerals. [27-31] At the local level, the “Refined grains and sweets” pattern explained 12% of the variability in intake among Saudi patients with T2DM and was inversely correlated with the composition of whole grains [19].

Low compliance with the dietary recommendations has been previously reported in Taif, Riyadh, Abha, and Medina [32-37]. Low adherence to diabetes dietary recommendations has been highlighted in other studies on adults with T2DM in KSA. Alhaiti *et al*., showed that only 36.9% of T2DM patients received advice to increase fruit and vegetable consumption, and less than 50% were instructed to consume complex carbohydrates, eat a high-fiber diet, or reduce sweet consumption [32]. Although Al Johani *et al*., reported higher proportions, they found that only 12% of the participants incorporated diet as a daily self-care behavior [35]. Adherence to pharmacological treatment scores higher than any lifestyle component among Saudis with T2DM [32-36]. Therefore, there are always calls for healthcare providers to emphasize the role of lifestyle factors in managing T2DM [19, 32-36].

Furthermore, it is necessary to involve the patients in the management plan to increase their awareness, as self-efficacy is positively associated with T2DM-related self-care behaviors [10, 19, 33, 34]. Another benefit can be derived from helping patients overcome hindrances related to eating styles and social and cultural norms, which have been suggested to interfere with adherence to self-care practices for T2DM among Saudis [19, 32, 33, 35].

Sociodemographic factors were associated with some dietary patterns among Saudis with T2DM [19]. An inverse association between age and the "Refined grains and sweets" pattern has been found. That is also reported in Brazil, New Zealand, Lebanon, France, and Norway [20, 38-42]. It has been suggested that because older age is associated with chronic diseases and more frequent visits to healthcare facilities, the chances of receiving recommendations about health and nutrition increase. Exposure to health information may result in better diet quality and habits [39]. Moreover, a positive association between the female sex and the "Fruits" pattern has been reported in many studies, including Saudi studies. These studies have reported higher fruit consumption among women than men [19, 43, 44].

Regarding eating habits, participants with high scores in the "Dates and beverages" pattern consumed fewer snacks. People in KSA are less likely to consider dates and Arabic coffee consumption as snacks. People with high scores in the "Vegetables and olive oil" pattern commonly reported lower fast food consumption. Regarding lifestyle factors, smoking was positively associated with the "Vegetables and olive oil" pattern and inversely associated with the "Dates and beverages" pattern [19]. Further studies on the holistic relationship between sociodemographic and lifestyle characteristics and dietary patterns are warranted.

More emphasis on incorporating lifestyle education (e.g., diet and physical activity) into T2DM management needs to be highlighted. More studies are needed to improve adherence to dietary recommendations among adults with T2DM. The impact of the learning effect on reported food consumption is crucial. Finally, representative population-based studies on consumption patterns in different regions of KSA are warranted [19].

Statements:

1. *When interviewing patients with non-communicable diseases such as obesity, pre-diabetes, and T2DM in healthcare visits, reviewing their diet patterns is essential.*

2. *All patients with T2DM should be assessed for body composition and disease progression via evaluation of fat distribution, BMI, waist circumference (WC), BP, HbA1c, fasting plasma glucose, lipid profile, and risk assessment should be conducted.*

2. Medical nutritional therapy (MNT) in T2DM: What? And Why?

Medical nutrition therapy treats a disease or condition through the modification of nutrient or whole-food intake [45]. The Saudi Diabetes Clinical Practice Guidelines (SDCPG) and the American Diabetes Association (ADA) emphasize that medical nutrition therapy (MNT) is fundamental in the overall DM management plan. The need for MNT should be reassessed frequently by healthcare providers in collaboration with people with DM across the life span, with particular attention during changing health status and life stages [10, 46-48].

Evidence-based guidance that allows people with DM to make healthy food choices that meet their individual needs and optimize their overall health should be recommended. Essential components of MNT are assessment, nutrition diagnosis, interventions (e.g., education and counseling), and monitoring with ongoing follow-up to support long-term lifestyle changes, evaluate outcomes, and modify interventions as needed [49, 50].

The goals of MNT for Adults with DM are to maintain the pleasure of eating while individualizing goals based on nutrition needs. Provide an educational program about healthy eating patterns rather than focusing on individual macronutrients, micronutrients, or single foods [51, 52]. The American Diabetes Association (ADA) 2022 goals include: Promoting and supporting healthy eating patterns, emphasizing a variety of nutrient-dense foods in appropriate portions to improve overall health, and Achieving and maintaining body weight goals. Attain individualized glycemic, blood pressure, and lipid goals. Delay or prevent complications of diabetes. To address individual nutrition needs based on personal and cultural preferences, health literacy and numeracy, access to healthful food choices, willingness, ability to make behavioral changes, and barriers to change. To maintain the pleasure of eating by providing nonjudgmental messages about food choices. To provide an individual with diabetes the practical tools for day-to-day meal planning rather than focusing on individual macronutrients, micronutrients, or single foods [48].

MNT is an evidence-based application of the nutrition care process provided by a registered nutritionist (RN) [49, 50, 53]. The unique academic preparation, training, skills, and expertise make the RN the preferred healthcare team member to provide diabetes MNT and leadership in interprofessional team-based nutrition and diabetes care [46, 49, 54-58].

Statements:

3. *MNT plays an integral role in diabetes management, yet many with diabetes have difficulty determining what to eat when self-managing their diabetes condition.*

4. *People with prediabetes and overweight or obesity should lose 7–10% of their body weight to prevent progression to T2DM. In conjunction with lifestyle therapy, medication-assisted weight loss can be considered for those at risk for T2DM when needed to achieve and sustain a 7–10% weight loss. Moreover, weight loss of around 10 to 15% in patients with T2DM may induce remission, especially in newly diagnosed patients with diabetes, within the first five years, primarily when diabetes is only managed by oral medications.*

5. *In people with T2DM, reduce sedentary time and increase physical activity, both structured and incidental, including stretching, aerobic, and resistance exercise. Aim to achieve a 5%–7% weight loss. Hydrate adequately on hot and/or humid days.*

6. *Specialized nutrition supplements, Glycemia-targeted Specialized Nutrition (GTSN), have been designed specifically for people with diabetes to use as meal or snack replacement.*

7. *MNT is crucial in preventing and treating T2DM and other non-communicable chronic diseases and should be recommended for all patients, always respecting their social, cultural, and economic circumstances.*

8. *MNT and regular physical activity should be customized to meet individual patient's unique clinical needs and conditions through professional counseling. They should be consistent with current clinical practice guidelines and local habits and practices.*

3. Medical nutritional therapy in T2DM: effectiveness

Substantial evidence supports the effectiveness of MNT interventions provided by RNs for improving hemoglobin A1c (HbA1c), with absolute decreases up to 2.0% (in T2DM) and up to 1.9% (in T1DM) at 3–6 months. Ongoing MNT support helps maintain glycemic improvements [48, 49]. The cost-effectiveness of lifestyle interventions and MNT for preventing and managing diabetes has been documented in multiple studies [53, 58-60]. Diabetes-individualized MNT provided by RNs should be part of the multidisciplinary approach to diabetes care. It should also be adequately reimbursed because it can result in improved outcomes such as reduced HbA1c and cost savings [53, 58, 60, 61].

The most robust evidence for T2DM prevention comes from several studies, including the Diabetes Prevention Program (DPP) [62–64]. The DPP demonstrated that an intensive lifestyle intervention resulting in weight loss could reduce the incidence of T2DM for adults with overweight/ obesity and impaired glucose tolerance by 58% over three years [62].

Follow-up of three large studies of lifestyle intervention for diabetes prevention has shown a sustained reduction in the rate of conversion to T2DM: 43% reduction at 20 years in the Da Qing Diabetes Prevention Study, 43% reduction at seven years in the Finnish Diabetes Prevention Study (DPS); and 34% reduction at ten years and 27% reduction at 15 years extended follow- up of the DPP in the US Diabetes Prevention Program Outcomes Study (DPPOS). The follow-up of the Da Qing study also demonstrated a reduction in cardiovascular and all-cause mortality [64-68].

Substantial evidence indicates that individuals with prediabetes should be referred to an intensive behavioral lifestyle intervention program modeled on the DPP and/or to individualized MNT typically provided by an RN with the goals of improving eating habits, increasing moderate-intensity physical activity to at least 150 min per week, and achieving and maintaining 7–10% loss of initial body weight if needed. More intensive intervention programs are the most effective in decreasing diabetes incidence and improving cardiovascular disease (CVD) risk factors [55, 58, 69-71].

DPP-modelled intensive lifestyle interventions and individualized MNT for prediabetes have demonstrated cost-effectiveness [58, 60, 72]. Preliminary research studies support that delivering diabetes prevention lifestyle interventions through technology-enabled platforms and digital health tools can result in weight loss, improved glycemia, and reduced risk for diabetes and CVD. However, more rigorous studies are needed [73–80].

4. Medical nutritional therapy in T2DM: components and recommendations

Many studies have been completed to determine the optimal combination of macronutrients. Based on available data**,** the best mix of carbohydrates, protein, and fat depends on the individual metabolic goals and preferences of the diabetic person. It is most important to keep total calories in mind for weight loss or maintenance [81].

4.1. Carbohydrates

The literature contains conflicting recommendations for low CHO diets in treating diabetes. Many studies have been conducted over the years to investigate using diets with lower CHO content and improved blood glucose levels without adverse effects [82, 83]. According to research, low carbohydrate eating plans may improve glycemia and have the potential to reduce antihyperglycemic medications for people with type 2 diabetes. Furthermore, low CHO diets are not recommended for pregnant or lactating women, people who have or are at risk of having disordered eating, or people who have kidney disease. Because of the risk of ketoacidosis, the ADA advises caution in people taking sodium-glucose cotransporter 2 (SGLT2) inhibitors. The most compelling reasons for limiting adoption may be that low CHO diet definitions vary and that low CHO diets are challenging to maintain in the long term, with few longer-term studies to support extended benefits [81, 83].

The American Diabetes Association recommended that CHO intake emphasize nutrient-dense carbohydrate sources that are high in fiber, such as vegetables, fruits, legumes, whole grains, and dairy products. People with T1DM and T2DM who are prescribed flexible insulin therapy should be educated on how to use CHO counting and, in some cases, consider fat and protein content to determine mealtime insulin dosing. A consistent pattern of CHO intake in terms of time and amount may be recommended for individuals with fixed daily insulin dosing to improve glycemic control and reduce the risk of hypoglycemia. People with diabetes and those at risk are advised to avoid sugar-sweetened beverages (including fruit juices) in order to control glycemia and weight and lower their risk of cardiovascular disease and fatty liver, as well as to limit foods with added sugar that have the potential to replace healthier, more nutrient-dense food choices [81, 83].

4.1.1. Nutritive Sweeteners

Clinical trials have demonstrated that dietary sucrose does not affect glycemia any differently than similar caloric quantities of starch. It is vital to remember that excessive nutritive sweetener use or foods and beverages with high nutritive sweetener content should be avoided because they can cause weight gain [12, 83].

A typical naturally occurring monosaccharide, fructose, can be found in honey, various vegetables, and fruits. High fructose corn syrup is a cheap substitute for sucrose in processed goods since it contains much fructose that has been processed. Free fructose is not anticipated to have adverse effects on triglycerides as long as intake is not high (12% energy), and it may result in better glycemic management when compared to isocaloric intake of sucrose or starch. To prevent weight gain and deterioration of the cardiometabolic risk profile, people with diabetes should limit or avoid consuming sugar-sweetened drinks (SSDs) (from any caloric sweetener, including high-fructose corn syrup and sucrose) [12, 83].

Fructose's effect on glycemic control was compared to other carbohydrate forms in a meta-analysis of 18 controlled trials in patients with diabetes. In these short-term studies (less than 12 weeks), the isocaloric exchange of fructose for carbs did not significantly influence fasting glucose or insulin levels while lowering HbA1c. The study's possible short duration is a drawback [84].

There is substantial evidence that, when compared to beverages sweetened with glucose, drinking many fructose-containing beverages may negatively affect lipid metabolism, blood pressure, insulin sensitivity, and the selective deposition of ectopic and visceral fat. As a result, recommendations for the ideal intake of dietary fructose are still debatable because of the potential metabolic effects that could increase insulin resistance and obesity [12, 83].

4.1.2. Non-Nutritive Sweeteners

Non-nutritive sweeteners produce negligible energy and cause a sweet sensation without raising insulin or blood sugar levels. Currently, seven non-nutritive sweeteners that have FDA approval have been determined to be safe when used in accordance with FDA-acceptable daily intake amounts (ADI) [85]. These are luo han guo, stevia, neotame, aspartame, sucralose, saccharine, acesulfame K, and neotame [83].

With nearly 200 research on the use of aspartame at typical levels in food, both in humans and animals, the safety is regarded as proven. It does not indicate any long-term negative consequences. There were no observed safety problems that could have increased the risk of cancer, gene, or neurological damage [83]. Artificial sweeteners do not raise blood glucose levels independently, according to a review of 29 randomized controlled trials involving 741 participants, 69 of whom have type 2 diabetes. However, the content of the food or drink containing the artificial sweetener must be considered, especially among People with diabetes [86].

4.1.3. Fiber

Individuals with DM should consume 20–35 g of fiber daily from unprocessed grains and raw vegetables (or roughly 14 g of fiber per 1,000 calories consumed). In previous years, fiber's definition and comprehension have changed. The carbohydrates and fiber found in plants that are neither digested by the stomach nor absorbed in the GI tract are called dietary fiber. The section of fiber known to have positive physiological effects on people is known as functional fiber [81]. Dietary and functional fiber together make up total fiber. Although it was often believed that a fiber's solubility would determine its physiological function, more recent research indicates that viscosity or fermentability may be more significant fiber characteristics [87].

Dietary fiber consumption is linked to lower all-cause mortality in diabetics. A fiber-rich meal is processed more slowly, which promotes satiety, is less caloric, and contains fewer added sugars, which can aid in the fight against obesity and may lower the risk of heart disease, type 2 diabetes, and colon cancer. The FDA recommends 25 g of dietary fiber per 2,000 calories consumed. This recommendation is based on epidemiologic studies that show cardiovascular disease prevention [83, 87, 88].

Fiber supplements and bulk laxatives are commonly used as additional dietary fiber sources; however, because few fiber supplements have been studied for physiological effectiveness, the best advice is to consume fiber-rich foods [87]. One systematic review of the literature concluded that eating whole grains was not associated with significant improvements in glycemic control in people with type 2 diabetes;

however, it may have other benefits, such as lowering systemic inflammation [89].

Individuals with diabetes, like the general population, should consume at least half of their grains as whole grains. Carbohydrate sources high in fiber (>5g/serving) include legumes, whole grain bread and cereals, whole fruits and vegetables, and should be included in the daily carbohydrate intake. For some people, a daily fiber intake of 25 gms or higher may be difficult to achieve because high fiber intake can cause adverse GI effects such as bloating and gas. If the person is not used to eating more fiber, it should be introduced gradually [83].

4.2. Fat

Goals should be tailored because there is insufficient evidence to determine the appropriate total fat intake for people with diabetes; fat quality is significantly more significant than quantity. The objective for dietary fat consumption (amount and type) for People with diabetes is comparable to that of people with CVD but without diabetes due to the elevated risk of CVD (cardiovascular disease) in individuals with diabetes. Current research has shown that reducing saturated and trans fatty acids, the primary dietary fatty acids linked to increased LDL cholesterol, lowers CVD risk. Therefore, the American Heart Association and American College of Cardiology advise reducing dietary intake of saturated and trans fats [12, 81, 90].

The Academy of Nutrition and Dietetics recommends that healthy persons consume 20% to 35% of their total calories as fat. There is currently little study on the ideal percentage of calories from fat for people with diabetes. Therefore, the individualized approach to fat content is advised [81, 91]. Encouragement to switch from high trans-fat, partly hydrogenated vegetable oils, animal fats, and tropical oils to healthier oils and foods higher in monounsaturated and polyunsaturated fats is recommended [83].

The American Diabetes Association's 2019 Lifestyle Management: Guidelines of Medical Treatment for Diabetes report offers the following recommendations: An eating regimen that emphasizes components of a Mediterranean-style diet rich in monounsaturated and polyunsaturated fats may be considered to improve glucose metabolism and lower CVD risk and can be a valuable alternative to a diet low in total fat but relatively high in carbohydrates. However, data on the ideal total dietary fat content for people with diabetes are conflicting. To prevent or cure CVD, it is advised to consume foods high in long-chain n-3 fatty acids, such as fatty fish (eicosapentaenoic acid: EPA and docosahexaenoic acid: DHA) and nuts and seeds (alpha-linolenic acid: ALA). However, no evidence suggests that taking n-3 dietary supplements has positive effects [81].

4.2.1. Monounsaturated Fatty Acids

Vegetable oils like olive, peanut, avocado, and canola oil often include monounsaturated fats (MUFA), which are liquid at low temperatures. Avocado, some fatty fish, nuts, and nut butter are MUFA-rich foods. Reduced risk of CVD has been linked to diets high in MUFA or PUFA and low in saturated fat, according to several sizable prospective observational studies [92]. One meta-analysis of RCTs comparing diets higher in MUFA vs CHO or PUFA found that high MUFA diets can improve T2DM patients' metabolic parameters [93].

4.2.2. Polyunsaturated Fatty Acids

The polyunsaturated fats (PUFAs) in vegetable oils, including corn, safflower, and soybean, are typically liquid at room temperature. The ideal omega-6 to omega-3 fatty acids ratio is a matter of debate. There is some support from a meta-analysis of RC feeding studies for the idea that dietary macronutrients affect glucose-insulin homeostasis in various ways. Compared to CHO, MUFA, or saturated fat, PUFA showed the most consistent benefits. Improvements in glycemia, insulin resistance, and insulin secretion capability were associated with PUFA replacement [94].

4.2.3. Omega-3 Fatty Acids

Although eating foods high in long-chain n-3 fatty acids, such as fatty fish (which include EPA and DHA) and nuts and seeds (which contain ALA), is advised to prevent or treat CVD, there is no evidence to suggest that taking these supplements has any positive effects. Fish contains EPA and DHA, two different types of omega-3 fatty acids. Alpha-linolenic acid (ALA) is the name for the type of omega-3 found in plants. These polyunsaturated fats are found in several fatty fish varieties, nuts, and grains. In healthy people, eating two servings per week of fish high in EPA and DHA is linked to a lower risk of sudden death as well as mortality from coronary artery disease [81, 83].

There are few conflicting studies on how omega-3 fatty acids (found in food and supplements) affect people with diabetes [12]. Regular fish consumption may help lower triglycerides by displacing other items higher in saturated and trans fats from the diet, such as fatty meats and full-fat dairy products, in addition to supplying EPA and DHA. It is advised to prepare fish without frying it or adding cream-based sauces. Salmon, albacore tuna, mackerel, sardines, herring, and lake trout are some fish high in omega-3. Walnuts, flax, chia, and soybeans are nuts and seeds high in ALA [83].

4.2.4. Saturated Fats

At room temperature, saturated fats are typically solid or almost solid. Animal fats, including those found in meat, poultry, and dairy products, are saturated. Saturated fats are abundant in processed and fast foods. Saturated vegetable oils include coconut, palm, and palm kernel oils. Although they are sourced

from plants, oils like coconut and palm (also known as tropical oils) are frequently promoted as healthy saturated fats, but this is untrue. Saturated fat intake should be kept to a minimum, and non-tropical vegetable oils such as canola, corn, olive, peanut, safflower, soybean, and sunflower oils should be used while cooking [83].

There have not been many studies looking at the relationship between dietary saturated fatty acids (SFA) and glycemic management and CVD risk in people with diabetes. According to the ADA's nutrition position paper, diabetes patients should adhere to these recommendations [12]. The Dietary Guidelines for Americans, 2015-2020, suggests ingesting fewer than 10% of calories from SFAs to minimize CVD risk [95].

Saturated fats are generally not recommended since they raise total and LDL cholesterol levels. The risk of cardiovascular disease has been linked to diets high in saturated fats. Compared to baseline values or a more typical Western-style diet, LDL cholesterol levels dropped from 9% to 12% on meals containing 7% SFA and 200 mg/day of cholesterol. Unsaturated fats, not refined carbohydrates, should replace saturated fats as they are gradually reduced in the diet. People with diabetes should try to keep their consumption of saturated fats to less than 10% of total calories [83, 96].

4.2.5. Trans Fats

When oils are "partially hydrogenated," trans fatty acids (TFA), also known as hydrogenated fats, are produced. Unsaturated fats undergo a chemical transformation known as "saturation" during the process of hydrogenation, which involves adding hydrogen atoms to the fat. Liquid oil is transformed into stick margarine or shortening through hydrogenation. To improve product stability and shelf life, manufacturers hydrogenate their products. As a result, production costs are reduced because a more significant quantity may be produced simultaneously. Synthetic TFA has been shown to reduce HDL cholesterol and raise LDL cholesterol in tests [83].

4.2.6. Cholesterol

Eating cholesterol is unnecessary because the body produces plenty of it for physiological needs. According to the most recent Dietary Guidelines for Americans, there is insufficient evidence to recommend restricting cholesterol intake for the general population, and recommendations for dietary cholesterol for particular populations, such as people with disabilities, are unclear. Consumption of cholesterol and serum cholesterol levels are associated; however, CVD events have not been adequately studied. Hence, more investigation is required into the connection between dietary cholesterol, blood cholesterol, and CVD events in diabetics. Given that meals high in saturated fat typically contain the most dietary cholesterol, the most up-to-date practical advice for people with diabetes addressing dietary cholesterol is to adhere to these recommendations [12].

4.2.7. Stanols and Sterols

By taking 1.6-3 g/day of plant stanols or sterols, commonly present in enriched foods, people with diabetes and dyslipidemia may be able to reduce total modestly and LDL cholesterol. Natural cholesterol compounds in vegetable oils, nuts, corn, wood, and beans are called plant sterols. Stanols are created when sterols are hydrogenated. *Phytosterols* is the general name used to describe sterols, stanols, and their esters. The capacity of phytosterols to prevent dietary and biliary cholesterol from being absorbed from the digestive tract is a crucial function of these compounds. In short-term trials, sterols and stanols can both reduce LDL cholesterol. A typical diet contains insufficient sterols and stanol esters to have a therapeutic impact [12, 83, 97].

For their ability to decrease LDL cholesterol, several manufacturers add them to various foods. Among the majority of dyslipidemia people who require additional lipid-lowering, a meta-analysis of well-controlled studies revealed that the short-term use of food supplements high in plant sterols is a safe and effective strategy to help maximize the effects of dietary and lifestyle treatment, whether with or without statin therapy. Plant sterol-containing products can lower LDL cholesterol by more than 10%. The daily requirement for plant sterols is at least 2 grams or about two 8-ounce (237 milliliters) glasses of orange juice enriched with plant sterols [97].

As fewer trials have been done, the evidence for long-term use in patients with diabetes is less substantiated [97, 98]. As part of a cardioprotective diet, the Evidence Analysis Library (EAL) of the Academy of Nutrition and Dietetics recommends using plant sterol/stanol esters in levels of 2 g/day or roughly two tablespoons/day. These enriched margarines taste similar to conventional margarine but cost three to four times as much. Also, it is crucial to remember that these fortified meals should be used as a replacement for ordinary foods rather than an additive because more is not always better, and adding more calories can result in weight gain [83].

4.3. Protein

Consuming protein can boost the insulin response in people with T2DM without raising blood sugar levels. Hence, it is not recommended to treat or prevent hypoglycemia with sources of carbohydrates that are high in protein. No proof that increasing or decreasing daily protein intake (typically 1–1.5 g/kg body weight/day or 15–25% of total calories) will improve health in people without diabetic kidney disease, and there is conflicting data on the optimum protein intake to reduce the risk of cardiovascular disease (CVD). Hence, protein intake targets should be tailored based on existing eating habits. According to some studies, type 2 diabetes can be successfully managed

with meal plans that contain slightly more protein (20–30%), which may promote satiety [99, 100].

Individuals who have diabetic kidney disease (with albuminuria and/or a lower estimated glomerular filtration rate) should try to keep their daily intake of protein at no more than 0.8 grams per kilogram of ideal body weight. Lowering dietary protein intake below the recommended daily allowance is not advised because it does not impact glomerular filtration rate decline, cardiovascular risk factors, or glycemic measurements. To lower albuminuria and stabilize kidney function, the National Kidney Foundation advises persons with diabetes and stages 1-4 chronic kidney disease to consume 0.8 g of protein per kilogram of desired body weight [81, 99, 100].

Two myths concerning dietary protein in managing diabetes are that it can cause diabetic kidney damage if ingested in excess and that a specific quantity of protein is transformed into blood glucose. However, there is less evidence supporting the idea that the source of protein—animal or plant—influences diabetes outcomes. Although some evidence from randomized controlled trials suggests that protein source matters, few prospective cohort studies have examined differences between protein source and T2DM-related outcomes [83, 100].

4.4. Micronutrients

Supplementing the diet with vitamins, minerals, herbs, or spices (such as cinnamon or aloe vera) does not appear to enhance outcomes in PWD who do not have underlying deficiencies, and they are not typically advised for glycemic management. There is no conclusive scientific evidence that vitamin or mineral supplements benefit PWD who do not have underlying deficiencies, either in preventing or treating progression or consequences. Nonetheless, it is crucial to demonstrate that there are no flaws. People living with Diabetes should be aware of the need for a balanced diet to achieve their vitamin and mineral requirements from natural food sources [81, 83].

A multivitamin-mineral supplement may be beneficial for some populations, including elderly persons, pregnant or breastfeeding women, strict vegetarians or vegans, and people following very low-calorie or very low-carbohydrate diets. Studies have shown that taking excessive amounts of some vitamin or mineral supplements when there is no deficiency is not beneficial and may even be dangerous. According to some data, people using metformin therapy have an increased chance of developing a B12 deficit and may require vitamin B12 supplementation if testing reveals one [81, 83, 101].

4.4.1. Vitamins

The use of high dosages of antioxidant vitamins has gained popularity because type 2 diabetes is characterized by increased oxidative stress. According to recent studies, Carotene and vitamins E and C do not appear to help glycemic control or treat problems. It is not advised to regularly add antioxidant supplements to the diet due to a lack of effect demonstrated in significant, placebo-controlled clinical trials and uncertainties regarding potential long-term safety. Moreover, insufficient evidence suggests frequent Vitamin D administration in the absence of deficiency [81, 101, 102].

4.4.2. Minerals

Sodium

As for the non-diabetics, people with diabetes should keep their daily sodium intake at 2,300 mg. The 2019 ADA standards of medical care propose adhering to the recommendations for sodium consumption for the general population, limiting sodium intake to 2300 mg/day, as there have been few research studies on sodium restriction in people with diabetes. To help achieve this aim, food producers and eateries must offer more low-sodium substitutes. It entails avoiding salting food when making or eating it and consuming fewer pre-made and pre-packaged items overall [81, 83].

It may be prudent to exercise caution when imposing a general sodium restriction of 1,500 mg in the diabetes population without hypertension, given that some studies in people with T1DM and T2DM measuring urine sodium excretion have shown increased mortality associated with deficient sodium intakes. Other lifestyle changes, such as losing excess body weight, increasing fruit and vegetable consumption (eight to ten servings daily), consuming low-fat dairy products (two to three servings daily), refraining from excessive alcohol use (no more than two servings per day for men and one serving per day for women), and increasing activity levels can be beneficial for those who have hypertension and diabetes. These nonpharmacological methods also improve cholesterol and glycemia control [81].

Large, randomized, controlled trials have demonstrated that the DASH (Dietary Approaches to Stop Hypertension) diet, high in fruit and vegetables, low-fat dairy products, and low in saturated and total fat, dramatically lowers blood pressure [81, 103].

Magnesium

The evidence supporting the use of magnesium supplements to enhance glycemic control needs to be more consistent and confounded by variations in trial designs and baseline variables. According to some research, both middle-aged men and women who are at a higher risk of developing type 2 diabetes may benefit from eating more magnesium in their diets. More extensive research is required to ascertain the most accurate methods for evaluating magnesium levels and the effects of magnesium insufficiency on people with

diabetes. Green leafy vegetables, whole grains, and nuts are dietary sources of magnesium [104, 105].

Chromium

Several studies have shown that chromium supplementation may be helpful in treating insulin resistance and type 2 diabetes. The ADA position statement claims that the findings with more significant effects were primarily obtained in research of lower quality, limiting the applicability of the findings. Thus, routine chromium supplementation is not currently advised for treating diabetes or obesity [81].

4.4.3. Herbal supplements

The effects of cinnamon, curcumin, and other herbs and spices on people with diabetes have drawn attention over the last few years. The most recent ADA Lifestyle Management recommendations state that there is not enough convincing evidence to support the use of herbs or spices as a treatment for T2DM after reviewing the available data. The ADA further notes that using any herbal supplements, which are unregulated and include a range of ingredients, may carry more danger than benefit because herbs may mix with other diabetic drugs. [12, 81]

4.4.4. Probiotics

Probiotics are certain "good" bacteria in fermented foods like yoghurt, kefir, and kimchi and are also sold as supplements. The words pro and biota indicate "for life" in Greek. They are generally present in the stomach but may become reduced due to poor diet, taking antibiotics, and being under stress. Many illnesses, such as irritable bowel syndrome, diarrhea, constipation, and genitourinary infections, to mention a few, have been investigated extensively concerning the use of probiotics to increase gut flora for treatment and maybe prevention. Various strains and dosages might be more beneficial for some ailments than others, but since the FDA does not control the supplements, neither their composition nor efficacy are governed. They are typically considered safe since they naturally occur in the digestive system [106-108].

Probiotic foods and supplements have been studied in persons with gestational and type 2 diabetes to see if they can reduce chronic inflammatory and glycemic indicators. The hypothesis is that the microbiome flora may influence glucose metabolism by affecting insulin sensitivity and inflammation. Some probiotic strains may be beneficial in modifying the gut flora since the microbiome in persons with and without T2DM differs. In most of the 12 randomized controlled studies on probiotic supplements in T2DM, glycemic and lipid markers showed a moderate improvement. The authors pointed out that lactobacillus and bifidobacterium were the most often utilized species in the trials. Additional investigations with longer durations, precise strains, and therapeutic doses should be conducted [106].

According to a meta-analysis, probiotic yoghurt did not enhance glycemic indicators compared to ordinary yoghurt when used to improve glycemic control in type 2 diabetes and obesity. The authors suggest that more extensive randomized trials lasting more than 12 weeks be conducted [108].

4.5. Chocolate

Many individuals love eating chocolate. There are numerous claims made about the health advantages of cocoa and chocolate. Consuming dark chocolate, as opposed to white chocolate, has been demonstrated in certain studies to improve endothelial function in healthy people and hypertensive patients with impaired glucose tolerance. The flavonoids found in cocoa and dark chocolate are thought to be responsible for improving endothelial function. The increase in insulin sensitivity and change in glucose metabolism could result from improved endothelial function. The long-term consequences of a diet high in dark chocolate or cocoa have not been studied in long-term randomized controlled studies in diabetics. Chocolate is frequently used as part of a snack or confectionery with a high energy content but little nutritional benefit. A person with diabetes may suffer from an increase in weight as a result of this. Other energy-dense, low-nutritional-value foods should be adjusted to maintain a healthy diet and energy balance if incorporated into their diet. The overall nutrient content of the chocolate-containing food or product, daily calorie intake, and energy balance should all be taken into consideration [83, 109].

4.6. Alcohol

Alcohol is prohibited in KSA. Hazards of excessive alcohol use include weight gain, hyperglycemia, and hypoglycemia (especially for people on insulin or insulin secretagogue treatments) (for those consuming excessive amounts). Alcohol's failure to convert to glucose, its inhibitory influence on gluconeogenesis, and its interference with the body's natural hormonal countermeasures to imminent hypoglycemia are only a few of the reasons why hypoglycemia might develop [81, 83].

Statements:

9. *Evidence suggests no ideal percentage of calories from carbohydrates, protein, and fat for people with diabetes. However, reducing glycemic load and glycemic index of carbohydrates is the most important to achieve better glycemic control.*

10. *However, some data suggest that approximately 40 percent of a person's daily calories come from carbohydrates of low glycemic index, increasing protein based on adjusted intake to 1-1.5 g/kg (unless the person has kidney disease); 30-35 percent come from fat, (primarily mono- and polyunsaturated fats); and at least 20-35 grams of fiber.*

11. *Macronutrient distribution should be based on an individualized assessment of eating patterns, preferences, and metabolic goals.*

12. *This dietary pattern can improve both glycemic management and blood lipids. Characteristics of these diets include:*

- *a. Plant-based dietary pattern abundant in vegetables, beans, nuts, and seeds, 2-3 servings of fresh whole seasonal fruits.*
- *b. Limit the amount of white bread or white flour products and cereals and replace them with whole wheat bread, protein bread, and high-fiber, whole-grain cereals. Fiber intake should be at least 14 gm/1000 calories.*
- *c. Minimally processed: locally grown, seasonally fresh foods.*
- *d. Limit sweets, sugar, all juices, sweetened beverages, and canned fruits. Use honey in moderation because it affects glycemic control. Diet sodas should be limited.*
- *e. Drink a good amount of 4-6 glasses of water or unsweetened beverages.*
- *f. High-quality fats: olive oil is the primary source of fat, and total intake is moderate (30%) to high (40%) of total energy intake.*
- *g. Moderate dairy intake is recommended: mainly cheese, laban, milk, and yogurt.*
- *h. Trans-fats should be eliminated*
- *i. Protein: High-fat red meats may be consumed in small amounts and with a low frequency; encourage moderate amounts of fish, preferably fatty fish, at least two servings of fish a week.*
- *j. Herbs and spices: used instead of salt to flavor foods.*
- *k. Minimize processed food*

13. *Lifestyle intervention is the first-line treatment for hypertension. For patients with blood pressure ≥120/80 mmHg, lifestyle intervention should include weight loss if overweight or obese; a Dietary Approaches to Stop Hypertension (DASH)-style eating pattern should be recommended.*

14. *A Mediterranean eating pattern can improve both glycemic management and blood lipids.*

15. *When providing MNT, cultural preferences should guide the selection of foods and meals and be consistent with general nutrition recommendations from the ADA and AACE.*

16. *For overweight and obese T2DM patients, use 1 to 2 units per day of a diabetes-specific nutrition formula (DSF) as part of a reduced-calorie meal plan, as a calorie replacement for a meal, partial meal, or snack. Daily calorie goals from diabetes-specific nutrition formulas and other healthy dietary sources: 1,500–1,800 kcal/day for men, 1,200–1,500 kcal/day for women (the difference in recommended daily calories is gender and height specific)*

17. *For patients with uncontrolled diabetes (HbA1c > 7%): use 1 to 2 units per day of diabetes-specific nutrition formula (DSF) incorporated into a meal plan as a calorie replacement for a meal, partial meal, or snack.*

18. *For patients with controlled diabetes (HbA1c < 7%), diabetes-specific nutrition formulas should be based on individual patient needs and body weight. In case of overweight and obesity, 1-2 units of diabetes-specific formula are recommended.*

19. *For underweight diabetes patients, use 1 to 3 units per day of diabetes-specific nutrition supplements per clinical judgment based on the desired rate of weight gain and clinical tolerance*

20. *Bariatric surgery may be considered for patients who have attempted lifestyle modification or/and anti-obesity medications but failed to achieve and sustain weight loss; are expected to tolerate the risk of surgery; are committed to treatment and long-term follow-up, have accepted the required lifestyle changes and aware of the long-term side effects, including postprandial hypoglycemia & nutritional insufficiencies. The decision for surgery should be taken carefully in collaboration between the endocrinologist, surgeon, and behavioral therapist.*

5. Medical nutrition therapy and dietary patterns during Ramadan fasting

Since foods eaten during Ramadan typically contain more carbohydrates, trained dietitians should recommend portion management techniques and maybe include physical activity after meals. The Ramadan Nutrition Plan is a web-based tool created by the Diabetes and Ramadan (DAR) International Alliance to assist HCPs in providing patient-specific nutrition instruction for Ramadan. Food intake during Eid, the three-day event that follows Ramadan and involves heavy calorie and carbohydrate eating with family and friends, is a topic that is frequently overlooked [111, 112].

5.1. Dates consumption

Muslims have a long-standing custom of eating dates daily, especially during Ramadan. Although recent changes in eating habits have occurred, most nations still consume dates. The people of the Arab Gulf states had the most remarkable rate of date eating, with daily intakes ranging from 68 to 164 g. Breaking the fast with dates is advised, just as Prophet Mohammad (peace and blessings be upon him) did. Dates have a low glycemic index (GI) if they are only eaten in moderation. As a result, eating up to two or three dates during breakfast is safe [113-117].

5.2. Physical activity and Taraweeh prayers

Even though all patients with T2DM should typically be encouraged to improve their physical activity, caution is advised during Ramadan. Ramadan's Taraweeh prayer, performed after Iftaar dinner and comprises numerous cycles of standing, kneeling, and bowing, should be viewed as a daily exercise. People with Diabetes should be encouraged to exercise, and normal blood sugar levels may be kept during Ramadan. However, people who are at high risk of hypoglycemia and those who are using insulin or insulin secretagogues

should avoid excessive physical activity, especially before the evening meal [118, 119].

Statements:

21. *Ramadan fasting can be risky for many people with T2DM.*

22. *Practical guidelines explicitly created to guide the management of people with diabetes during Ramadan suggest visiting a healthcare provider for a risk assessment and advice well before the start of the fast. Structured education should include self-monitoring, time to break the fast (based on blood glucose levels), fluids and meal planning, and medication adjustments. The recommended intake of dates is 1-2 dates at the fast break.*

23. *Ramadan Can be a good opportunity for weight reduction.*

24. *Those classified as very high risk are advised to avoid fasting.*

REFERENCES

1. International Diabetes Federation, IDF Diabetes Atlas, International Diabetes Federation, Brussels, Belgium, 8th edition, 2017,http://www.diabetesatlas.org.
2. Al-Nozha MM, Al-Maatouq MA, Al-Mazrou YY. Diabetes Mellitus in Saudi Arabia. Saudi Med J 2004; 25:1603-10.
3. Alzaid A. Diabetes; the tale of two culture. The British Journal of Diabetes & Vascular Disease. April 2012
4. Saeedi P, Petersohn I, Salpea P, Malanda B, Karuranga S, Unwin N. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9(th) edition. Diabetes Res Clin Pract. 2019;157:107843.
5. World Health Organization. Diabetes Fact Sheet 2021 [cited 2023 9 March]. Available from: https://www.who.int/news-room/fact-sheets/detail/diabetes.
6. IDF Diabetes Atlas 2021-10th edition. Saudi Arabia: Diabetes report 2010–2045 [cited 2023 9 March]. Available from: https://www.diabetesatlas.org/data/en/country/174/sa.html.
7. IDF Diabetes Atlas 2021-10th edition. Middle East and North Africa fact sheet 2019 [cited 2023 9 March]. Available from: https://diabetesatlas.org/upload/resources/material/20191218_144557_mena_factsheet_en.pdf.
8. Naeem Z. Burden of Diabetes Mellitus in Saudi Arabia. Int J Health Sci (Qassim). 2015;9(3):V–VI.
9. Slattery ML. Analysis of dietary patterns in epidemiological research. Appl Physiol Nutr Metab. 2010;35(2):207–10.
10. Saudi Diabetes Clinical Practice Guidelines (SDCPG), Saudi National Diabetes Center (SNDC), Saudi Health Council, (2021). Available online: https://shc.gov.sa/Arabic/Documents/SDCP%20Guidelines.pdf
11. Norris SL, Lau J, Smith SJ, Schmid CH, Engelgau MM. Self-management education for adults with type 2 diabetes: a meta-analysis of the effect on glycemic control. Diabetes Care 2002;25:1159–1171
12. Evert AB, Dennison M, Gardner CD. Nutrition therapy for adults with diabetes or prediabetes: a consensus report. Diabetes Care 2019;42:731–754
13. MacLeod J, Franz MJ, Handu D. Academy of Nutrition and Dietetics nutrition practice guideline for type 1 and type 2 diabetes in adults: nutrition intervention evidence reviews and recommendations. J Acad Nutr Diet 2017;117:1637–1658
14. Sainsbury E, Kizirian NV, Partridge SR, Gill T, Colagiuri S, Gibson AA. Effect of dietary carbohydrate restriction on glycemic control in adults with diabetes: a systematic review and meta-analysis. Diabetes Res Clin Pract 2018;139:239–252
15. Franz MJ, Boucher JL, Rutten-Ramos S, VanWormer JJ. Lifestyle weight-loss intervention outcomes in overweight and obese adults with type 2 diabetes: a systematic review and meta-analysis of randomized clinical trials. J Acad Nutr Diet 2015;115:1447–1463
16. Forouhi NG, Misra A, Mohan V, Taylor R, Yancy W. Dietary and nutritional approaches for prevention and management of type 2 diabetes. BMJ. 2018;361:k2234.
17. Jannasch F, Kroger J, Schulze MB. Dietary Patterns and Type 2 Diabetes: A Systematic Literature Review and Meta-Analysis of Prospective Studies. J Nutr. 2017;147(6):1174–82.
18. Papamichou D, Panagiotakos DB, Itsiopoulos C. Dietary patterns and management of type 2 diabetes: A systematic review of randomised clinical trials. Nutr Metab Cardiovasc Dis. 2019;29(6):531–43.
19. Aljahdali AA, Bawazeer NM. Dietary patterns among Saudis with type 2 diabetes mellitus in Riyadh: A cross-sectional study. PLoS One. 2022 May 5;17(5):e0267977.
20. Marques-Vidal P, Waeber G, Vollenweider P, Guessous I. Socio-demographic and lifestyle determinants of dietary patterns in French-speaking Switzerland, 2009–2012. BMC Public Health. 2018;18(1):1–11.
21. Centritto F, Iacoviello L, di Giuseppe R, De Curtis A, Costanzo S, Zito F. Dietary patterns, cardiovascular risk factors and C-reactive protein in a healthy Italian population. Nutr Metab Cardiovasc Dis. 2009;19(10):697–706.
22. Slavin JL, Lloyd B. Health benefits of fruits and vegetables. Adv Nutr. 2012;3(4):506–16.
23. Alkhaldy AA, Alamri RS, Magadmi RK, Elshini NY, Hussein R, Alghalayini KW. Dietary Adherence of Saudi Males to the Saudi Dietary Guidelines and Its Relation to Cardiovascular

Diseases: A Preliminary Cross-Sectional Study. J Cardiovasc Dev Dis. 2019;6(2):17.
24. Foscolou A, Critselis E, Panagiotakos D. Olive oil consumption and human health: A narrative review. Maturitas. 2018;118:60–6.
25. Salas-Salvado J, Bullo M, Estruch R, Ros E, Covas MI, Ibarrola-Jurado N. Prevention of diabetes with Mediterranean diets: a subgroup analysis of a randomized trial. Ann Intern Med. 2014;160(1):1–10.
26. Basterra-Gortari FJ, Ruiz-Canela M, Martinez-Gonzalez MA, Babio N, Sorli JV, Fito M. Effects of a Mediterranean Eating Plan on the Need for Glucose-Lowering Medications in Participants With Type 2 Diabetes: A Subgroup Analysis of the PREDIMED Trial. Diabetes care. 2019;42(8):1390–7.
27. Aune D, Norat T, Romundstad P, Vatten LJ. Whole grain and refined grain consumption and the risk of type 2 diabetes: a systematic review and dose-response meta-analysis of cohort studies. Eur J Epidemiol. 2013;28(11):845–58.
28. Della Pepa G, Vetrani C, Vitale M, Riccardi G. Wholegrain Intake and Risk of Type 2 Diabetes: Evidence from Epidemiological and Intervention Studies. Nutrients. 2018;10(9):1288.
29. Marventano S, Vetrani C, Vitale M, Godos J, Riccardi G, Grosso G. Whole Grain Intake and Glycaemic Control in Healthy Subjects: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Nutrients. 2017;9(7):769.
30. Fung TT, Hu FB, Pereira MA, Liu S, Stampfer MJ, Colditz GA. Whole-grain intake and the risk of type 2 diabetes: a prospective study in men. Am J Clin Nutr. 2002;76(3):535–40.
31. Hu Y, Ding M, Sampson L, Willett WC, Manson JE, Wang M. Intake of whole grain foods and risk of type 2 diabetes: results from three prospective cohort studies. BMJ. 2020;370:m2206.
32. Alhaiti AH, Senitan M, Dator WLT, Sankarapandian C, Baghdadi NA, Jones LK. Adherence of Type 2 Diabetic Patients to Self-Care Activity: Tertiary Care Setting in Saudi Arabia. J Diabetes Res. 2020;2020:4817637.
33. ALAboudi IS, Hassali MA, Shafie AA, Saleem F. Self-efficacy, self-care behaviours and glycaemic control in type 2 diabetic patients in Riyadh, Saudi Arabia. J Public Health. 2016;24(4):281–90.
34. Saad AMJ, Younes ZMH, Ahmed H, Brown JA, Al Owesie RM, Hassoun AAK. Self-efficacy, self-care and glycemic control in Saudi Arabian patients with type 2 diabetes mellitus: A cross-sectional survey. Diabetes Res Clin Pract. 2018;137:28–36.
35. Al Johani K, Kendall G, Snider P. Self-management practices among type 2 diabetes patients attending primary health-care centres in Medina, Saudi Arabia. East Mediterr Health J. 2015;21(9):621–8.
36. Abu Sabbah KO, Al Shehri AA. Practice and perception of self-management among diabetics in Taif, KSA: Impact of demographic factors. Int J Med Sci Public Health. 2014;3(1):264–71.
37. Salam MA, Siddiqui AF. Socio-demographic determinants of compliance among type 2 diabetic patients in Abha, Saudi Arabia. J Clin Diagn Res. 2013;7(12):2810.
38. Andrade SC, Previdelli AN, Cesar CL, Marchioni DM, Fisberg RM. Trends in diet quality among adolescents, adults and older adults: A population-based study. Prev Med Rep. 2016;4:391–6.
39. Ternus DL, Henn RL, Bairros F, Costa JSd, Olinto MTA. Dietary patterns and their association with sociodemographic and behavioral factors: 2015 Women's Health Research, São Leopoldo (RS). Rev Bras Epidemio. 2019;22:e190026.
40. Beck K, Jones B, Ullah I, McNaughton S, Haslett S, Stonehouse W. Associations between dietary patterns, socio-demographic factors and anthropometric measurements in adult New Zealanders: an analysis of data from the 2008/09 New Zealand Adult Nutrition Survey. Eur J Nutr. 2018;57(4):1421–33.
41. Naja F, Nasreddine L, Itani L, Chamieh MC, Adra N, Sibai AM. Dietary patterns and their association with obesity and sociodemographic factors in a national sample of Lebanese adults. Public Health Nutr. 2011;14(9):1570–8.
42. Petrenya N, Rylander C, Brustad M. Dietary patterns of adults and their associations with Sami ethnicity, sociodemographic factors, and lifestyle factors in a rural multiethnic population of northern Norway-the SAMINOR 2 clinical survey. BMC public health. 2019;19(1):1–15.
43. Stea TH, Nordheim O, Bere E, Stornes P, Eikemo TA. Fruit and vegetable consumption in Europe according to gender, educational attainment and regional affiliation-A cross-sectional study in 21 European countries. PLoS One. 2020;15(5):e0232521.
44. Prattala R, Paalanen L, Grinberga D, Helasoja V, Kasmel A, Petkeviciene J. Gender differences in the consumption of meat, fruit and vegetables are similar in Finland and the Baltic countries. Eur J Public Health. 2007;17(5):520–5.
45. Lu M, Pilla S J, Oh S H. Diabetes mellitus: Dietary management. Editor(s): Benjamin Caballero, Encyclopedia of Human Nutrition (Fourth Edition), Academic Press, 2023, Pages 234-251.
46. Powers MA, Bardsley J, Cypress M. Diabetes self-management education and sup- port in type 2 diabetes: a joint position statement of the American Diabetes Association, the American Association of Diabetes Educators, and the Academy of Nutrition and Dietetics. Diabetes Care 2015;38:1372–1382
47. Inzucchi SE, Bergenstal RM, Buse JB. Management of hyperglycemia in type 2 diabetes, 2015: a patient-centered approach: update to a position statement of the American Diabetes Association and the European Association for the Study of Diabetes. Diabetes Care 2015;38:140– 149

48. American Diabetes Association; *Standards of Medical Care in Diabetes—2022* Abridged for Primary Care Providers. *Clin Diabetes* 1 January 2022; 40 (1): 10–38.
49. Franz MJ, MacLeod J, Evert A. Academy of Nutrition and Dietetics Nutrition practice guideline for type 1 and type 2 diabetes in adults: systematic review of evidence for medical nutrition therapy effectiveness and recommendations for integration into the nutrition care process. J Acad Nutr Diet 2017;117:1659–1679
50. American Diabetes Association. 5. Lifestyle management: Standards of Medical Care in Diabetesd2019. Diabetes Care 2019;42(Suppl. 1): S46–S60
51. Diabetes Canada Clinical Practice Guidelines Expert Committee. Diabetes Canada 2018 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. Can J Diabetes. 2018;42(Suppl 1):S1-S325.
52. Davies MJ, D'Alessio DA, Fradkin J. Management of hyperglycemia in type 2 diabetes, 2018. A consensus report by the American diabetes association (ADA) and the European association for the study of diabetes (EASD). Diabetologia 2018;61:2461–98.
53. Davidson P, Ross T, Castor C. Academy of Nutrition and Dietetics: Revised 2017 Standards of Practice and Standards of Professional Performance for Registered Dietitian Nutritionists (Competent, Proficient, and Expert) in Diabetes Care. J Acad Nutr Diet 2018;118:932–946. e48
54. Andrews RC, Cooper AR, Montgomery AA. Diet or diet plus physical activity versus usual care in patients with newly diagnosed type 2 diabetes: the Early ACTID randomised controlled trial. Lancet 2011;378:129–139
55. Parker AR, Byham-Gray L, Denmark R, Winkle PJ. The effect of medical nutrition therapy by a registered dietitian nutritionist in patients with prediabetes participating in a randomized controlled clinical research trial. J Acad Nutr Diet 2014;114:1739–1748
56. Berry DC, Williams W, Hall EG, Heroux R, Bennett-Lewis T. Imbedding interdisciplinary diabetes group visits into a community-based medical setting. Diabetes Educ 2016;42:96–107
57. Battista M-C, Labonte´ M, Me´nard J. Dietitian-coached management in combination with annual endocrinologist follow up improves global metabolic and cardiovascular health in diabetic participants after 24 months. Appl Physiol Nutr Metab 2012;37:610–620
58. Briggs Early K, Stanley K. Position of the Academy of Nutrition and Dietetics: the role of medical nutrition therapy and registered dietitian nutritionists in the prevention and treatment of prediabetes and type 2 diabetes. J Acad Nutr Diet 2018;118:343–353
59. Sun Y, You W, Almeida F, Estabrooks P, Davy B. The effectiveness and cost of lifestyle interventions including nutrition education for diabetes prevention: a systematic review and meta-analysis. J Acad Nutr Diet 2017;117:404– 421.e36
60. Academy of Nutrition and Dietetics Evidence Analysis Library. MNT: cost effectiveness, cost-benefit, or economic savings of MNT (2009) [Internet]. Available from https://www.andeal.org/topic.cfm?cat=4085&conclusion_statement_ id=251001. Accessed 2 October 2018
61. Institute of Medicine. The Role of Nutrition in Maintaining Health in the Nation's Elderly: Evaluating Coverage of Nutrition Services for the Medicare Population [Internet], 1999. Available from https://www.nap.edu/catalog/9741/the- role-of-nutrition-in-maintaining-health-in-the- nations-elderly.
62. Knowler WC, Barrett-Connor E, Fowler SE. Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med 2002;346:393–403
63. Lindstro¨m J, Louheranta A, Mannelin M. Finnish Diabetes Prevention Study Group. The Finnish Diabetes Prevention Study (DPS): lifestyle intervention and 3-year results on diet and physical activity. Diabetes Care 2003;26: 3230–3236
64. Knowler WC, Fowler SE, Hamman RF. Diabetes Prevention Program Research Group. 10-year follow-up of diabetes incidence and weight loss in the Diabetes Prevention Program Outcomes Study. Lancet 2009;374:1677–1686
65. Li G, Zhang P, Wang J. The long-term effect of lifestyle interventions to prevent diabetes in the China Da Qing Diabetes Prevention Study: a 20-year follow-up study. Lancet 2008; 371:1783–1789
66. Lindstro¨m J, Ilanne-Parikka P, Peltonen M. Finnish Diabetes Prevention Study Group. Sustained reduction in the incidence of type 2 diabetes by lifestyle intervention: follow-up of the Finnish Diabetes Prevention Study. Lancet 2006;368:1673–1679
67. Diabetes Prevention Program Research Group. Long-term effects of lifestyle intervention or metformin on diabetes development and microvascular complications over 15-year follow-up: the Diabetes Prevention Program Out- comes Study. Lancet Diabetes Endocrinol 2015;3: 866–875
68. Li G, Zhang P, Wang J. Cardiovascular mortality, all-cause mortality, and diabetes incidence after lifestyle intervention for people with impaired glucose tolerance in the Da Qing Diabetes Prevention Study: a 23-year follow-up study. Lancet Diabetes Endocrinol 2014;2:474– 480
69. Raynor HA, Davidson PG, Burns H. Medical nutrition therapy and weight loss ques- tions for the Evidence Analysis Library prevention of type 2

diabetes project: systematic reviews. J Acad Nutr Diet 2017;117:1578–1611
70. Academy of Nutrition and Dietetics Evidence Analysis Library. Prevention of Type 2 Diabetes (PDM) Guideline (2014) [Internet]. Available fromhttps://www.andeal.org/topic.cfm?menu=5344&cat=5013. Accessed 10 March 2023
71. Balk EM, Earley A, Raman G, Avendano EA, Pittas AG, Remington PL. Combined diet and physical activity promotion programs to prevent type 2 diabetes among persons at increased risk: a systematic review for the Community Preventive Services Task Force. Ann Intern Med 2015; 163:437–451
72. Diabetes Prevention Program Research Group. The 10-year cost-effectiveness of lifestyle intervention or metformin for diabetes prevention: an intent-to-treat analysis of the DPP/ DPPOS. Diabetes Care 2012;35:723–730
73. Mao AY, Chen C, Magana C, Caballero Barajas K, Olayiwola JN. A mobile phone-based health coaching intervention for weight loss and blood pressure reduction in a national payer population: a retrospective study. JMIR Mhealth Uhealth 2017;5:e80
74. Sepah SC, Jiang L, Peters AL. Long-term outcomes of a Web-based diabetes prevention program: 2-year results of a single-arm longitudinal study. J Med Internet Res 2015;17:e92
75. Bian RR, Piatt GA, Sen A. The effect of technology-mediated diabetes prevention interventions on weight: a meta-analysis. J Med Internet Res 2017;19:e76
76. Chen F, Su W, Becker SH. Clinical and economic impact of a digital, remotely-delivered intensive behavioral counseling program on Medicare beneficiaries at risk for diabetes and cardiovascular disease. PLoS One 2016;11: e0163627
77. Azar KMJ, Aurora M, Wang EJ, Muzaffar A, Pressman A, Palaniappan LP. Virtual small groups for weight management: an innovative delivery mechanism for evidence-based lifestyle interventions among obese men. Transl Behav Med 2015;5:37–44
78. Sepah SC, Jiang L, Peters AL. Translating the Diabetes Prevention Program into an online social network: validation against CDC standards. Diabetes Educ 2014;40:435–443
79. Michaelides A, Raby C, Wood M, Farr K, Toro-Ramos T. Weight loss efficacy of a novel mobile Diabetes Prevention Program delivery platform with human coaching. BMJ Open Diabetes Res Care 2016;4:e000264
80. Block G, Azar KM, Romanelli RJ. Diabetes prevention and weight loss with a fully automated behavioral intervention by email, web, and mobile phone: a randomized controlled trial among persons with prediabetes. J Med Internet Res 2015;17:e240
81. American Diabetes Association. Diabetes Care. 2019 Jan;42 Supplement 1:S46–S60.
82. Feinman RD, Pogozelski WK, Astrup A, Bernstein RK, Fine EJ, Westman EC. Dietary carbohydrate restriction as the first approach in diabetes management: critical review and evidence base. Nutrition. 2015 Jan;31(1):1-13. doi: 10.1016/j.nut.2014.06.011. Epub 2014 Jul 16. Erratum in: Nutrition. 2019 Jun;62:213.
83. Gray A, Threlkeld RJ. Nutritional Recommendations for Individuals with Diabetes. [Updated 2019 Oct 13]. In: Feingold KR, Anawalt B, Blackman MR. editors. Endotext [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK279012/
84. Cozma AI, Sievenpiper JL, de Souza R.J. Effect of fructose on glycemic control in diabetes: a systematic review and meta-analysis of controlled feeding trials. Diabetes Care. 2012;35:1611–1620.
85. Position of the Academy of Nutrition and Dietetics. Use of Nutritive and Nonnutritive Sweeteners Acad Nutr Diet. 2012;112:739–758.
86. Nichol AD, Holle MJ, An R. Glycemic impact of non-nutritive sweeteners: a systematic review and meta-analysis of randomized controlled trials. Eur J Clin Nutr. 2018 Jun;72(6):796-804.
87. Dahl WJ, Stewart ML. Position of the Academy of Nutrition and Dietetics: Health Implications of Dietary Fiber. J Acad Nutr Diet. 2015 Nov;115(11):1861-70.
88. Burger KN, Beulens JW, van der Schouw YT, Sluijs I, Spijkerman AM, Sluik D, Boeing H, Kaaks R, Teucher B, Dethlefsen C, Overvad K, Tjønneland A, Kyrø C, Barricarte A, Bendinelli B, Krogh V, Tumino R, Sacerdote C, Mattiello A, Nilsson PM, Orho-Melander M, Rolandsson O, Huerta JM, Crowe F, Allen N, Nöthlings U. Dietary fiber, carbohydrate quality and quantity, and mortality risk of individuals with diabetes mellitus. PLoS One. 2012;7(8):e43127.
89. Wheeler ML, Dunbar SA, Jaacks LM. Macronutrients, food groups, and eating patterns in the management of diabetes: a systematic review of the literature,2010. Diabetes Care. 2012;35:435–445.
90. Millen BE, Wolongevicz DM, de Jesus JM, Nonas CA, Lichtenstein AH. 2013 American Heart Association/American College of Cardiology Guideline on Lifestyle Management to Reduce Cardiovascular Risk: practice opportunities for registered dietitian nutritionists. J Acad Nutr Diet. 2014 Nov;114(11):1723-9.
91. Position of the Academy of Nutrition and Dietetics. Dietary Fatty Acids for Healthy Adults. J Acad Nutr Diet. 2014;114:136–153.
92. Sacks FM, Lichtenstein AH, Wu JHY, Appel LJ, Creager MA, Kris-Etherton PM, Miller M, Rimm EB, Rudel LL, Robinson JG, Stone NJ, Van Horn LV; American Heart Association. Dietary Fats and Cardiovascular Disease: A Presidential Advisory

From the American Heart Association. Circulation. 2017 Jul 18;136(3):e1-e23.
93. Qian F, Korat AA, Malik V, Hu FB. Metabolic Effects of Monounsaturated Fatty Acid-Enriched Diets Compared With Carbohydrate or Polyunsaturated Fatty Acid-Enriched Diets in Patients With Type 2 Diabetes: A Systematic Review and Meta-analysis of Randomized Controlled Trials. Diabetes Care. 2016 Aug;39(8):1448-57.
94. Imamura F, Micha R, Wu JHY, de Oliveira Otto MC, Otite FO, Abioye AI. Effects of Saturated Fat, Polyunsaturated Fat, Monounsaturated Fat, and Carbohydrate on Glucose-Insulin Homeostasis: A Systematic Review and Metanalysis of Randomized Controlled Feeding Trials. PLoS Med. 2016;13(7):e1002087.
95. The Dietary Guidelines for Americans. https://health.gov/dietaryguidelines/2015 /resources/2015-2020_Dietary_Guidelines.pdf
96. Van Horn L, McCoin M, Kris-Etherton PM, Burke F, Carson JA, Champagne CM, Karmally W, Sikand G. The evidence for dietary prevention and treatment of cardiovascular disease. J Am Diet Assoc. 2008 Feb;108(2):287-331.
97. Gupta AK, Savopoulos CG, Ahuja J, Hatzitolios AI. Role of phytosterols in lipid-lowering: current perspectives. QJM. 2011 Apr;104(4):301-8.
98. Bard JM, Paillard F, Lecerf JM. Effect of phytosterols/stanols on LDL concentration and other surrogate markers of cardiovascular risk. Diabetes Metab. 2015 Feb;41(1):69-75.
99. Navaneethan SD, Zoungas S, Caramori ML, Chan JCN, Heerspink HJL, Hurst C, Liew A, Michos ED, Olowu WA, Sadusky T, Tandon N, Tuttle KR, Wanner C, Wilkens KG, Lytvyn L, Craig JC, Tunnicliffe DJ, Howell M, Tonelli M, Cheung M, Earley A, Rossing P, de Boer IH, Khunti K. Diabetes Management in Chronic Kidney Disease: Synopsis of the 2020 KDIGO Clinical Practice Guideline. Ann Intern Med. 2021 Mar;174(3):385-394.
100. Campbell AP, Rains TM. Dietary protein is important in the practical management of prediabetes and type 2 diabetes. J Nutr. 2015 Jan;145(1):164S-169S.
101. Valdés-Ramos R, Guadarrama-López AL, Martínez-Carrillo BE, Benítez-Arciniega AD. Vitamins and type 2 diabetes mellitus. Endocr Metab Immune Disord Drug Targets. 2015;15(1):54-63.
102. Seida JC, Mitri J, Colmers IN, Majumdar SR, Davidson MB, Edwards AL, Hanley DA, Pittas AG, Tjosvold L, Johnson JA. Clinical review: Effect of vitamin D3 supplementation on improving glucose homeostasis and preventing diabetes: a systematic review and meta-analysis. J Clin Endocrinol Metab. 2014 Oct;99(10):3551-60.
103. Saneei P, Salehi-Abargouei A, Esmaillzadeh A, Azadbakht L. Influence of Dietary Approaches to Stop Hypertension (DASH) diet on blood pressure: a systematic review and meta-analysis on randomized controlled trials. Nutr Metab Cardiovasc Dis. 2014 Dec;24(12):1253-61.
104. Hruby A, Meigs JB, O'Donnell CJ, Jacques PF, McKeown NM. Higher magnesium intake reduces risk of impaired glucose and insulin metabolism and progression from prediabetes to diabetes in middle-aged Americans. Diabetes Care. 2014 Feb;37(2):419-27.
105. Workinger JL, Doyle RP, Bortz J. Challenges in the Diagnosis of Magnesium Status. Nutrients. 2018 Sep 1;10(9):1202.
106. Shah NJ, Swami OC. Role of probiotics in diabetes: A review of their rationale and efficacy. EMJ Diabet. 2017;5:104–110
107. Bezirtzoglou E, Stavropoulou E, Kantartzi K, Tsigalou C, Voidarou C, Mitropoulou G, Prapa I, Santarmaki V, Kompoura V, Yanni AE, Antoniadou M, Varzakas T, Kourkoutas Y. Maintaining Digestive Health in Diabetes: The Role of the Gut Microbiome and the Challenge of Functional Foods. Microorganisms. 2021 Mar 3;9(3):516.
108. Barengolts E, Smith ED, Reutrakul S, Tonucci L, Anothaisintawee T. The Effect of Probiotic Yogurt on Glycemic Control in Type 2 Diabetes or Obesity: A Meta-Analysis of Nine Randomized Controlled Trials. Nutrients. 2019 Mar 20;11(3):671.
109. Shah SR, Alweis R, Najim NI, Dharani AM, Jangda MA, Shahid M, Kazi AN, Shah SA. Use of dark chocolate for diabetic patients: a review of the literature and current evidence. J Community Hosp Intern Med Perspect. 2017 Sep 19;7(4):218-221.
110. Ibrahim M, Davies MJ, Ahmad E. Recommendations for management of diabetes during Ramadan: update 2020, applying the principles of the ADA/EASD consensus. BMJ Open Diabetes Research and Care 2020;8:e001248.
111. Shadman Z, Akhoundan M, Poorsoltan N. Nutritional education needs in relation to Ramadan fasting and its complications in Tehran, Iran. Iran Red Crescent Med J 2016;18:e26130.
112. Handy O, Yusof BNM, Reda WH. Chapter 7: the Ramadan nutrition plan (RNP) for patients with diabetes, 2016. Available: http://www.daralliance.org/daralliance/Google Scholar
113. Al-Mssallem MQ. Consumption of dates among Saudi adults and its association with the prevalence of type 2 diabetes. Asian J. Clin. Nutr 2018;10:58–64.
114. Aleid SM, Al-Khayri JM, Al-Bahrany AM. Date Palm Status and Perspective in Saudi Arabia. In: Al-Khayri JM, Jain SM, Johnson DV, eds. Date palm genetic resources and utilization, volume 1. Ed. Netherlands: Springer, 2015: 49–95.
115. Qazaq HS, Al Adeeb NZ. The consumption pattern of dates and its related food habits among UAE citizens in Al-Ain City, UAE: a pilot study. Acta Hortic 2010;882:1083–9.

116. Ismail B, Henry J, Haffar I. Date consumption and dietary significance in the United Arab Emirates. J Sci Food Agric 2006;86:1196–201.
117. Alkaabi JM, Al-Dabbagh B, Ahmad S. Glycemic indices of five varieties of dates in healthy and diabetic subjects. Nutr J 2011;10:59.
118. Al-Arouj M, Assaad-Khalil S, Buse J. Recommendations for management of diabetes during Ramadan: update 2010. Diabetes Care 2010;33:1895–902.
119. Ibrahim M, Abu Al Magd M, Annabi FA. Recommendations for management of diabetes during Ramadan: update 2015. BMJ Open Diabetes Res Care 2015;3:e000108.