

Dietary Management of Diabetes Mellitus with Focus on Nigeria

Nwawuba Stanley Udogadi¹, Nwozo Sarah Onyenibe¹, Mohammed Khadija Abdullahi²

¹ Nutritional and Industrial Biochemistry, Department of Biochemistry, College of Medicine, University of Ibadan, Ibadan, Oyo State, Nigeria, 200005.

² Molecular Drug Metabolism and Toxicology, Department of Biochemistry, College of Medicine, University of Ibadan, Ibadan, Oyo State, Nigeria, 200005.

Conflict-of-interest statement: The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

Open-Access: This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

Correspondence to: Nwawuba Stanley Udogadi, Nutritional and Industrial Biochemistry, Department of Biochemistry, College of Medicine, University of Ibadan, Ibadan, Oyo State, Nigeria, 200005.
Email: nwawubastanley@gmail.com
Telephone: +234-8065699068

Received: January 7, 2018

Revised: April 7, 2018

Accepted: April 10, 2018

Published online: May 12, 2019

ABSTRACT

Nutrition/Diet remains a key player in diabetes prevention and management, and rightly so, one of the focuses of international diabetes federation centers on healthy eating as a key factor in the management of type-1-diabetes, the prevention of type 2 diabetes and other related complications. Importantly, knowledge of the glycemic index (GI) of food types is essential for rational advice on calorie recommendation, and the quality of dietary fats and carbohydrates consumed is more crucial than the quantity of these macronutrients. In this light, of course, evidences from prospective observational studies, clinical trials and experimental findings have demonstrated

the crucial role of dietary approach in the management of diabetes mellitus and regardless of the evident role of dietary approach, studies still revealed a low adherence to dietary recommendation among diabetic patients in Africa. Thus, this review aims to explore this issue.

Key words: Diabetes Mellitus; Diabetes in Nigeria; Diabetes and Nutrition; Dietary Management

© 2019 The Author(s). Published by ACT Publishing Group Ltd. All rights reserved.

Nwawuba SU, Nwozo SO, Mohammed KA. Dietary Management of Diabetes Mellitus with Focus on Nigeria. *International Journal of Diabetes Research* 2019; 2(1): 26-32 Available from: URL: <http://www.ghrnet.org/index.php/ijhr/article/view/2493>

INTRODUCTION

Diabetes mellitus (DM) is a chronic disorder that is not only assuming pandemic proportions worldwide but also poised to affect the developing countries of the world much more than their developed counterparts. The world prevalence is estimated to increase from 425 million people in 2017 to 629 million by 2045^[1], and in Africa, the number of people with diabetes will increase from 14.2 million in 2015 to 34.2 million in 2040; predominantly populated in some of the region's most populous countries: South Africa, the Democratic Republic of Congo, Nigeria and Ethiopia^[2]. In 2015, diabetes was one of the leading causes of non-communicable diseases (NCD) death, contributing 1.5 million deaths globally^[3,4] and 321,100 deaths in the African region^[2].

Along with urbanization and economic growth, many countries have experienced dietary changes favoring increased caloric consumption^[5,6], and diet is one of the major risk factors of DM. Dietary management is a key cornerstone modality in the attainment of good glycemic control in DM, and of course, dietary management of DM is targeted at improving the overall health by achieving and maintaining optimal nutritional status, attaining good glycemic control and preventing acute and long term complications of DM. The current general recommendation is that carbohydrates should provide between 45%-65% of the daily caloric intake, fat should be 25%-35% of total daily calories and protein should be

15%-20% of total daily calories^[7,8]. In Nigeria, there is a delusion particularly amongst the diabetic populace that consumption of carbohydrate foods is usually associated with hyperglycemia; hence the popular view that people with DM should either completely avoid carbohydrates or at best take minimal quantities^[8].

It is a well-known fact that DM, being a metabolic, endocrine disorder, is directly connected to carbohydrate, lipid and protein metabolism. As a result, nutrition therapy forms an integral part of diabetes management and diabetes self - management education^[9]. Medical nutrition therapy has been introduced to guide a systematic and evidence-based approach to the management of diabetes through diet, and its effectiveness has been demonstrated^[10]. Also, most diabetes guidelines recommend starting pharmacotherapy only after first making nutritional and physical activity lifestyle changes, but this is not always followed in practice globally^[11,12]. Additionally, it is commonly believed that diabetes cannot be completely cured, but it may be more easily regulated and controlled with the right diet; and with strict adherence to nutritionist's advice, diabetic patients may be able to significantly improve their quality of life^[9].

Nigeria is mainly an agrarian country^[13], and in the early nineties, not much was known about DM in Nigeria, and traditionally, people related DM to "curses" or "hexes"^[8]. Also, As far back as the beginning of the twentieth century, DM was described by Dr. Cook as being an uncommon disorder in Africa^[8]. The low incidence of DM then, perhaps, is traceable to dietary habit which was predominated with local foods. In this light of course, it is not beyond reach for diabetic patients to sustain a good dietary habit which in turn will improve the diabetic condition. However, the transition from our local foods to processed foods and junks tends to be a key player in poor dietary habit. In recent times, there has been an exponential increase in the number of established fast food, consequently contributing to availability of unhealthy diets with high calorie content and unhealthy fats^[14,6]. Another key component in the food system transition has been the saturation of large chain supermarkets, which displace fresh local food and farm shops and serve as a source of highly processed foods, high-energy snacks, and sugary beverages^[14,6].

Diabetes mellitus (DM) is a diverse group of metabolic disorders that is often associated with a high disease burden in developing countries such as Nigeria^[8]; and most Governments of African countries including Nigeria do not recognize the catastrophic potential of the diabetes epidemic and need to reverse the current trend where DM occupies very low priority in their National Health care agenda, before time runs out^[15]. Additionally, cross-sectional studies in Africa indicate low adherence to dietary recommendation for macronutrients intake, and fruits and vegetables consumption among diabetic patients^[16,17]. Similarly, most physicians are not trained in nutritional interventions and this is a barrier to the counselling of patients^[11,12], and dietary information is often neglected, even though at least modest attention to diet is needed to achieve adequate glycaemic control^[12,18].

Despite several recommendations and a number of scientific findings on the beneficial role of diet in the management of diabetes, there are still reports on the poor adherence to dietary/nutritional recommendations amongst people with DM^[19,20,8], and dietary management as an aspect of DM care is seen as the turf of the nutritionists and as a result, quite a number of physicians have a poor knowhow on dietary counselling^[8]. Thus, this review aims to explore dietary interventions for the management of diabetes mellitus and to highlight various food types suitable for diabetes.

METHODOLOGY

This review was carried out by a comprehensive electronic literature search using PubMed, Google Scholar and google search, using the following key words and their combination: "diabetes and nutrition", "dietary intervention", "diabetes in Nigeria", "glycemic index", "diabetes prevalence" and "dietary recommendation". All works meeting the subject matter were considered, including observational cohort studies, reviews, meta-analyses, organization recommendations, and original articles in animals and humans. Preference was placed on the most recent papers but did not exclude commonly referenced and highly regarded older publications.

Prevalence/Epidemiology of Diabetes in Nigeria

Researchers have raised alarm over the increasing rate of diabetes among Nigerians; saying over 5.5 per cent of the country's population was suffering from the ailment^[21]. According to IDF, an estimated 15.5 (9.8-27.8) million adults aged 20-79 years have diabetes in Africa (AFR), representing a regional prevalence of 2.1 (6%). The highest prevalence of diabetes in AFR is between ages 55 and 64. AFR has the highest proportion of undiagnosed diabetes; over two-thirds (69.2%) of people with diabetes are unaware they have the disease^[1]. Some of AFR's most populous countries have the highest numbers of people with diabetes, including Ethiopia [2.6 (1.1-3.8) million], South Africa [1.8 (1.1-3.6) million], Democratic Republic of Congo [1.7 (1.4-2.1) million], and Nigeria [1.7 (1.2-3.9) million]. About 45.1% of all adults, aged 20-79 years, with diabetes in the region live in these four countries^[1,22] and in terms of mortality, in 2017, more than 298,160 deaths (6% of all mortality) in AFR are attributed to diabetes with the highest percentage of all-cause mortality due to diabetes in age group 30-39. Regardless of the obvious huge burden of diabetes faced in Nigeria, Nigeria is still not listed among African countries with largest percentage of healthcare budget allocation. The countries in sub-Sahara Africa with the largest percentage of healthcare budget allocated to diabetes in 2017 are the Seychelles and Comoros^[1]. However, it is widely perceived that prevalence figures reported by the IDF grossly under-report the true burden of DM in Nigeria, given that they are derived through the extrapolation of data from other countries^[23]. Vis-à-vis morbidity, diabetes contributes to the development of heart failure, stroke, renal disease, pneumonia, bacteremia, and tuberculosis (TB)^[24,25,26,27]; and it is known that people with diabetes are 3 times more likely to develop tuberculosis and approximately 15% of TB globally is thought to have background diabetes as a predisposing factor^[24].

Diabetes has a wide range of prevalence across the country. In the rural areas of Nigeria, diabetes is prevalent in 0%-2% of the population, whereas in the urban regions the figures are much higher at 5%-10%^[13,28,29]. The difference in prevalence values is often seen as a result of westernization and demographic transition and the progressive shift in the population from rural to urban centers^[13].

Diabetes mellitus and nutrition

Nutrition/Diet remains a key player in diabetes prevention and management and rightly so, IDF World Diabetes Day campaign in 2015, focused on healthy eating as one of the key factors in managing type 1 diabetes and preventing type 2 diabetes, and also highlighted that unhealthy dietary practices increases the occurrence of type 2 diabetes, related complications and other NCDs^[1]. In this light, IDF encouraged using research evidence strategically,

adopting an ethical and effective whole-of-society approach in public-private partnership to promote the intake of healthy diet through education and local adaptations of comprehensive lifestyle programs^[1]. Nutrition therapy has long been recognized before the era of modern scientific medicine^[30,31]. Before insulin discovery, a starvation diet of very low caloric content (400-500 calories/day), known as the Allen diet, was commonly used to treat diabetes^[32]. Another diet with extreme carbohydrate restriction to approximately 2% and very high fat to approximately 70% was used by Elliot P. Joslin for managing diabetes in the 1920s^[33], and at that time, diabetes was commonly defined as carbohydrate-intolerance disease^[30,34]. Although a high carbohydrate diet has been frequently questioned as a major contributing factor to poor diabetes control and weight gain, little has changed for the past 3 decades^[35], and after insulin discovery, the amount of carbohydrates in the diabetes diet evidently was increased to a maximum of 35% to 40% of the total daily caloric intake^[30,36].

As reported by^[30], in 1994, the American Dietetic Association used the term “medical nutrition therapy” (MNT) to better articulate appropriate nutrition care and process in diabetes management. However, despite recent progress in pharmacologic management of diabetes, MNT remains a crucial tool for achieving optimal glycemic control^[37]. In the same light, in 2004 WHO/FAO, emphasized that nutritional intervention is an integral part of diabetes management^[6].

Regardless of the crucial role of nutrition in the management of diabetes, studies revealed a low adherence to dietary recommendation for macronutrients intake, and fruits and vegetables consumption among diabetic patients in Africa^[17,38]. In the same regards, Low- and middle-income countries (LMICs) face a rapid change in the nutrition transition toward increases in non-communicable diseases, and the resulting major shifts in diet are toward increased refined carbohydrates, added sweeteners,

edible oils, and animal-source foods, and reduced legumes, other vegetables, and fruits, consequently increasing severity of diabetes in LMICs^[39]. Although, they still remain a controversy around the right class of food for diabetics.

Dietary carbohydrate and Diabetes

The role of carbohydrate in the diet of people living with diabetes is an area of much debate, especially with respect to ideal amounts and types of carbohydrate^[40]. Results from National Diet & Nutrition Survey London as reported by^[41] revealed that in many countries of the world, cereal and cereal products make the largest contribution to daily carbohydrate intake, principally from white bread, pasta and rice and the biggest source of carbohydrate in the diet is in fact not sugar^[41]. Thus, carbohydrate quality is important in terms of glycemic index and fiber, and may have other health benefits; although, the quantity of carbohydrate is a more important predictor of glycemic response^[41]. However, it is worthy to note that these recommendations (Table 1) may not generally be applicable to people living with diabetes in Africa, particular Nigeria, and perhaps due to regional and genetic variation. Also, there is no final or conclusive evidence for an ideal macronutrient proportion for all patients with T2D, but rather, there is an emphasis on individualization of eating plan^[30,42]. Again, when referring to common food carbohydrates, the following terms are preferred: sugars, starch, and fiber. Thus, in view of this, it is important to include foods containing carbohydrate, particularly from whole grains, fruits, vegetables, and low-fat milk in the diet of people with diabetes^[43,44].

Dietary Fats and Diabetes

The role of dietary fat has been long studied as a modifiable variable in the prevention and treatment of diabetes and in general, the type (quality) of fat is more important than the amount (quantity)

Table 1 Recommendations of medical nutrition therapy for diabetes.

	ADA 2016 Recommendations	Benefits
Energy Balance	Recommend reduced energy intake to promote weight loss in overweight/obese adults.	Modest weight loss may improve glycemia, BP, lipids, particularly early in disease process
Carbohydrates	Recommend carbohydrate intake from veggies, fruits, whole grains, legumes and dairy. Avoid other carbohydrate sources, especially those with added fats, sugar and sodium. Substitute foods with lower glycemic load for those with higher load. Consume at least, Fiber: 25 g/day women; 38 g/day men (14 g fiber/1,000 kcals/day) and ≥50% of all grains should be whole grains	Modest improvement in glycemic control
Sucrose, Fructose, Caloric Sweeteners	Recommend minimizing sucrose intake when substituting for starch. Avoid displacing nutrient-dense foods. Limit/avoid sugar-sweetened beverages.	Reduce risk for weight gain and worsening of cardiometabolic profile.
Protein	Diabetes without diabetic kidney disease; No ideal intake to improve glycemic control or CVD risk with emphasis on individual goals. Diabetes and macro-or microalbuminuria; reduction of protein intake below daily allowance of 0.8g/kg body weight not recommended. Do not use carb sources high in protein to treat or prevent hypoglycemia for type 2 diabetes.	No ideal intake to improve glycemic control.
Dietary fats	Recommends alternatives like Mediterranean-style, MUFA-rich eating pattern, < 10% of calories of saturated fats, < 300 mg dietary cholesterol/day of cholesterol, Limit as much as possible Trans-fat, Eat fish (particularly fatty fish) ≥ 2 times/week, and Increase intake of foods with EPA, DHA, ALA rather than low-fat, high carbohydrate in patients with type 2 diabetes	May improve glycemic control, CVD risk factors. Benefits on lipoproteins, CVD prevention, health outcomes.
Alcohol	Recommends daily moderation. Women: ≤ 1 drink/day and Men: ≤ 2 drinks/day	Alcohol consumption may increase risk for delayed hypoglycemia, especially if taking insulin, insulin secretagogues
Micronutrients	Recommends optimizing food choices to meet recommended micronutrient dietary allowance/intake	
Sodium	Recommends Reduced intake to < 2,300 mg/day for Patients with diabetes and hypertension	

Abbreviations: ADA, American Diabetes Association; CDA, Canadian Diabetes Association; DASH, Dietary Approach to Stop Hypertension; GI, glycemic index; BP: blood pressure, MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; SFA, saturated fatty acids.

of fat intake^[30]. This is consistent with the recommendations to limit saturated fat, high fat diet and dietary cholesterol intake as stipulated by the American Diabetes Association^[37,43,45,46]; American Heart Association^[47]; and also as shown in table 1^[37]. Also, the American Diabetes Association in 2004 reported that, persons with diabetes appear to be more sensitive to dietary cholesterol than the general public^[43]. The quality of fat is generally specified by the relative content of saturated fatty acid (SFA), monounsaturated fatty acid (MUFA), and polyunsaturated fatty acids (PUFA), including the proportion or amount of essential fatty acids, that is, linoleic acid (LA) and α -linolenic acid (ALA), as well as the proportion or amount of long-chain n-3 fatty acids (n-3 LCPUFA), that is, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA)^[48]. Fat is a problem for people with diabetes. The more fat there is in the diet, the harder time insulin has in getting glucose into the cells. In the same regard, minimizing fat intake and reducing body fat help insulin do its job much better^[46]. Fatty acids influence glucose metabolism by altering cell membrane function, enzyme activity, insulin signaling, and gene expression^[49]; and fat containing foods may affect the rise in blood sugar and yield a lower GI than similar foods without fat^[50]. Recent evidence suggests that a diet high in healthy fat, rich in unsaturated fatty acids, such as the Mediterranean dietary pattern, may, in fact, prevent the development of metabolic diseases such as type 2 diabetes mellitus, but also reduce cardiovascular events^[51,45].

Dietary Protein and Diabetes

Dietary proteins are important modulators of glucose metabolism^[52]. However, its role in diabetes still remains an issue of debate. Protein-rich foods increase insulin secretion leading to lowering of postprandial blood glucose concentrations^[50]. Contrary, a meta-analysis^[53], observational studies^[54], and original research report^[52] demonstrated that, the intake of total protein and animal protein was associated with a high risk of T2DM. In high animal protein food, red meat, and processed meat were associated with a high risk of T2DM, while total dairy products, low-fat dairy, and yogurt were associated with a low risk of T2DM, and egg and fish were not associated with a decreased risk of T2DM. In high plant protein food, soy was associated with a low risk of T2DM^[53,54,52].

Examining the role of dietary protein and establishing intake guidelines among individuals with diabetes is complex^[55]. The 2014 American Diabetes Association (ADA) recommends (Table 1) an

individualized approach to protein intake and among individuals with impaired renal function, the ADA recommends reducing protein intake to 0.8-1.0 g/kg per day in earlier stages of chronic kidney disease (CKD) and to 0.8 g/kg per day in the later stages of CKD^[37,55,46].

A key factor in choosing food type for diabetes; Glycemic index

The glycemic index identifies foods that increase blood sugar rapidly. This handy tool allows for selecting suitable foods that have much less effect on blood sugar levels^[46]. The glycemic index (GI) is a measure of the change in blood glucose following ingestion of carbohydrate-containing foods^[43]. Glycemic load (GL) reflects more accurately, the glycemic effect, and has been defined as the product of the GI of a particular food item and the available carbohydrate content. Thereby, the potential glycemic effect of a meal may be altered by changing either the GI or the carbohydrate content, consequently affecting the GL^[41]. Even though the simple sugar is readily absorbed into the blood stream, resulting in blood sugar elevation, it should still not be the only consideration while making dietary choices for people living with diabetes. In the same regard, the quantity of available carbohydrate in the diet is also a crucial consideration.

Knowledge of the glycemic index (GI) of food types is essential for rational advice on calorie recommendation^[56]. Glycemic index is rated on 1 to 100. Foods which raises the blood glucose quickly after meal are known as high glycemic index meals and they are assigned a value of 70 and above, Medium- GI = 56-69 %, while foods which releases glucose slowly into the blood stream are known as low GI foods and their values are 55 and below^[57,58]. Low GI foods reduce postprandial blood glucose levels and this knowledge can be used in recommending and planning meals for people living with diabetes^[59,60,58]. It is apparent that food meal type with high glycemic index classification (Table 2) should not be encouraged in the dietary plan for people with diabetes. However, food meals with intermediate GI may sparingly be allowed.

Foods for the management of diabetes mellitus in Nigeria

The need for functional foods that promote healthy status, including diabetes mellitus is pertinent, going by the increasing prevalence of DM particularly in Nigeria. Some of these functional foods (table 3) commonly used in Nigeria can be incorporated into the dietary plan for people living with diabetes so as to attenuate hyperglycemia

Table 2 Glycemic index of commonly consumed Nigerian food

SN	Food Type	Serving Size (g)	(GI)	(GL)	Mode of Analysis	Classification	Health Status	Authors
1	Agidi (Maize)	373.13	92.30±0.05	46.15±3.1	FBS/Postprandial response	High	Healthy Persons	[61]
2	Tuwo Shinkafa (Rice)	160.9	95.30±1.25	47.65±2.2	FBS/Postprandial response	High	Healthy Persons	[61]
3	Yam Flour	280	49.81±10.38	–	FBS/Postprandial response	Low	Diabetic	[56]
4	Cassava Flour	205	59.34±32.42	–	FBS/Postprandial response	Intermediate	Diabetic	[56]
5	Maize Flour	250	54.83±26.74	–	FBS/Postprandial response	Low	Diabetic	[56]
6	Akara (beans)	180	43.7	23.59	FBS/Postprandial response	Low	Healthy Persons	[62]
7	MoiMoi (Beans)	180	41.14	17.71	FBS/Postprandial response	Low	Healthy Person	[62]
8	Abacha (cassava)	167	84.88	–	FBS/Postprandial response	High	Healthy Persons	[63]
9	Fufu (cassava)	205	84.06	–	FBS/Postprandial response	High	Healthy Persons	[63]
10	Garri (cassava)	169	92.36	–	FBS/Postprandial response	High	Healthy Persons	[63]
11	Boiled Rice	169	56	–	FBS/Postprandial response	Intermediate	Healthy Persons	[64]
12	Boiled Yam	163	58	–	FBS/Postprandial response	Intermediate	Healthy Persons	[64]
13	Sweet Potatoes	205	62	–	FBS/Postprandial response	Intermediate	Healthy Persons	[64]
14	Amala (Yam)	50	36.8±7	–	FBS/Postprandial response	Low	Healthy Person	[65]

Abbreviations: FBS: Fasting blood sugar, GI: Glycemic Index, GL: Glycemic Load.

Table 3 Readily available foods for the management of diabetes in Nigeria

S/N	Food Types	Diagnosis	Type of DM	Mode of Action	Authors
1	Oat	FBS, HOMA-IR Index & lipid profile	Type 2	Contains β-glucan which modulates deregulations associated with the metabolic syndrome. Decreases in FBSL, reduces resistant to insulin and improves lipid profile status.	[66, 67]
2	Brown Rice	FBS, GI	Type 2	Reduction of FBSL and demonstrated a low glycemic index	[68]
3	Millet	FBS & lipid profile.	Type 1	Contains high amount of magnesium which helps to increase the levels of adiponectin hormone. Reduces blood sugar levels and enhances lipid profile levels	[69]
4	Okra	FBS, Lipid profile, HOMA-IR Index, PPAR-γ and PPAR-α mRNAs expression.	Type 2	Down-regulates PPARs genes, attenuates HOMA-IR, stabilizes lipid profile status, improves glucose homeostasis and β-cells impairment in diabetes through a PPAR-dependent mechanism.	[70]
5	Sorghum	OGTT, serum glucose conc, insulin levels, PPAR-α, TNF-α & adiponectin expression, lipid profile	Type 2	Improves insulin sensitivity via (PPAR-γ) from adipose tissue, down-regulates of TNF- α, up-regulates adiponectin, and improves lipid profile status.	[71]
6	Soybean	FBS, postprandial glucose, lipid profile & HbA1C	Type 2	Lowers FBS levels, improves lipid profile status and attenuates HbA1C levels.	[72]
7	Unripe Plantain	FBS	Type 1	Aids reduction in blood sugar levels	[73]
8	Bitter leaf	Blood glucose, PFK, HK, & G6PDH genes.	Type 1	simultaneous suppression of gluconeogenesis and potentiation of glucose oxidation via PPP pathway, almost exclusively in the liver	[74]

Abbreviations: FBS: Fasting blood sugar, HOMA-IR: Homeostatic model assessment and insulin resistance, GI: Glycemic Index, OGTT: Oral glucose tolerant test, PPAR-γ: peroxisome proliferator-activated receptor gamma, TNF-α: Tumor necrotic factor alpha, HbA1C: Glycated hemoglobin, PFK: Phosphofruktokinase, HK: Hexokinase, G6PDH: Glucose 6 phosphate dehydrogenase.

and enhance the effectiveness of the conventional medication for the management of diabetes. The importance of dietary intervention cannot be over emphasized, as diet plays a critical role in DM.

Recommendations

Dietary intervention being a key factor in the management of diabetes, we recommend that producers of all marketed processed/ consumable food items in Nigeria should clearly state the glycemic index as part of the nutritional information. Furthermore, dietary management as an aspect of DM care is seen as the turf of the nutritionists and as a result, quite a number of physicians have a poor knowhow on dietary counselling. In this regard, we recommend that professional Nutritionist should be made available at least in local government areas so as to sensitize the general public, retrain health practitioners, and make recommendations on the nutritional needs, especially for those living with DM.

CONCLUSION

Investment in effective diabetes prevention and management has become necessary to battle this global epidemic. It is clear that most of the recommendation for dietary management of diabetes was rationalized by international bodies and as such, a call for various umbrellas of diabetes organizations in Nigeria to further expand research in this regard and consequently stipulate indigenous recommendations to better suit the increasing diabetes population, rather than continual dependence on foreign bodies.

REFERENCES

1. International Diabetes Federation. Diabetes atlas. 8th ed. Brussels: International Diabetes Federation. 2017. Available at www.diabetesatlas.org
2. International Diabetes Federation. Diabetes atlas. 7th ed. Brussels: International Diabetes Federation. 2015. Available at http://www.diabetesatlas.org.
3. Mutyambizi C, Milena P, Lumbwe C, Charles H, and Wim G. Cost of diabetes mellitus in Africa: a systematic review of existing literature. *Global Health* 2018; **14(1)**: 1-13. [PMID: 29338746]; [DOI: 10.1186/s12992-017-0318-5]
4. Wang H, Naghavi M, Allen C, Barber RM, Bhutta ZA, Carter A, et al. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980-2015: a systematic analysis for the global burden of disease study 2015. *Lancet* 2016; **388(10053)**: 1459-544. [PMID: 27733281]; [DOI: 10.1016/S0140-6736(16)31012-1]
5. Hu FB. Globalization of diabetes: the role of diet, lifestyle, and genes. *Diabetes Care* 2011; **34(6)**: 1249-57. [PMID: 21617109]; [DOI: 10.2337/dc11-0442]
6. Ley SH, Hamdy O, Mohan V, and Hu FB. Prevention and management of type 2 diabetes: dietary components and nutritional strategies. *Lancet* 2014; **383(9933)**: 1999-2007. [PMID: 24910231]; [DOI: 10.1016/S0140-6736(14)60613-9]
7. Franz MJ, Powers MA, Leontos C, Holzmeister LA, Kulkarni K, Monk A, et al. The evidence for medical nutrition therapy for type 1 and type 2 diabetes in adults. *J Am Diet Assoc* 2010; **110**: 1852-1889. [PMID: 21111095]; [DOI:10.1016/j.jada.2010.09.014]
8. Ogbera AO and Ekpebegh C. Diabetes mellitus in Nigeria: The past, present and future. *World J Diabetes* 2014; **5(6)**: 905-911. [PMID: 25512795]; [DOI: http://dx.doi.org/10.4239/wjd.v5.i6.905]
9. Folorunso O and Oguntibeju O. The Role of Nutrition in the Management of Diabetes Mellitus. *Diabetes Mellitus - Insights and Perspectives*. Publisher: INTECH, 2013; Chapter 5: pp.84 - 94. [DOI: http://dx.doi.org/10.5772/48782]
10. Pastors JG, Warshaw H, Daly A, Franz M, Kulkarni K. The evidence for the effectiveness of medical nutrition therapy in diabetes management. *Diabetes Care* 2002; **25(3)**: 608-613. [PMID: 11874956]; [DOI: 10.2337/diacare.25.3.608]
11. Lianov L and Johnson M. Physician competencies for prescribing lifestyle medicine. *JAMA* 2010; **304**: 202-3. [PMID: 20628134]; [DOI: 10.1001/jama.2010.903]
12. Kahan S and Manson JE. Nutrition counseling in clinical practice: how clinicians can do better. *JAMA* 2017; **318**: 1101-2. [PMID: 28880975]; [Doi:10.1001/jama.2017.10434].
13. Fasanmade OA, Dagogo-Jack S. Diabetes Care in Nigeria. *Annals of Global Health* 2015; **81(6)**: 821-829. [DOI: 10.1016/j.aogh.2015.12.012]
14. Popkin BM, Adair LS, and Ng SW. Global nutrition transition

- and the pandemic of obesity in developing countries. *Nutr Rev* 2012; **70(1)**: 3-21. [PMID: 22221213]; [DOI: 10.1111/j.1753-4887.2011.00456.x.]
15. Oguejiofor O, Odenigbo C, and Onwukwe C. Diabetes in Nigeria: Impact, Challenges, Future Directions. *Endocrinol Metab Syndr* 2014; **3(2)**: 1-9. [DOI:10.4172/2161-1017.1000130]
 16. WHO/FAO. Promoting fruits and vegetables consumption around the world. A joint meeting of WHO/FAO on fruits and vegetables for health improvement kobe, Japan. 2004.
 17. Oladapo AA, Jude-Ojei BS, Koleosho AT, and Roland-Ayodele MA. Nutritional status and Food consumption pattern of Diabetics in owo, Nigeria. *IJRRAS* 2013; **17(2)**: 207-211.
 18. England CY, Andrews RC, Jago R, Thompson JL. A systematic review of brief dietary questionnaires suitable for clinical use in the prevention and management of obesity, cardiovascular disease and type 2 diabetes. *Eur J Clin Nutr* 2015; **69**: 977-1003. [PMID: 25711954]; [DOI: 10.1038/ejcn.2015.6]
 19. Abioye-Kuteyi EA, Ojofeimi EO, Ijadunola KT, Fasanu AO. Assessment of dietary knowledge, practices and control in type 2 diabetes in a Nigerian teaching hospital. *Niger J Med* 2005; **14(1)**: 58-64. [PMID: 15832645]
 20. Ntui I, Udoh AE, Esiere KS, Essien O, and Egbe ER. The Pattern of Dietary Habits and Glycemic Control of Diabetics in Eastern Nigeria. *PJN* 2006; **5**: 43-45. [DOI: 10.3923/pjn.2006.43.45]
 21. Ochuko A. Over 5.5 per cent Nigerians suffering from diabetes--Researchers. Accessed November 21, 2018. Available at <https://www.vanguardngr.com/2018/06/5-5-per-cent-nigerians-suffering-diabetes-researchers/>.
 22. World Health Assembly. Follow-up to the Political Declaration of the High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases. Geneva: World Health Organization; 2013.
 23. Uloko AE, Baba MM, Mansur A, Ibrahim D, Fabian H, Ayekame T. et al. Prevalence and Risk Factors for Diabetes Mellitus in Nigeria: A Systematic Review and Meta-Analysis. *Diabetes Ther* 2018; **9**: 1307-1316. [PMID: 29761289]; [DOI: <https://doi.org/10.1007/s13300-018-0441-1>]
 24. Dahiru T, Aliyu AA, and Shehu AU. A review of population-based studies on diabetes mellitus in Nigeria. *Sub-Saharan Afr J Med* 2016; **3**: 59-64. [DOI: 10.4103/2384-5147.184351]
 25. Ogbera AO, Fasanmade O, and Ohwovoriole AE. An assessment of the disease burden of foot ulcers in patients with diabetes mellitus attending a teaching hospital in Lagos, Nigeria. *Int J Low Extrem Wounds* 2006; **5(4)**:244-9. [PMID: 17088600]; [DOI: 10.1177/1534734606294538]
 26. Saydah SH, Eberhardt MS, Loria CM, and Brancati FL. Age and the burden of death attributable to diabetes in the United States. *Am J Epidemiol* 2002; **156**: 714-9. [PMID: 12370159]
 27. Jeon CY, and Murray MB. Diabetes mellitus increases the risk of active tuberculosis: A systematic review of 13 observational studies. *PLoS Med* 2008; **5**:e152. [PMID: 18630984]; [DOI: 10.1371/journal.pmed.0050152]
 28. Sabir A, Ohwovoriole A, and Isezuo S. Type 2 diabetes mellitus and its risk factors among the rural Fulanis of Northern Nigeria. *Ann Afr Med* 2013; **12(4)**:217-22. [PMID: 24309410]; [DOI: 10.4103/1596-3519.122689]
 29. Nyenwe EA, Odia OJ, Ihekawaba AE, Ojule A, Babatunde S. Type 2 diabetes in adult Nigerians: a study of its prevalence and risk factors in Port Harcourt, Nigeria. *Diabetes Res Clin Pract* 2003; **62(3)**: 177-85. [PMID: 14625132]
 30. Osama Hamdy and Mohd-Yusof BN. Nutrition in Diabetes. Clinical review article (Elsevier) 2016; **45(4)**: 799-817. [<https://doi.org/10.1016/j.ecl.2016.06.010>]
 31. Evert AB, Boucher JL, Cypress M. Nutrition therapy recommendations for the management of adults with diabetes. *Diabetes Care* 2013; **36(11)**: 3821-42. [PMID: 24107659]; [DOI: 10.2337/dc13-2042]
 32. Allen F. Studies concerning diabetes. *J Am Med Assoc* 1914; **13(11)**: 939.
 33. Hockaday TD. Should the diabetic diet be based on carbohydrate of fat restriction?. In: Turner M, Thomas B, editors. Nutrition and diabetes. London. Libbey; 1981; p. 23-32.
 34. Joslin EP. 5th edition. A diabetic manual for the mutual use of doctor and patient, vol. 26. Philadelphia: Lea & Febiger; 1934.
 35. Feinman RD, Pogozelski WK, and Astrup A. Dietary carbohydrate restriction as the first approach in diabetes management: critical review and evidence base. *Nutrition* 2014; **31(1)**: 1-13. [PMID: 25287761]; [DOI: 10.1016/j.nut.2014.06.011. Epub 2014 Jul 16]
 36. Kannel WB, and McGee DL. Diabetes and glucose tolerance as risk factors for cardiovascular disease: the Framingham study. *Diabetes Care* 1979; **2(2)**: 120-6. [PMID: 520114]
 37. American Diabetes Association. Foundations of care and comprehensive medical evaluation. *Diabetes Care* 2016; **39(Suppl 1)**:S23-35.
 38. Pomerleau J and Knai M. Intervention designed to increase adult fruit and vegetable intake can be effective. *Journal of Nutrition* 2005; **135(10)**:2486-95. [PMID: 16177217]; [DOI: 10.1093/jn/135.10.2486]
 39. Popkin MB. Nutrition Transition and the Global Diabetes Epidemic. *Curr Diab Rep* 2015; **15(9)**: 64. [PMID: 26209940]; [DOI:10.1007/s11892-015-0631-4]
 40. Mann J and Morenga LT. Carbohydrates in the treatment and prevention of type 2 diabetes. *Diabet Med* 2015; **32(5)**: 572-5. [PMID: 25510817]; [DOI: 10.1111/dme.12673]
 41. Mcardle DP, Duane M, Sian R and Julie Taplin. The role of carbohydrate in diabetes management. *Practical Diabetes* 2016; **33(7)**: 237-242. [DOI:<https://doi.org/10.1002/pdi.2048>]
 42. Canadian Diabetes Association. Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association clinical practice guidelines for the prevention and management of diabetes in Canada. *Can J Diabetes* 2013; **37 (Suppl 1)**: S1-212.
 43. American Diabetes Association. Nutrition Principles and Recommendation in Diabetes. *Diabetic Care*. 2004; Vol: 27 no suppl 1536.
 44. Ye EQ. Greater whole-grain intake is associated with lower risk of type 2 diabetes, cardiovascular disease, and weight gain. *J Nutr* 2012; **142(7)**: 1304-13. [PMID: 22649266]; [DOI: 10.3945/jn.111.155325]
 45. American Diabetes Association. Obesity management for the treatment of type 2 diabetes: Standards of Medical Care in Diabetes-2018. *Diabetes Care* 2018; **41(Suppl. 1)**: S65-S72
 46. Mohammad Asif. The prevention and control the type-2 diabetes by changing lifestyle and dietary pattern. *Journal of education and health promotion* 2014; **3(1)**: 1-5. [PMID: 24741641] [DOI:10.4103/2277-9531.127541]
 47. Fox CS, Golden SH, and Anderson C. Update on prevention of cardiovascular disease in adults with type 2 diabetes mellitus in light of recent evidence: a scientific statement from the American Heart Association and the American Diabetes Association. *Diabetes Care* 2015; **38(9)**: 1777-803. [PMID: 26246459]; [DOI: 10.2337/dci15-0012]
 48. Ursula S, Lotte L, Tine T, Thorhallur I, Ulf R, Matti U et al. Effect of the amount and type of dietary fat on cardiometabolic risk factors and risk of developing type 2 diabetes, cardiovascular diseases, and cancer: a systematic review. *Food & Nutrition Research* 2014; **58**: 25145. [PMID: 25045347]; [DOI: 10.3402/fnr.v58.25145]
 49. Risérusa Ulf, Walter CW, and Frank BH. Dietary fats and prevention of type 2 diabetes. *Prog Lipid Res* 2009; **48(1)**: 44-51. [PMID: 19032965]; [DOI: 10.1016/j.plipres.2008.10.002]
 50. Eleazu CO. The concept of low glycemic index and glycemic load foods as panacea for type 2 diabetes mellitus; Prospects, challenges and solutions. *Afri Health Sci* 2016;**16(2)**: 468-479. [PMID: 27605962]; [DOI: 10.4314/ahs.v16i2.15]

51. Hayley EB, Salvatore C and Carl JL. Dietary Fats and Chronic Noncommunicable Diseases. *Nutrients* 2018; **10(10)**: 1385. [PMID: 30274325]; [DOI: 10.3390/nu10101385]
52. Malik SV, Yanping L, Deirdre KT, An P and Frank BH. Dietary Protein Intake and Risk of Type 2 Diabetes in US Men and Women. *American Journal of Epidemiology* 2015; **183(8)**: 715-728. [PMID: 27022032]; [DOI: 10.1093/aje/kwv268]
53. Shuang T, Qian X, Ruyue J, Tianshu H, Changhao S and Lixin N. Dietary Protein Consumption and the Risk of Type 2 Diabetes: A Systematic Review and Meta-Analysis of Cohort Studies. *Nutrients* 2017; **9(9)**: 982. [PMID: 28878172]; [DOI: 10.3390/nu9090982]
54. Comerford BK and Gonca P. Protein Source on Glucoregulatory Markers and Type 2 Diabetes: Different Effects of Dairy, Meat, Fish, Egg, and Plant Protein Foods. *Nutrients* 2016; **8(446)**: 1-18. [PMID: 27455320]; [DOI:10.3390/nu8080446.]
55. Beasley MJ and Judith WR. The Role of Dietary Proteins among Persons with Diabetes. *Curr Atheroscler Rep* 2013; **15(9)**:348. [PMID: 23881544]; [DOI: 10.1007/s11883-013-0348-2]
56. Fasanmade AA, and Anyakudo MMC. Glycemic Indices of selected Nigerian Flour Meal Products In Male Type 2 Diabetic Subjects. *Diabetologia Croatica* 2007; **36(2)**: 33-38.
57. Ogbonna OC, Fadeiye EO, Ikem RT, Oladipo KO, Soyoye DO, Olulana TM et al. Blood glucose response on consumption of cassava varieties (Garri) in healthy Nigerian subjects. *J Nutr Hum Health* 2018; **2(1)**: 22-27.
58. Famakin O, Akindele F, Oluwole S, Adebajo AB, and Tayo NF. Assessment of nutritional quality, glycaemic index, antidiabetic and sensory properties of plantain (*Musa paradisiaca*)-based functional dough meals. *J Food Sci Technol* 2016; **53(11)**: 3865-3875. [PMID: 28035142]; [DOI 10.1007/s13197-016-2357-y]
59. Hermansen MF, Nina MBE, Lene SM, Lotte H, and Kjeld H. Can the Glycemic Index (GI) be used as a tool in the prevention and management of type 2 diabetes? *Rev Diabet Stud* 2006; **3**:61-71. [PMID: 17487328]; [DOI: 10.1900/RDS.2006.3.61]
60. Agama-Acevedo E, Islas-Herna'ndez JJ, Pacheco-Vargas G, Osorio- Di'az P, Bello-Pe'rez LA. Starch digestibility and glycemic index of cookies partially substituted with unripe banana flour. *LWT Food Sci Technol* 2012; **46**:177-182
61. Omeregbe ES and Osagie AU. Glycemic Indices and Glycemic load of some Nigerian foods. *Pakistan Journal of Nutrition* 2008; **7(5)**: 710-716. [DOI: 10.3923/pjn.2008.710.716]
62. Akinlua O, Sedodo NS, and Victoria AJ. Glycemic Index of Selected Nigerian Foods for Apparently Healthy People. *J Obes Wt Loss Ther* 2013; **3**: 160. [DOI: 10.4172/2165-7904.1000160]
63. Ogbuji CA and David-Chukwu NP. Glycemic Indices of Different Cassava Food Products. *European Journal of Basic and Applied Sciences* 2016; **3(3)**: 1-7.
64. Okafor EN, Onyechi AU, Ozumba ON, Kayode OF, and Asieba GO. Glycemic Index of some commonly consumed staples in Nigeria. *Pakistan Journal of Nutrition* 2011; **10(11)**: 1058-1060. [DOI: 10.3923/pjn.2011.1058.1060]
65. Jimoh AK, Adediran SO, Adebisi SA, Akande AA, Olarinoye JK, and Okesina AB. Glycaemic response to different preparations of yam in diabetic and non-diabetic Nigerians. *Mera: Diabetes International* 2008; 19.
66. Schuster J, Gabriela B, Renata V, and Simone M. Effects of oats on lipid profile, insulin resistance and weight loss. *Nutr Hosp* 2015; **32(5)**: 2111-2116. [PMID: 26545667]; [DOI:10.3305/nh.2015.32.5.9590]
67. Othman RA, Moghadasian MH, and Jones PJ. Cholesterol-lowering effects of oat β -glucan. *Nutr Rev* 2011; **69(6)**: 299-309. [PMID: 21631511]; [DOI: 10.1111/j.1753-4887.2011.00401.x.]
68. Panlasigui NL, and Thompson UL. Blood glucose lowering effects of brown rice in normal and diabetic subjects. *International Journal of Food Sciences and Nutrition* 2006; **57(3/4)**: 151-158. [PMID: 17127465]; [DOI: 10.1080/09637480500410879]
69. Sada NH, Tanko Y, Gidado NM. and Mohammed A. Antidiabetic Effect of Fermented Pennisetum Glaucum (Millet) Supplement in Alloxan Induced Hyperglycemic Wistar Rats. *Bayero Journal of Pure and Applied Sciences* 2016; **9(1)**: 138-141. [DOI: 10.4314/bajopas.v9i1.21]
70. Erfani MN, Tabandeh MR, Shahriari A, and Soleimani Z. Okra (*abelmoscus esculentus*) improved islets structure, and down-regulated PPARs gene expression in pancreas of high-fat diet and streptozotocin-induced diabetic rats. *Cell J* 2018; **20(1)**: 31-40. [PMID: 29308616]; [DOI: 10.22074/cellj.2018.4819]
71. Ji HP, Sun HL, Ill-Min C and Yongsoon P. Sorghum extract exerts an anti-diabetic effect by improving insulin sensitivity via PPAR- γ in mice fed a high-fat diet. *Nutrition Research and Practice (Nutr Res Pract)* 2012; **6(4)**: 322-327. [PMID: 22977686]; [DOI: 10.4162/nrp.2012.6.4.322.
72. Ji HC, Min SK, Tae WK and Sang SL. Effects of soybean supplementation on blood glucose, plasma lipid levels, and erythrocyte antioxidant enzyme activity in type 2 diabetes mellitus patients. *Nutrition Research and Practice* 2008; **2(3)**: 152-157. [PMID: 20126600]; [DOI: 10.4162/nrp.2008.2.3.152]
73. Iroaganachi M, Eleazu CO, Okafor PN and Nwaohu N. Effect of Unripe Plantain (*Musa paradisiaca*) and Ginger (*Zingiber officinale*) on Blood Glucose, Body Weight and Feed Intake of Streptozotocin-induced Diabetic Rats. *The Open Biochemistry Journal* 2015; **9**: 1-6
74. Atangwho IJ, Khoo BY, Muhammad IU, Mariam A and Mohd ZA. Vernonia amygdalina simultaneously suppresses gluconeogenesis and potentiates glucose oxidation via the pentose phosphate pathway in streptozotocin-induced diabetic rats. *BMC Complementary and Alternative Medicine* 2014; **14(426)**: 1-13. [DOI: 10.1186/1472-6882-14-426]