Nigerian Journal of Health Promotion
ISSN: 0995-3895
Vol. 10, 2017

The Role of Nutrition Education in Management of Diabetes Mellitus

Afoke Eunice Nwafor and Omaka-Amari Lois Nnenna
Department of Huma Kinetics and Health Education, Ebonyi State University Abakaliki

Abstract
Nutrition therapy occupies a very important position in health care delivery. This is because most non-communicable diseases such as hypertension, diabetes and malnutrition among others can be prevented and controlled through proper nutrition. This paper thus focuses on the role of nutrition education in the management of diabetes mellitus. The use of nutrition in diabetes management aims at preventing the disease, managing existing condition as well as reducing the rate of developing complications. The general guidelines for individuals with all types of diabetes is to achieve and maintain a reasonable body weight by adoption of healthy food choices from carbohydrates, proteins, vitamins, fats and oil, mineral salts and roughages . The introductory aspect of the paper gave an overview of the concept of diabetes mellitus capturing its prevalence in Nigeria, definition, types, signs and symptoms and complications. The paper also discusses the role of nutrition education in diabetes management by articulating its usefulness in enhancing diabetic patient's knowledge, attitude and compliance to nutritional recommendations. Numerous nutritional teachings which should form part of nutrition education programme were identified and discussed. These include teachings on carbohydrate counting and portion sizes, reduction of saturated fatty acid and cholesterol consumption, balanced meal, dietary integration of insulin therapy, alcohol use in diabetes and nutritional guide for specific population. Important teaching Tips in diabetes nutrition education are also presented. The paper concludes that diabetes nutrition education is a vital tool in diabetes management and thus should be geared towards meeting individual nutritional needs of diabetics. Finally, the paper recommends among others that health care providers should focus on nutrition counseling rather than micronutrient supplementation in diabetic patients and diabetes nutrition education should be individualized.
Key words: Diabetes, Management, Education and Nutrition

Introduction

Diabetes Mellitus (DM) is one of the major health threats in the world. The world prevalence of the disease especially among adults above 18 years has increased from 4.7 per cent in 1980 to 8.5 per cent in 2014 (WHO, 2016). In 2016 the International Diabetes Federation (IDF) reported 415 million cases of diabetes in the world, and a projected 600.5 million cases by 2040 (Pidduck, 2016). It has also been estimated that by 2030 diabetes will become the seventh leading cause of mortality in the world. This increase in the prevalence of diabetes is reportedly more in countries with low to middle income status such as Nigeria (World Health Organization-WHO, 2016). Diabetes is a crippling and deadly disease which can affect all ages. In addition to premature death, diabetes can lead to stroke, kidney disease, blindness and amputation of limb. It reduces life expectancy and productivity as a result of disability, illness, sudden retirement and death (D'Cunha, 2012; WHO, 2016).

Diabetes Mellitus (DM) has been described as a disease which suggests the body's inability to either produce sufficient insulin-type 1 or to use it efficiently-type 2 (D'Cunha, 2012). Ludvigson & Afoke (1989); & Oyebola (2004) conceived Diabetes (DM) as a heterogeneous group of disorders characterized by a deficiency of insulin in the circulatory system or of its actions at the tissue level. Karam (1991) defined DM as a syndrome with disordered metabolism and inappropriate hyperglycemia due to either an absolute deficiency of insulin secretion or a reduction in its biological effectiveness or both. It is a chronic disease that results either when the pancreas is unable to produce enough insulin or when the body cannot effectively use the insulin it produces (WHO, 1999). A common factor which reflects in almost all the definitions of diabetes as stated above is the function of insulin being compromised either because of lack of it or due to ineffectiveness of circulating insulin at the level of the tissues. Operationally, Diabetes for this paper remains a metabolic disorder in which insulin is no longer produced in sufficient amount or that the action is decreased, resulting in excess blood glucose in the human body. Insulin is one of the body hormones which is needed for the absorption and utilization of sugar as a fuel for the body cells. When insulin signaling system fails to function appropriately, the resultant effect is an increase in blood sugar levels accompanied by other metabolic abnormalities and disabling complications (Healthy People, 2016).

There are two major types of diabetes mellitus namely, type1 (insulin-dependent) or juvenile-onset and type 2 (non-insulin dependent) or adult diabetes. The type1 diabetes also known as classical form often starts at childhood at about age 8 or 12. This type of diabetes develops when the body is unable to produce sufficient insulin *(*Griffin, 2013). Type 2 on the other hand usually begins from age 40 and is often associated with obesity.

This type which is usually called non-insulin dependent or adult onset occurs due to the body's inability to effectively use insulin (WHO, 1999). Although this is the most common form of diabetes its negative health consequences can be prevented and delayed (Santos-Longhurst, 2014). A third type of diabetes mellitus is Malnutrition Related Diabetes Mellitus (MRDM) which affects the poor people (Ahuja, 1986, Afoke, 2015).

The cardinal signs and symptoms of diabetes are polyuria (excessive passage of urine), polydipsia (excessive thirst), polyphagia (excessive hunger), nocturia, rapid weight loss and hyperglycemia especially in the classical DM and MRDM (Karam, 1991). Ezeilo (2005) included air-hunger and ketosis (a metabolic state in which some of the body's energy supply comes from ketone bodies in the blood) as the hallmarks of type 1 DM. This author further stated that the catabolism of protein which is associated with water and electrolytes within cells leads to the release of potassium (K) and magnesium (Mg^2ion) into the extra- cellular fluid (ECF) in addition to nitrogen which results to increased loss of potassium and magnesium in urine. MRDM usually shows additional signs and symptoms such as intraductal calculi, pancreatitis and calcifications but no Ketosis (Oli, 1980). Others are skin and hair changes, parotid gland enlargement, cachectic appearance and abdominal pain (Abdulkadir, 1987). High resistance to insulin treatment which increases insulin requirement in MRDM compared to classical type1 diabetes mellitus makes the cases of the poor people that suffer from this aberrant form of diabetes more difficult (Afoke, 2015).

Complications in the classical diabetic patients are production of few number of functioning islet B cells with measurable levels of insulin at diagnosis, indicated by their level of C-peptide at diagnosis. However, the few remaining and functioning islet B cells at diagnosis of the disease totally degenerate within 10 years, causing almost total absence of insulin thereafter (Ludvigson & Afoke, 1989; Elamin, Abahir & Tuvemo, 1992; Karam, 1991). With the cessation of endogenous insulin production, the circulation of energy giving substances like glucose and fats increases and are easily deposited at critical areas of the body where they cause complications (Oyebola, 2004; Ezeilo, 2005). These diabetes complications include; ischaemic heart disease, nephropathy, hypertension, cerebrovascular disease and peripheral vascular disease. Other complications are; retinopathy, maculopathy and cataract, limited joint mobility, soft tissue thickening, neuropathy and infections. The damages caused by the complications on the various organs and systems of the body after many years of DM are the main concern (Afoke, 2015).

Till date, diabetes has no cure and when not properly managed could result in severe complications and death (Pietrangelo & Cherney, 2017). Among ten diabetic patients, four are likely to develop long-term complications and the resultant effects of complications of diabetes are responsible for the high social and economic burdens associated with the disease (WHO, 2016). Although diabetes remains a serious life threat, with appropriate management the negative outcome of the disease can be prevented and life of the victim prolonged (WHO, 2016). An important means of reducing the general burden of diabetes is through the adoption of simple lifestyle measures such as good nutrition. Just a slight change in lifestyle activities such as physical activity and diet has the potential of providing long-term benefits for the individual. Eating healthy diet, reducing sugar and fat intake as well as avoidance of smoking and high alcohol consumption are some nutritional steps that could help to avert diabetes and its severe health outcomes (D'Cunha, 2012). Phyllis & Stacy (2010) observed that the human body is a complex organism that has the ability to heal itself if well diagnosed and responded to with proper nourishment and care. Healthy eating is particularly important for both children and adult as this helps to reduce obesity and consequently DM with its associated complications (American Diabetes Association, 2016). To reduce the negative outcome of diabetes and other nutrition related diseases, Phyllis & Stacy (2010) emphasized the need of involving nutrition education in developing society in order to help individuals acquire more knowledge about nutritional diseases for prevention, health promotion and longevity.

This paper therefore addresses the role of nutrition education in the management of diabetes mellitus. The choice of this topic is predicated upon the ravaging effects of diabetes in human population, especially in developing countries like Nigeria where most citizens are living below the poverty level. According to Ahuja (1986) & Afoke (2015), Malnutrition Related Diabetes Mellitus (MRDM) is very common in most poverty stricken populations, including Nigeria where about 70% of the population suffers from MRDM. In Nigeria, most cases of DM/MRDM are undiagnosed until complications set in due to low level of awareness. Besides, there is no strong campaign against DM in Nigeria as in some other diseases such as albinism and sickle cell (Afoke, 2015). These submissions indicate a serious concern on the nutritional needs of diabetic patients; hence the choice of this paper.

Nutrition and Diabetes Management

Nutrition is the process by which food is taking into the body and utilized as raw material to stimulate growth and normal body functions (Shereen, 2016). Nutrition has also been defined as the general process involved in the consumption and utilization of food nutrients for growth, repair and maintenance of the body (Brookover, 2017). It is the act of being nourished (Dictionary.com, 2017). From the above definitions this paper conceives nutrition as the appropriate consumption and utilization of food to sustain good health. For this paper also nutrition

in relation to diabetes management, refers to the process of consuming food in line with recommended food regimen that is needed to enhance as far as possible normal blood glycemia in diabetics. As a component of diabetes self-management education, nutrition therapy is important at all levels of diabetes prevention. It can be used in the management of all types of diabetes (Pastors, Warshaw, Daly, Franz & Kulkarni, 2002).

Nutrition in diabetes is the regimen area where individuals especially those with type II diabetes (non-insulin-dependent) have the greatest difficulty and the area in which improvements could potentially lead to the greatest health benefits. American Diabetic Association (2013) observed that the most challenging part of the treatment plan for people with diabetes is determining what to eat and the fact that eating pattern for individuals with diabetes should be individualized to suit each person's health condition. American Diabetic Association (2013) in recognition of the integral role of nutrition therapy in overall diabetes management , suggested that each person with diabetes be actively engaged in self-management, education, and treatment planning with his or her health care provider, including the collaborative development of an individualized eating plan. It is important that all members of the health care team (diatetician, physician, nurse, patient educator etc) and diabetics should have knowledge about diabetes nutrition therapy and support its implementation (Inzucchi, Bergenstal & Buse, 2012).

Nutrition Therapy was introduced into the management of diabetes mellitus by the American Diabetic Association with the aim of preventing diabetes, managing existing diabetes, preventing and reducing the rate of development of diabetes complications. Whether for management or prevention of diabetes and its complications, the basic nutrition recommendations is the underlying concern for optimal nutrition through healthy food choices and an active lifestyle (Benson, & Hartz, 2000).

The Role of Nutrition Education in Diabetes Management

Nutrition Education refers to the communication of information regarding nutrition that enables individuals, families, and communities to make good food choices (Encyclopedia.com, 2016). It has also been defined as the combination of different strategies of education backed up by environmental support, planned in such away as to enhance willful acceptance of food choices and other nutrition related behaviour that is favourable to good health and well being (WPHNA Secretariat, 2013). School of Open Learning University of Delhi (2017) conceived nutrition education as the means through which individuals are informed and encouraged to change existing practice and adopt healthy nutrition that will ultimately lead to desirable positive changes in knowledge, attitude and practice for the general health benefits of individuals and communities. Drawing from the above definitions this paper conceives nutrition education as the persuasive act of helping individuals to become better informed about their nutritional needs and the need to adopt good eating habits in order to maintain good health.

The main aim of nutrition education in diabetic management is to provide nutrition information that will equip a diabetic with the appropriate knowledge, skills and the motivation needed to nutritionally self manage diabetes (Funnell, Brown & Childs, 2012). This is very important since positive knowledge helps to eliminate fear, ignorance and superstitious beliefs as well as enhances compliance to recommended therapies. It also helps to build patients confidence in his or her ability to make useful contribution to the amelioration of the problem. Due to the fundamental role of diet in the management of diabetes, it is vital for every diabetic to have good knowledge of recommended food regimen (Diabetes Education Online, 2017). School of Open Learning University of Delhi (2017) observed that the cardinal purpose of nutrition education is to assist diabetic individuals to adopt food patterns and practice that are consistent with the nutritional needs of the body and modified to suit the cultural and food resources of the area in which they live. Through nutrition education therefore, patients could acquire improved understanding of diabetes and its management, the benefit of which empowers them to take adequate care of their condition as well as the ability to make appropriate food choices (Diabetes Education Online, 2017).

Nutrition education enhances patience awareness and compliance to nutrition regimen which Askari, Rabiei, Rastmanesh (2013) observed help to reduce considerable diabetes complications and may also lead to saving economic resources. Education on healthy food choices and consumptions is one of the most effective ways to control particularly type 2 diabetes and it has a pivotal role in encouraging and supporting these patients to the daily control of their condition (Rutten, 2005, National Institute for Clinical Excellence 2003, Department of Health, 2003). Although nutrition education alone is not a cure for the disease, the type 2 diabetes patient for instance is not able to achieve metabolic regulation, if patient is not aware of the basic principles of nutrition (Tessier & Lassmann-Vague, 2017). Consequently a well planned nutrition education programme play the significant role of helping patients to obtain nutritional training that will assist them to co-operatively make useful contributions in the management of the disease. Nutrition education in diabetes include teachings on carbohydrate counting and portion sizes, reduction of saturated fatty acid and cholesterol consumption, balanced meal, dietary integration of insulin therapy, alcohol use in diabetes and nutritional guide for specific populations.

Carbohydrate Counting and Portion Sizes:

An important role of nutrition education in diabetic management is helping patients to learn about carbohydrate counting and portion sizes. Patients should understand what portion size is required for each type of food. The importance of this training stem from the fact that carbohydrate foods have the greatest effect on blood sugar levels. It is therefore necessary that diabetics who take meal time insulin should know the amount of carbohydrate in the food in order to obtain the required insulin dose (Mayo Foundation for Medical Education and Research, 2017). Through nutrition education diabetics are taught how to portion-size carbohydrate rich foods by providing training on the weighing and measuring of foods to determine correct portion sizes and amounts. Patients are also taught to check the total-carbohydrate grams on nutrition facts labels to check and determine carbohydrate content, bearing in mind that sugar is included in the total carbohydrate. Sugar- free and fat- free foods almost contain carbohydrate and should be worked in to the meal plan (United Health Care Insurance Company, 2009).

Reduction of Saturated Fatty Acid and Cholesterol Consumption

Another important training giving to diabetics through nutrition education is nutritional guide on reduction of saturated fatty acid and cholesterol consumption. The primary goal regarding dietary fat in individuals with diabetes is to limit saturated fatty acids, trans- fatty acids, and cholesterol intake so as to reduce risk for cardiovascular diseases. Through nutrition education patients are made to understand that saturated and trans- fatty acids are the principal dietary determinants of plasma low density lipoprotein cholesterol (Gannon & Nuttall, 2004). Low fat diets help to prevent weight gain and lower the risk for heart diseases. consequently through nutrition education, patients get to know that unsaturated fats (like oils, nuts, and seeds) should be used when cooking and baking instead of saturated fats like butter to help raise good cholesterol l(high density lipoprotein) and lower bad cholesterol (low density lipoprotein) (United Health Care Insurance Company, 2009).

Balance Meal

Daily intake of a healthy diet is indispensable in the successful management of diabetes mellitus (Diabetes Education Online, 2017). Through nutrition education individuals with diabetes are taught the importance of acquiring daily vitamin and mineral requirements from natural food sources and a balance diet. Diabetics are trained to have good insight on what constitutes a balance meal. This is particularly important since patients are expected to have daily meal that has good mix of carbohydrate, fruits, vegetables and healthy fats. Although some amount of carbohydrate is required in diabetes management, patients are taught to obtain their carbohydrate from low sources such as fruits, vegetables, and whole grains. These sources are preferred because they contain fiber which is needed in maintaining normal blood sugar level (Mayo Foundation for Medical Education and Research, 2017). To successfully achieve this, health care providers should focus on nutrition counseling rather than micronutrient supplementation in order to reach metabolic control of their patients (Guerrero & Rodrigue, 2005).

Dietary Integration of Insulin Therapy

Crowther, Hiller, Moss, McPhee, Jefferies & Robinson (2005) stated that the first nutrition priority for individuals requiring insulin therapy is to integrate an insulin regimen into their lifestyle. For individuals with type 1 diabetes, insulin therapy should be integrated into an individual's dietary and physical activity pattern. Individuals using rapid-acting insulin by injection or an insulin pump should adjust the meal and snack such that insulin doses are based on the carbohydrate content of the meals and snacks. For individuals using fixed daily insulin doses, carbohydrate intake on a daily basis should be kept consistent with respect to time and amount. This will help to reduce high levels of blood glucose and also the rate of occurrence of hypoglycemia (Olabuyi & Oluwafemi, 2013).

Alcohol Use in Diabetes

Nutrition education helps patients to understand and follow recommended amount of alcohol in diabetes. Adults with diabetes, who choose to use alcohol, should be taught to limit daily intake to moderate amount only (one drink per day or less for women and two drinks per day or less for men). In diabetes, moderate alcohol consumption has no acute effect on glucose and insulin concentrations, but carbohydrate co-ingested with alcohol (as in a mixed drink) may raise blood glucose (Howard, Arnsten & Gourevitch 2004). To reduce the risk of nocturnal hypoglycemia in individuals using insulin, alcohol should be consumed with food. It is dangerous for diabetics to drink alcohol in an empty stomach but safer when taken with food. This is because food reduces the rate of alcohol absorption into the blood stream. Binge drinking is also very dangerous for diabetics and must be avoided (Davidson & Moreland, 2011).

Nutritional Guide for Specific Populations

Crowther, Hiller, Moss, McPhee, Jefferies & Robinson (2005), observed that the first nutrition priority for individuals requiring insulin therapy is to integrate an insulin regimen into their lifestyle. Through nutrition education patients could be properly informed on the need and how to integrate insulin therapy with dietary pattern. Patients using rapid-acting insulin by injection or an insulin pump could also be made to adjust their meals and snacks such that insulin doses are based on the carbohydrate content of the meals and snacks. For those using fixed daily insulin doses, carbohydrate intake on a daily basis should be kept consistent with respect to time and amount while for unplanned exercise, extra carbohydrate may be needed (American Diabetes Association, 2013). Diabetes for pregnant, lactating mothers, older adults, individuals with complications is usually very challenging and requires specific nutritional therapy.

Specifically, the goal of nutrition therapy in the management of this category of diabetics is to meet the nutritional needs of these unique times in their life cycle (WHO, 2004). To meet this need nutrition education for diabetic pregnant mother emphasizes the need for adequate energy intake that provides appropriate weight in order to maintain normal gycaemia, avoidance of ketosis and type 11 diabetes after delivery. In older adult diabetes, nutrition education preaches modest energy restriction and an increase in physical activity. In diabetic complications, counseling on reduction of protein intake in individuals with diabetes in the earlier stages of chronic kidney disease is important in the management of retinopathy and nephropathy (Alberti, Zimmet & Shaw, 2005)

Teaching Tips in Diabetes Nutrition Education

The following tips were developed by *Joslin Diabetes Center, 2013* to help plan a balanced diet for diabetics:

1. The average size of a dinner plate today is 13 inches in diameter; advise using a smaller plate or even a salad plate to help reduce portions.
2. Explain how to build a healthy plate, to fill half the plate with colorful non -starchy vegetables like broccoli and/or salad.
3. Fill one quarter of the plate with a whole-grain carbohydrates like brown rice or a starchy vegetable, such as peas; fill the other quarter of the plate with lean meat, eggs, tofu or lower-fat cheese; add a small amount of heart-healthy fat such as canola or olive oil, trans-fat-free margarine, nuts or avocado; add one or two more carbohydrate choices, such as a piece of fruit and/or a small cup of low-fat, light-style yogurt.
4. Discuss with diabetics meals that include a combination of foods, such as casseroles, stews, a burrito or a chicken stir-fry dish.
5. Help patients visualize what these meals would look like on the plate if each of the ingredients were separated.
6. Emphasize that Joslin's Healthy Plate can be used by the whole family. Joslin healthy plate is a meal planning tool that helps people with diabetes understand the carbohydrate, fat and protein content of each meal. This tool allows people with diabetes to exert control over their eating plan while planning their meals.
7. Diabetes meal planning is similar to nutritional recommendations for everyone-the goal is for all family members to eat as healthfully as possible, (Joslin Diabetes Center, 2013).

Conclusion

Nutrition education is an essential health programme that plays important role in achieving positive outcome in the management of diabetes. It is a comprehensive package that focuses on training diabetics to acquire skills on how to meet their nutritional needs in order to remain healthy and reduce the risk of developing complications. It is pertinent to prevent the rate of development of the chronic complications of diabetes by modifying nutrient intake according to individual nutritional needs, taking into account personal and cultural preferences and willingness to change. If concerned diabetic healthcare providers such as Registered Dietician (RD), certified diabetes educator (CDE), hospital or local diabetes association should focus more on this concept, the aim of maintaining optimal glycaemia, weight reduction and reduction of vascular diseases in diabetics would be achieved.

Recommendations

Based on the above discussions, the following recommendations are made:

1. All members of the health care team should receive training in other to be knowledgeable about diabetes nutrition therapy and support its implementation.
2. Dieticians and health care providers who manage diabetic cases should encourage consumption of balanced calories for weight management and increased intake of nutrient-dense foods such as fruits, vegetables, whole grains, low-fat dairy and protein

3. Nutrition education in diabetic management should also focus on encouraging individuals at high risk for developing type11 diabetes to observe lifestyle changes that include moderate weight loss and regular physical activities.
4. Sodium, fats, added sugars, refined grains and alcohol intakes should be reduced. The cultivation of Healthy eating patterns should be emphasized
5. Blood sugar measurement as directed by a healthcare provider should be practiced to determine how food choices affect blood sugar control.
6. Health care providers should focus on nutrition counseling rather than micronutrient supplementation in diabetic patients.
7. Personal and cultural preferences and willingness to change should be considered in diabetes nutrition education.

References

Abdulkadir, J., Mengesha, B., Welde, G. Z., Gebre, P., Beastal, G., & Thorson, G. (1987). Insulin Ketosis resistant diabetes in Ethiopia. *Trans R. Soc Trop Med Hyg, 81*; 539 543.

Afoke, A. O. (2015). Malnutrition related diabetes mellitus: Challenging the consequences of the bastard on the poor of the earth. *9th Inaugural lecture of Ebonyi State University, Abakaliki.*

Ahuja, M.M.S. (1986). *Profile of young Indian diabetics*. Biochemical Studies. *J. Assoc Physicians India 21*:8799.

Alberti, K.G., Zimmet, P., & Shaw, J. (2005). The metabolic syndrome: A new worldwide definition. *Lancet,* 366; 1059–1062.

American Diabetes Association. (2013). Standards of medical care in diabetesd2013. *Diabetes Care,* 36 (Suppl. 1); S11–S66

American Diabetes Association. (2016). *Diabetes prevention*. Retrieved October 11, 2016 from http://www.diabetes.org/advocacy/advocacy-priorities/prevention/

Askari, F., Rabiei, S., & Rastmanesh, R. (2013). The Effects of nutrition education and diet therapy on Glycemic and Lipidemic control in Iranian patients with Type 2 diabetes. *Journal of Obesity Weight Loss Ther, 3*, 186. doi:10.4172/2165-7904.1000186

Benson, K., Hartz, A.J. (2000). A comparison of observational studies and randomized, controlled trials. *N Engl J Med* 342; 1878–1886**.**

Brookover, A. (2017*). What is the definition of Nutrition*. Retrieved 21st June 2017 from http://www.healthguidance.org/entry/9975/1/What-Is-the-Definition-of-Nutrition.html

Crowther, C.A, Hiller, J.E., Moss, J.R., McPhee, A.J, Jeffries, W.S., & Robinson, J.S. (2005): Effect of treatment of gestational diabetes mellitus on pregnancy outcomes. *N Engl J* Med 352:2477–2486.

D'Cunha, C. O. (2016). Diabetes: strategies for prevention. Retrieved October 11, 2016 from http://health.gov.on.ca/en/common/ministry/publications/reports/diabetes/diabetes.as

Davidson, N. K. & Morel and P. (2011). Alcohol and diabetes: drinking safely. Retrieved 22nd June 2017 from http://www.mayoclinic.org/diseases-conditions/diabetes/expert-blog/alcohol-and-diabetes/bgp-20056464.

Department of Health. (2003). *National service framework for diabetes: Delivery strategy.* London.

Delta Country Memorial Hospital. (2017). Clinical nutrition services and diabetes. Retrieved 21 June 2017 from Education http://www.deltahospital.org/getpage.php?name=Diabetes.

Diabetes Education Online. (2017). *Diet and nutrition*. Retrieved 21 June 2017 from https://dtc.ucsf.edu/living-with-diabetes/diet-and-nutrition/

Dictionary.com (2017). Nutrition. Retrieved 21st June 2017 from http://www.dictionary.com/browse/nutrition.

Elamin, A., Abahir, H., Ismail, B., & Tuvemo, T, (1992). Clinical pattern of Childhood type 1 (insulin dependent) diabetes in the Sudan. *Diabetologia. 35*, 645 - 648.

Encyclopedia.com. (2016). Nutrition education. Retrieved 22nd June 2017 from <http://www.encyclopedia.com>.

Ezeilo, G. (2005). *A text book of Human Physiology.* London.

Funnell, M. M., Brown, T. L, & Childs, B. P. (2012). National standards for diabetes self-management education. *Diabetes Care, 35(Supplement_1):* S101–S108. 10.2337/dc12- s101

Gannon, M.C. & Nuttall, F.Q. (2004). Effect of a high-protein, low-carbohydrate diet on blood glucose control in people with type 2 diabetes. *Diabetes* 53, 2375- 2382.

Gannon, M.C., Nuttall, J.A., Damberg, G., Gupta, V., & Nuttall, F.Q. (2001). Effect of protein ingestion on the glucose appearance rate in people with type 2 diabetes. *J Clin Endocrinol Metab*, 86, 1040–1047.

Griffin P. R. (2013). *Diabetes research: reducing the burden of diabetes at all ages and stages.* Retrieved October 11, 2016 from https://www.niddk.nih.gov/accessibility

Guerrero-Romero, F., & Rodriguez-Moran, M. (2005). Complementary therapies for diabetes: the case for chromium, magnesium, and antioxidants. *Arch Med Res*, 36, 250–257.

Howard, A.A., Arnsten, J.H., & Gourevitch, M.N. (2004). Effect of alcohol consumption on diabetes mellitus: a systematic review. *Ann Intern Med*, 140, 211–219.

Inzucchi, S.E., Bergenstal, R.M., & Buse, J.B. (2012). Management of hyperglycemia in type 2 diabetes: a patient-centered approach: position statement of the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care*, 35, 1364–1379.

Joslin Diabetes Center. (2013). *Diabetes*. Retrieved October 11, 2016 from www.joslin.org.

Karam, J.H. (1991). Diabetes Mellitus, Hypoglycemia and Lipoprotein Disorders in: Shroeder, S. A., Krupp, M. A., Tierney, L. M & McPhec, J. (Eds). *Current Medical Diagnosis and treatment.* California: Lange Medical Books. Pp 852-893

Ludvigson, J. & Afoke, A.O. (1989). Seasonality of type 1 (Insulin. Dependent) Diabetes Mellitus; Values of peptide, insulin antibodies and heamoglobin Show evidence of a more rapid loss of insulin secretion in epidemic patients. *Diabetologia*, 84-91.

National Institute for Clinical Excellence. (2003). *Guidance on the use of patient-education models for diabetes.* London.

Mayo Foundation for Medical Education and Research. (2017). Diabetes management: how lifestyle, daily routine affect blood sugar. Retrieved 22nd June 2017 from www.mayoclini.org/disease/indepth/diabetes-management/art-20047963.

Oli, J.M. (1980). Diabetes mellitus in Africans. *J Roll Coll physicians*, 224-6

Oyebola, D.O. (2004). *Essential Physiology*. Ibadan: NHORT Press.

Pastors, J.G., Warshaw, H., Daly, A., Franz, M., & Kulkarni, K. (2002). The evidence for the effectiveness of medical nutrition therapy in diabetes management. *Diabetes Care*, 25, 608–613.

Phyillis, A. B. & Stacy, J. B. (2010). *Prescription for Nutritional Healing*. U.S. A: Pengium Group Incorporated.

Pidduck, A. (2016). *Reducing the burden of diabetes. This Day News Paper*. Retrieved October 11, 2016 from http://www.newsday.co.tt/features/0,226221.html

Pietrangelo, A & Cherney, K (2017). *The effect of diabetes on your body*. Retrieved 3rd July from http://www.healthline.com/health/diabetes/effects-on-body

Rutten, G. (2005.) Diabetes patient education: time for a new era. Di*abetes Medicine*, 22, 671-673.

Santos-Longhurst, A. (2014). *Type 2 Diabetes Statistics and Facts*. Retrieved, October 11, 2016 from http://www.healthline.com/health/type-2-diabetes/statistics#overlaypassive

School of open Learning University of Delhi. (2017) *Nutrion and education, study material 1, lesson 4 nutrition education*. Retrieved 20th June 2017 from https://sol.du.ac.in/mod/book/view.php?id=1354&chapterid=1099

Shereen, L. (2016). *Overview of nutrition*. Retrieved 21st June 2017 from https://www.verywell.com/nutrition-diet-and-health-4013923

Tessier, D. M., Lassmann-Vague, V. J. (2007). Diabetes and education in the elderly. *Diabetes Metab, 33* Suppl 1:S75-8.

United Health Care Insurance Company. (2009). *Diabetes.* Retrieved October 10, 2016 from www.PrescriptionSolutions.com/diabetes.

WPHNA Secretariat (2013). *The enact project: education for effective nutrition in action*. Retrieved 22nd June 2013 from http://wphna.org/the-enact-project-education-foreffective-nutrition-in-action/.

WHO(1999). Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: Diagnosis and classification of diabetes mellitus. *Report Number: WHO/NCD/NCS/99.2.*

WHO Expert Consultation (2004). Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet*, 363, 157–163. www.diabetes.org

WHO (2016). Diabetes. *WHO Fact sheet*. Reviewed October 11, 2016 from http://www.who.int/mediacentre/factsheets/fs312/en/