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ARTICLE

Prevention of Non Communicable Diseases

Effect of diabetes nutrition education on the dietary feeding practices and lifestyle of type 2 diabetic patients

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Abstract

Background Type 2 diabetes mellitus (T2DM) is one of the most common global diseases of public concern. In developing countries like Uganda, dietary habits and sedentary lifestyle are the major factors for rapidly rising incidence of DM. Therefore, awareness about diabetes dietary practices and life style are paramount in the control of the disease.

Methodology One hundred type 2 diabetic patients were randomly selected and divided into two groups of intervention and control (50 patients in each group) to participate in the study. The intervention consisted of two educational sessions each for 30 min with various learning segments. A conversation map for type 2 diabetes, 24-h dietary recall and glycemic load tables were used. Data were collected using a pre-tested questionnaire before intervention and on monthly basis for a period of four months of intervention. Data were entered and analyzed using SPSS software version 21.

Results There was a significant ($p < 0.001$) increase in water, vegetables, fruits, and number of meals intake per day coupled with quitting alcohol, soda, and beer among the intervention group. On the other hand, it was revealed that meat and milk consumption significantly reduced by 81.6 and 82.4% respectively among the intervention group. At the end of study period, milk, meat, vegetable, beer, soda, cigarettes intake, and duration of physical activity increased among the control group.

Conclusions Nutrition education improves dietary feeding practices and lifestyle among type 2 diabetes patients within four months of intervention.

Introduction

Type 2 diabetes mellitus is a chronic condition that affects the way the body processes blood glucose [1]. With type 2 diabetes, the body either doesn't produce enough insulin, or it resists insulin. Thus improvement in the elevated blood sugar levels can be achieved through diet management where the patients could be prevented from developing diabetes complications [2]. In this case, health-care providers have a vital role in encouraging patients to understand the importance of diet which is important in diabetes management, appropriate self-care and better quality of life. However, many people find it difficult to make changes in their routine diet [3]. For better outcomes among type 2 diabetes patients, health-care providers trained to work with people who have diabetes are needed for appropriate goal-setting around self-care behaviors to better enable them to accomplish the changes in their diets to suit that of diabetes patients. To enable diabetes patients, change their dietary practices and lifestyle, nutrition education is one of the interventions that may be useful in achieving such a goal. Diabetes can be controlled through improvement in patient's knowledge, attitudes, and practices [4]. These factors are considered as an integral part of comprehensive diabetes care. Unhealthy eating habits are one of the leading causes of diabetes [5]. Failure to follow strict diet plan and physical activities, along with prescribed medication are leading causes of complications among patients with type 2 diabetes [2, 6]. Diabetic patients require reinforcement of diabetes education including dietary management through health-care providers to encourage them to understand the disease management better, for more appropriate self-care

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and better quality of life [7, 8]. However, the comparative effectiveness of these approaches and the characteristics of patients who benefits from each approach are still unknown. Dietitians or other health-care providers seldom evaluate the effect of dietary education for patients with type 2 diabetes during their routine work. It is important to examine the effectiveness of diabetes education from related factors and settings such as nutrition information and barriers. Nutrition education is a critical component of diabetes self-management education and improves glycemic control similar to many glucose-lowering medications [9]. Patients' food selection and dietary behaviors may be influenced by the strong knowledge about diabetic diet recommendations. Knowledge regarding diabetic diet is essential and is needed to achieve better dietary behaviors [10]. Dietitians advise that nutrition is very important in managing diabetes, not only the type but also the quantity of food which influences blood sugar.

Methodology

Study area, design, and population

A longitudinal cohort non blinded intervention study was conducted from March 2012 to July 2012. In this study, 100 type 2 diabetes out-patients were randomly selected by requesting patients to pick a folded piece of paper written on either "I'' for intervention or "C" for control group. Patients were then divided into two groups of intervention and control (50 patients in each group). To control potential confounding factors, the two groups were matched. Although, only 34 and 18 of the 50 patients in the intervention and control group respectively completed the study. Inclusion criteria included: having type 2 diabetes, aged at least 18 years, attending diabetic clinic, able and willing to perform physical activity for atleast 30 min daily during the study period. Those excluded from the study included: very ill type 2 diabetes patients, type 1 diabetes patients, type 2 diabetes patients not willing to perform physical activity, and pregnant diabetic patients. The intervention group received nutrition education geared towards promoting dietary diversity, change in feeding practices, meal frequency, limiting intake of soft drinks like sodas, health lifestyle like physical activity, abstinence from alcohol and smoking in addition to usual medication and some teaching about dos and don'ts of diabetes patients that was provided in the diabetes clinic for a period of four months. This was based on the nutritional recommendations of the World Health Organization [11] and American Diabetes Association [12]. The intervention consisted of two educational sessions, each 30 min with six learning segments. The information education and communication materials included; conversation map for type 2 diabetics, British serving cups, fist illustrations, a localized table of glycemic load of foods per serving, an outline of foods with zero glycemic load that were consumed sparingly due to their fat or salt content. A 24-h dietary recall and key informant interviews and an oral examination was also administered to ascertain nutrition knowledge level and practice. Physical activity illustration of brisk walking lessons was also conducted. Data were collected using pre-tested questionnaire with four sections including demographic data, nutritional knowledge, health belief models components. The questionnaire was completed before and after intervention by both groups.

Sample size determination

The endocrine unit receives about 500 clients in one month. The statistical equation by Dell [13] was modified and used to calculate the number of patients who were recruited in the study.

$$n = \frac{\left[\left(Z\alpha X 2S^2\right)^{1/2} - Z_\beta\left(S_e^2 + S_c^2\right)\right]^2}{\left(S_e^2 - S_c^2\right)^2}$$ Where:

n = Sample size for each group

$Z\alpha = Z$ value for type I error (e.g.,1.96 at 5% level)

$Z\beta = Z$ value for type II error (e.g., 0.84 at 20% level)

Se = Variance estimate of outcome for intervention group receiving nutrition education to promote dietary diversity in addition to the usual care given in the endocrine unit.

Sc = Variance estimate of outcome for control group having only the usual care given in the endocrine unit without the nutrition education promoting dietary diversity.

$$S^2 = (Se^2 + Sc^2)/2 = \frac{(1.00)^2 + (1.02)^2}{2} = 1.0202$$

$$n = \frac{\left[(1.96 \times 2 \times 1.0202)^{1/2} - 0.84 \times 2.0404\right]^2}{(1 - -1.0404)^2}$$

$$n = \frac{\left[(3.999184)^{1/2} - -1.713936\right]^2}{(-0.0404)^2}$$

That is $n = 50$ participants

Total population size that was included in the study was $2n = 2 \times 50 = 100$ participants/patients.

That is 50 patients were randomly recruited as controls while 50 were also randomly recruited as intervention group. The participants who completed the study were 34 of the 50 patients in the intervention group and 18 of the 50 patients in the control group.

Determination of overall dietary glycemic load

The glycemic load (GL) of recommended foods for diabetes patients was calculated by multiplying the glycemic index (GI) by the amount of carbohydrate in grams (g) provided by a food serving and then dividing the total by 100 [12–

Table 1 Demographic characteristics of diabetic patients in the intervention ($n = 34$) and control groups ($n = 18$).

No.	Variable	Control group (%)	Intervention group (%)
1.	Age (years)	48.44	46.76
2.	Sex		
	Male	33.33	34.69
	Female	66.67	64.10
3.	Education level		
	Pre-primary	5.56	2.94
	Primary	11.11	11.76
	O-Level	16.67	17.65
	A-level	16.67	14.71
	Tertiary institution	27.78	29.41
	University	22.22	23.52
4.	Occupation status		
	Self-employed	55.56	41.18
	Unemployed	11.11	5.88
	Civil servant	22.22	35.29
	Retired	11.11	17.65
5.	Marital status		
	Married	22.22	23.53
	Widows	16.67	32.35
	Widowers	11.11	11.75
	Divorced	66.67	23.53

14]. GI values used in this study were according to the international tables of glycemic index and glycemic load values [15]. British serving cups, a fist of the hand, glasses and trimmed ordinary cups and plates were used to approximate food portions/sizes. Food samples were also used to make the learning easy. A 24-h dietary recall was used together with key informant interviews to record data and to calculate eventual glycemic loads.

Statistical analysis

Data were analyzed using SPSS (version 21). Student's *t* test was used to compare the values between the two groups before and after intervention. The mean differences of variables were compared by paired t-test and p-values less than 0.05 were considered significant.

Results

Social demographic characteristics of type 2 diabetic patients

Table 1 shows results of socio-demographic characteristics of type 2 diabetic who participated in the study. The average age of patients was 48 (40–51) years. Most of the patients were females (65.39%), compared to males (34.01%). On average, 22.88% of the patients were married. Findings also showed that 48.37% of patients were self-employed while only 8.50% were unemployed. In addition, 28.60% of patients had tertiary education while 4.25% had pre-primary education.

Table 2 Risk factor profile of diabetic patients in the case ($n = 34$) and control ($n = 18$) groups.

No.	Variable	Control group, *n* (%)	Intervention group, *n* (%)
1.	Knowledge regarding diabetes	40.39	41.26
2.	Duration of diabetes		
	<5 years	06 (33.33)	11(32.35)
	5–10 years	08 (44.44)	13 (38.24)
	11–15 years	03 (16.67)	7 (20.59)
	>15 years	01 (5.56)	03 (8.82)
3.	Family history		
	Yes	04 (22.22)	06 (16.65)
	No	14 (77.78)	28 (82.35)
4.	Smoking		
	Yes	02 (11.11)	0 (0)
	No	16 (88.89)	34 (100)
5.	BMI (kgm^{-2})	27.22	27.77

Risk factor profile of diabetic patients in the intervention and control groups

Results of risk factor profile of diabetic patients are presented in Table 2. Exactly 40.83% of patients had knowledge regarding diabetes. Results further revealed that 41.34% of the patients' duration of diabetes was between 5–10 years; around one third of the patients (32.84%) had diabetes less than 5 years, and only 18.63% had diabetes 11–15 years, while 7.19% had diabetes for more than 15 years. The family history of diabetes was positive in 19.44% of the patients. The majority of patients were non-smokers (94.45%). The average BMI of patients was 27.50 kgm^{-2}.

Dietary feeding practices and lifestyle of type 2 diabetic patients before and after intervention in the control and intervention group

Results for the dietary feeding practices and lifestyle of Type 2 diabetic patients are presented in Table 3. At baseline, within the control and intervention groups, the feeding practices and the lifestyle were the same and characterized by very high glycemic load, low water

Table 3 Mean ± standard deviations of dietary feeding practices and lifestyle of Type 2 diabetic patients before and after intervention in the control and intervention group.

Parameter	Recommended value	Control group (18 Patients)			Intervention group (34 patients)			*P* value for comparing control and intervention groups	
		Baseline	Post intervention	*P* value	Baseline	Post intervention	*P* value	Control	Intervention
Glycemic load	50	275.38 ± 34.9	284 ± 61.4	0.615	295.11 ± 24.56	63.0 ± 10.84	<0.001*	0.021*	<0.001*
Water intake (ml)	Adlibtum, 3000	527.7 ± 419.1	1200 ± 746.8	0.001*	772.4 ± 473.3	3311.8 ± 986.1	<0.001*	0.071	<0.001*
Meal frequency (number of times/day)	6	3.1 ± 0.68	3.4 ± 0.70	0.163	3.4 ± 0.54	4.9 ± 0.9	<0.001*	0.168	<0.001*
Vegetable intake (servings)	3 to 5	0.14 ± 0.31	0.3 ± 0.57	0.323	0.28 ± 0.55	2.89 ± 1.96	<0.001*	0.311	<0.001*
Fruit intake (servings)	3 to 4	0.22 ± 0.55	0.06 ± 0.24	0.269	0.59 ± 0.89	1.8 ± 1.1	<0.001*	0.119	<0.001*
Meat consumption (g)	113.4-198.45	205 ± 191.5	217.8 ± 157.3	0.820	161 ± 166.2	29.7 ± 56.2	<0.001*	0.397	<0.001*
Milk consumption (ml)	240	305.6 ± 348.9	361.1 ± 375.95	0.607	215.2 ± 278.5	37.9 ± 126.9	0.001*	0.316	<0.001*
Soda (ml)	15^{+}	355.6 ± 436.9	555.6 ± 379.2	0.197	383.8 ± 383.1	0.0 ± 0.0	<0.001*	0.810	<0.001*
Beer (ml)	Not Recommended	194.4 ± 348.9	333.3 ± 514.5	0.263	191.2 ± 492.6	0.0 ± 0.0	0.030*	0.980	0.001*
Smoking (Cigarettes sticks)	Not Recommended	1 ± 2.6	1.3 ± 3.1	0.636	0.0 ± 0.0	0.0 ± 0.0	–	0.027*	0.021*
Physical activity duration (minutes)	30	1.7 ± 7.1	10 ± 14.55	0.020*	0.03 ± 0.17	17.2 ± 14.61	<0.001*	0.649	<0.001*

Values with * are statistically significant / different from the baseline at $p < 0.05$. one cup is equivalent to one serving. $^{+}$Only in hypoglycemic.

consumption less than the recommended 3 litres a day. Findings of the study indicated that the overall dietary glycemic load in the control was higher than that in the intervention group at the end of the study. Results indicated that there was a significant reduction (78.7%) in the overall dietary glycemic load in the intervention group. Results further revealed that there was a significant ($p < 0.001$) increase in the intake of water, vegetables, fruits and number of meals taken per day among the intervention group. On the other hand, it was revealed that meat and milk consumption significantly reduced by 81.6 and 82.4% respectively. At the end of study period, there was an increase in the milk, meat, vegetable, beer, soda, cigarettes intake, and duration of physical activity among the control group (Table 3). Furthermore, there was an increase in the duration of physical activity and 100% reduction in smoking, soda and beer intake among the intervention group. Findings of the study also indicated that there was a significant increase in the water intake among the intervention ($p < 0.001$) and control ($p = 0.001$) groups at the end of intervention period.

Discussion

The average age of patients was 48 years and 28.60% of patients had tertiary education while 4.25% had pre-primary education. Therefore, level of formal education of patients with type 2 diabetes strongly influenced the assimilation of information provided by trainer in this study. Age was also strongly associated with how much information a patient was able to grasp and remember. Continuous education on recommended dietary practices was noted as important. The results from this study (Table 3) showed that there was a significant reduction in the mean daily glycemic load of the diets eaten by the type 2 diabetic patients after intervention. The recommended daily glycemic load for type 2 diabetic patients [16] is 50. The higher the glycemic load above 50 the worse the following occur: hyperglycemia leading to other complications like poor vision, neuropathy [17]; formation of advanced glycemic end products which have deleterious effects on cells of the body [18]. In this study, it was clear that patients learnt to measure meals portions so that their glycemic load could be around 50–67 per day which implies that nutrition education is important in the management of diabetes. One of the important observations made in this study was that when the intervention group tried to have a daily glycemic load of about 50 (50–67), the vision improved and they could read small letters which they could not read before and this was because of low sorbitol formation and reduction in hyperglycemia that usually causes destruction of the tiny blood vessels that feed the eye and nerves [17]. The study in Iran reported that

patients who received nutrition recommendation to eat low glycemic load foods did reduce it with various benefits like reduction of HbA1c [19]. Another study conducted in Japan [20] reported that a glycemic index based nutrition education improved blood glucose control in Japanese adults whose staple food was white rice.

The significant increase in the meal frequency, volume of water, fruits, and vegetables intake among type 2 diabetic patients after the intervention is attributed to knowledge acquired during training sessions among the intervention group. The recommended water intake per day for non-diabetic people is 3 litres [21]. The significant ($p = 0.001$) increase in the water consumption in the control group may have resulted from discussions/interactions among patients and given the fact that of all foods which the intervention group was eating, water was the only food that was widely abundant and also, the message attached to water was very attracting, that is water washes away the excess sugar in blood so that the chances of getting hyperglycemia and related complications are reduced [22]. A study done in Beirut [23], reported that nutrition education significantly increased water intake among school children. On the other hand, the recommended meal frequency is six meals a day [24]. At baseline, all type 2 diabetic patients had similar mean meal frequencies of about 3 meals per day but after nutrition education, the intervention group had a significantly higher ($p < 0.001$) mean meal frequency compared to that of the control group because the intervention group understood it clearly that when one eats small meals but more frequently, the chances of getting either hypoglycemia or hyperglycemia are reduced and the fact that small frequent meals reduce the huge load of glucose at once into blood stream and therefore damage onto the vital organs of the body like the eyes, the liver, the kidney is reduced. A study done in Hathras City, India [25] reported that nutrition education significantly increased the frequency of meals by obese females. Increase in fruits and vegetable intake is attributed to nutrition education that highlighted the importance of eating vegetables like relieving constipation, reducing colon cancer, acting as road humps that is reduce the speed at which glucose and fats enter into circulation, and that some vegetables like broccoli having a nutraceutical importance of increasing insulin sensitivity, their love for vegetables increased that is the reason behind the significant increase in vegetable consumption in the intervention group. Findings of this study are in similar to those by Pimentel et al. (2010) who reported [26] that nutrition counseling increased the consumption of vegetables among type 2 diabetes patients in Brazil. Another study done in Hathras City, India [25] reported that nutrition education significantly increased consumption of green leafy vegetables by obese females. Another study by Bemelmans et al., (2004) reported [27] that nutrition education significantly increased consumption of vegetables. Another similar study done in Ludhiana, Punjab, India [28] by Gulati et al., (2006) reported that nutrition education increased vegetable consumption among smokers. Another study done in Hathras City, India [25] by Yadav et al., (2010) reported that nutrition education significantly increased consumption of fruits by obese females. Another study [27] by Bemelmans et al., (2004) reported that nutrition education significantly increased consumption of fruits. Another study done in Ludhiana, Punjab, India [28] by Gulati et al., (2006) reported that nutrition education increased fruit consumption among smokers.

In this study walking 30 min daily was considered as the only acceptable physical activity and if any one decided to go to gym that was not considered as physical activity fit for patients with type 2 diabetes. Walking was considered because it relied on the principal that when one walks he or she burns the fat and when somebody runs, glucose and phosphocreatine are burnt in the muscles and joints [29] and yet these highly need the glucose and phosphocreatine in their muscles and joints in order to be active and flexible given the fact that these patients have insulin resistance. Among diabetics, fat accumulation is a more serious problem than high blood sugar because it causes atherosclerosis resulting in escalating blood pressures, more fatty degeneration of organs like the liver to worsen insulin resistance so when a patient walks the fat is burnt to help control the above complications of type 2 diabetes. Observations made during this study were that patients gained energy to walk longer distances than they used to walk due to improvement in energy yield in muscles by the respiratory chain (Kreb's cycle and glycolysis) since glucose was now increasingly being pumped in the muscles and joints due to reduction in insulin resistance as a result of fat burning; patients were not covering themselves with blankets before the study due to excess heat as a result of excess parasympathetic innervations as a neuropathic sign in diabetes but mid-way to end of study they could sweat due to opening of skin pores, feel the coldness at night and cover themselves with blankets and then got uninterrupted sleep patterns. A study done in Hathras City, India [25] by Yadav et al., (2010) reported that nutrition education significantly increased physical activity performance by obese females.

The fact that patients in the intervention group were taught that hypertension moves hand in hand with diabetes, it is very necessary to control meat intake. This is because meat intake is known to increases dietary lipids and cholesterol build up in circulation worsening blood pressure that rises uncontrollably. The intervention group had a significantly lower ($p < 0.001$) meat intake at the end of the study compared to the control group because the patients had learnt the bad effects of eating too much meat in conjunction with the fact that too much proteins in diet put a lot

of load on the kidney during deamination yet these patients already have nephropathy and their kidneys also suffer a huge load of glucotoxicity. A study [30] by Valsta, Tapanainen & Männistö (2005) reported that nutrition counseling decreased the consumption of meats and fat rich foods. Another study done in Ludhiana, Punjab, India [28] by Gulati et al., (2006) reported that nutrition education decreased meat consumption among smokers. Furthermore, after 4 months of intervention, patients in the intervention group significantly ($p = 0.001$) reduced milk consumption especially whole milk probably because of the knowledge received during study sessions to take skimmed milk not more than three times a week that is about 250 ml in ratio of 1:2 (milk:water) to get calcium for strengthening bones but also to avoid cholesterol build up in the blood stream since there's need to reduce fat. In the control group, milk consumption at end of study period was not significantly different ($p = 0.607$) from that at baseline because no nutrition knowledge received. A similar study [30] by Valsta et al. (2005), reported that nutrition counseling decreased the consumption of milk in the intervention group.

Significant ($p < 0.05$) reduction in beer/alcohol, soda, and cigarette consumption among the type 2 diabetic patients is attributed to advise given to stop or reduce alcohol/beer, soda, and cigarette consumption as this would help to improve the health status of their body organs like the liver. Findings of this study were in agreement with that done in Minneapolis at the University of Wisconsin–Stout [31] who reported that weekly nutrition education was found to be effective in lowering the alcohol cravings in the treatment group. A similar study done on Inpatients of a specialized rehabilitation clinic in central Italy [32] reported that a nutritional education intervention reduced alcohol consumption markedly [33]. Salaudeen et al. (2014) also reported [34, 35] that health education is effective in changing attitude to cigarette smoking among young adults in tertiary institutions in Nigeria.

Conclusion

Nutrition education increases dietary intake and improves lifestyle among type 2 diabetes patients after the intervention of four months.

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Compliance with ethical standards

Conflict of interest The authors declare no competing interests.

Ethical approval The research was approved by the Research and Ethics committee of Mulago Hospital and Institutional Review Board of Mulago hospital (Protocol MREC 113). Written and oral informed consent was obtained from all study participants.

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