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ARTICLE

Nutrition in acute and chronic diseases

Using dietary serving scores to assess adequacy of dietary intake and associated factors among adult patients with type 2 diabetes in Kampala: a cross-sectional study

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Abstract

Background/Objectives Adequate dietary intake for type 2 diabetes mellitus (T2DM) patients is central in preventing or delaying onset of diabetes related complications. This study used dietary serving scores (DSS) to determine the adequacy of dietary intake and associated factors among patients with T2DM in Kampala.

Subjects/Methods A facility based cross-sectional study among adult T2DM patients attending diabetes clinics attached to health care facilities in Kampala was conducted. Semi structured demographic and 7-day Food Frequency Questionnaires (FFQ) were used to collect data on sociodemographic characteristics, environmental factors and dietary intake respectively. Dietary intake was computed using Dietary Serving Scores (DSS) and was grouped into two: "adequate dietary intake (DSS of 78 and above)" and "inadequate dietary intake (DSS below 78)". Multiple linear regression was used to assess correlates of dietary intake.

Results Out of the 400 participants, only 49 (12.25%; 95% CI: 9.04, 15.46) were classified as having adequate dietary intake. After adjusting for potential confounders, unmarried individuals ($\beta = -2.367$; $p = 0.024$) and those who are salaried ($\beta = -3.162$; $p = 0.012$) or self-employed ($\beta = -4.214$; $p = 0.001$) had significantly lower mean DSS compared to their respective counterparts. T2DM patients who attended Nsambya hospital diabetes clinic had significantly higher mean DSS ($\beta = 3.698$; $p = 0.022$) compared to those who receive treatment in Lubaga hospital.

Conclusions The prevalence of adequate dietary intake among patients with T2DM attending health facilities in Kampala is very low. More efforts are needed to educate patients on better dietary choices aligned with disease management.

Introduction

Type 2 diabetes (T2DM), one of the main non communicable disease (NCD) with increasing prevalence at global level represents ~85–95% of the population with diabetes [1]. It results from insulin resistance due to failure in production by the pancreas or failure of the body to react to insulin [2]. According to the Uganda National Non-communicable Diseases (NCD) Risk Factor Survey (2014), the prevalence of T2DM in Uganda was estimated at 3.3% with urban areas showing a higher prevalence (4.8%) than rural areas (2.9%) [3]. Kampala is one of the areas in Uganda with a higher prevalence of T2DM [3]. In addition, it is estimated that adults aged 18–79 years are most affected by this condition in Uganda [3]. In many cases, T2DM is associated with excess mortality mainly due to vascular complications of the disease [2]. The disease is likely to affect a number of organs in the body and with time this leads to complications if poorly managed which

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increases the risk of premature death, disability and economic burden among those affected. Some of the incapacitating complications of T2DM include heart diseases, lower extremity amputations, stroke, kidney diseases, blindness and neuropathy [4]. In Uganda, a retrospective study conducted at Nsambya hospital in Uganda among 250 adult patients with T2DM revealed that diabetic neuropathy and hypertension were the most prevalent diabetes complications attributing a prevalence of 76.4% and 31.2% respectively [5]. If diabetes related complications are not prevented, patients' productivity is affected and their risk of dying prematurely is amplified [6]. To lessen the risk of developing complications among this population, there is need for continued glycemic control over a couple of years [7]. Diet plays a central role in glycemic control and constitutes a vital aspect of the general management of the condition. Consumption of diets adequate for those with T2DM plays a crucial role in promoting the overall nutrition wellbeing, glycemic control and preventing complications. There are no documented dietary guidelines specifically for the Ugandan population with T2DM. However according to American Diabetes Association (ADA), a daily diet typically consisting of 2–3 serving of milk/dairy products, 2–3 servings of meat/fish/poultry, 2–4 servings of fruits, 3–5 servings of vegetables, and 6 or more servings of grains, starches, nuts and legumes is considered to be adequate for patients with T2DM [6]. In Kampala (Uganda), data on diet adequacy among people with T2DM is lacking. Additionally, only a few studies have established the prevalence of adequate dietary intake among people with T2DM using dietary serving scores (DSS). In Malaysia, only 2% of individuals with T2DM were able to meet an adequate diet [8]. Finding from studies in Botswana [9], Jordan [10], and India [11] revealed that dietary intake among patients with T2DM was still not satisfactory. Data on factors associated with adequate dietary intake among individuals with T2DM in Uganda has also not been documented. Therefore, the aim of this study was to determine the prevalence of adequate dietary intake and associated factors among patients with T2DM so as to provide a basis for enhancing diets among this population group and lower their risk of developing diabetes related complications.

Materials and methods

A cross-sectional study design was employed among adult T2DM patients attending diabetes clinics affiliated to health centres in Kampala between May and July 2017. A 15-food group Food Frequency Questionnaire (FFQ) consisting of over 60 food items was used to collect data on dietary intake which was later assessed via DSS. Data on sociodemographic parameters and environmental factors associated with dietary intake was captured using a pretested semi-structured questionnaire.

Study population and sampling

The study included adult (18 years and older) T2DM patients recruited randomly from five (5) purposively selected diabetes clinics in the five divisions of Kampala. Clinics were selected basing on volume of patient attendance. Diabetes clinics attached to Naguru (Nakawa division), Kisenyi (Central division), Lubaga (Lubaga division), Nsambya (Makindye division) and Mulago (Kawempe divison) hospitals were selected. At the clinics, simple random sampling was applied separately at each day of data collection basing on the list of all eligible patients that were expected to turn up for the clinic on a given clinic day. Instances where a patient did not turn up for their appointment on the day of data collection, the immediate patient on the patients' register was considered. Due to the busy nature of the diabetes clinics as most of them run weekly and monthly, there is quiet an overwhelming attendance. Consecutive sampling (or considering a finite population) could not be feasible as patients are seen by the clinicians in a sequential manner in the order of which patient arrives first. Conducting a random sampling enabled the researchers to collect data without interrupting clinic flow and enabling patients to meet their appointments timely but also allowing a representative sample to be collected. The study excluded patients who were severely ill, pregnant and lactating women, those with mental disorientation, severe renal diseases and gastrointestinal diseases. T2DM was ascertained through reviewing clinical records from which diagnosis was made; basically following the World Health Organisation definition and diagnosis criteria for T2DM [12]. Trained interviewers administered the questionnaires which had been translated to Luganda – the most commonly spoken local language in Kampala. The study used the formula proposed by Leslie Kish [13] to obtain a calculated sample size of 404 after incorporating a 5% margin of error; assuming a 50% proportion of diet adequacy (as there is no comparable literature within the East African region), a standard normal value corresponding to the 95% confidence interval ($Z = 1.96$) and a non-response rate of 5%.

Measurements of variables

Information on sociodemographic characteristics including sex, age, marital status, educational level, religion, family size and occupation was collected. Questions used to measure sociodemographic variables were adapted from the Uganda Demographic and Health Survey (UDHS) report [14].

Dietary intake

A 15-food group FFQ consisting of over 60 food items was used to determine the prevalence of adequate dietary intake in terms of DSS. Dietary intake was the primary dependent variable and was categorised as "adequate dietary intake" or "inadequate dietary intake." The 15 food groups included: fat free/skimmed milk and dairy products; whole grains and products; whole fruits; vegetables; starches and related foods; nuts/legumes/seeds; lean meats/poultry/fish; full cream/whole milk and dairy products; breakfast and refined cereals; vegetable fries; fruit juices and dried fruits; red and processed meats; fats and oils; and sweets and added sugars and alcoholic drinks. DSS put into account the number of servings of different food groups consumed in accordance with recommended servings as per dietary guidelines and as an indicator of nutrient adequacy [15]. In this study, the number of recommended servings of the 15 food groups was adapted from American Diabetes Association dietary guidelines [6]. DSS have been evidenced to be a good proxy for nutrient adequacy and diversity [16]. Food groups that consisted of food items which have been reported to be positively associated with improvement in glycaemic control and blood lipids [17] scored from 0 to 7 according to the number of days these foods were consumed per week (only if their consumption met the recommended servings for each of those days). The more days a food was consumed and within the recommended servings, the higher the score. The seven food groups that positively associated with glycaemic control and blood lipids included: fat free/skimmed milk and dairy products; whole grains and products; whole fruits; vegetables; starches and related foods; nuts/legumes/seeds; and lean meats/poultry/fish. For instance, if a participant consumed 500 mls of low-fat milk for 4 days in a week, they scored a DSS of 4 because the recommended servings for milk a day are 2–3 servings (500–750 mls) and a serving of milk is 250 mls. Recommended servings of the above food groups are presented in Supplementary material 1.

On the contrary, food groups that consisted of foods that have been reported to negatively influence glycaemic control and blood lipids had reversed scores [18]. Increase in number of days of consumption of such foods contributed a lower score. The eight food groups included: full cream/whole milk and dairy products; breakfast and refined cereals; vegetable fries; fruit juices and dried fruits; red and processed meats; fats and oils; sweets and added sugars and alcoholic drinks [19].

Using the 15 food groups, DSS for each participant was calculated. First, a participant was asked if he or she consumed a food item under any of the above food groups in the previous 7 days. In case they did, the participant was further asked to tell the number of days they consumed that food item in the previous 7 days. By the help of household utensils (cups, plates, spoons, etc.), food models and albums, a participant was further asked to estimate the average serving size of that food item consumed on each of the days. A participant earned a DSS of 1 in a day for one food group if it was consumed in the recommended ranges and a DSS of 0 was attained if they failed to meet the recommended number of servings. For the 15 food groups in a day, the maximum DSS was 15 and for 7 days, the maximum DSS was 105. Therefore the maximum DSS a participant could attain from all the 15 food groups in the previous 7 days was 105 and the lowest was zero. Due to the fact that the DSS is a relatively new and unique technique in assessing dietary adequacy, appropriate cut-offs for participants with adequate and inadequate dietary intake could not be fully ascertained within our setting. However, previous research has demonstrated that a cut-off of 75% depicts adequate dietary intake in a rather similar assessment method [20]. Therefore, we adopted a 75% of the maximum DSS to represent participants meeting the adequate dietary intake. A participant was classified as having "adequate dietary intake" if their calculated DSS was at least 78, and classified as having "inadequate dietary intake" if their DSS was below 78.

Environmental variables

The environmental variables included: source of nutrition information, place where food was mainly obtained, cultural and religious influences on diet. Source of nutrition information was determined by asking participants on where they obtained information related to nutrition and diet. This was classified into: media, health workers and friends/peers. Cultural influences on diet were determined by asking participants on whether they faced any cultural beliefs which hindered intake of certain foods that would be found in diets adequate for those with T2DM. Religious influences on diet were determined by asking participants on whether they faced any religious beliefs which hindered intake of certain foods. Place where food is obtained was ascertained by asking participants where they normally obtained the foods they ate. This was categorised as home and eat outs.

Quality control

Research assistants with prior experience in collecting health and nutrition related data were identified and trained for 3 days prior to the study. They were guided on the study objectives, ethical procedures, right interviewing skills, correct recording of responses, correct procedure of identifying participants and in general the whole procedure of data collection. Strict adherence to the procedures laid down in the proposal was emphasised.

The questionnaires used for this research were pretested prior to the study [21] in a sample of 30 patients within a different study area to that where the current study was conducted. During the study, debrief meetings were held at the end of each day and questionnaires filled in within that period were checked for completeness, spelling errors and corrected accordingly to ensure consistence and accuracy. Data from completed questionnaires was entered and cleaned using Epi-Info version 3.5.1 (Centre for Disease Control, Atlanta, GA, USA).

Statistical analysis

Sociodemographic characteristic of the participants were summarised using descriptive statistics i.e. median and inter quartile range (IQR) for continuous data like age and family size (Shapiro–Wilk test "swilk command in STATA" was used to test for normality of data), while frequencies and percentages were applied for categorical data like sex, level of education and occupation.

The prevalence of adequate dietary intake among the T2DM patients was calculated by obtaining the proportion of participants who met the required DSS (a score of ≥78 out of 105) and expressing this as a percentage. The proportion of participants with adequate and inadequate dietary intake was obtained and the respective 95% confidence interval for these proportions was also calculated and reported.

To further characterise results from the DSS, mean estimates of DSS (with their corresponding 95% confidence intervals) for each food group were computed and reported in a table. Food groups with higher mean DSS were considered to be consumed appropriately i.e. within their recommended serving sizes per week. On the contrary, food groups with low mean DSS were considered not to have been consumed within the recommended serving sizes in the 7-day period. To compare DSS means between any two groups, we applied the Wilcoxon signed-rank test because the data were not normally distributed (Supplementary material 2), and had a within-patient correlation structure. In order to maintain a 5% type 1 error rate against inflation arising from multiple comparisons ($n = 105$, ${}_{15}C_2$), an adjusted P value of 0.0005 (Bonferroni, 0.05/105) was adopted for hypothesis testing.

To establish sociodemographic and environmental correlates of dietary intake (measured as DSS) among participants in this study, simple linear regression was used and the resultant β coefficients (slopes) and 95% confidence intervals were obtained and reported. This was further followed by modelling multiple factors (including probable confounders) to establish independent correlates of dietary intake in a multiple linear regression model. The resultant adjusted β coefficients (slopes) and 95% confidence intervals were again obtained and reported. When a multilevel mixed effects linear model was initially considered, including health facility as a random effect, it was not significant for this data (likelihood-ratio test P value = 0.249), thus an ordinary multiple linear regression was deemed sufficient for the analysis. Linearity assumptions between the dependent variable and independent variables in the multiple regression model were tested and passed (Supplementary material 3). All analyses were performed using STATA version 16.0 (StataCorp LLC, College Station, TX, USA).

Model building for the multivariable model

Variables to be included in the multivariable model were first tested for co-linearity using the variance inflation factor (VIF). Logical model building/purposeful selection method was used [22], thus following the conceptualisation of the study outcome, literature and theoretical model. Known confounders in the association (such as age and sex) were retained in the model. Likelihood ratio tests were run to select the final model, for each model building analysis done. Independent predictors with a P value of <0.05 after multivariable analysis were considered significant and reported.

Results

Sociodemographic characteristics of the participants

A total of 400 adult patients with T2DM had complete data and were considered for the final analyses. The results show that the median age of the patients was 50 years (IQR = 15). The minimum age of the participants was 19 years while the maximum age was 91 years. The median family size was 5.5 members (1QR = 3). Majority of the patients were female (64.5%) as compared to males (35.5%). Nearly a half of the total participants had salaried employment (41.0%) and almost three quarters of the total participants were married (74.5%). Regarding the religious affiliations of the participants, Catholics comprised the majority (40.5%). A summary for the rest of the participants' sociodemographic characteristics is presented in Table 1.

Dietary intake of the participants

Out of the 400 participants, 49 of them representing a prevalence of 12.25% (95% CI: 9.04–15.46) had adequate dietary intake while the rest (351/400), that is a prevalence of 87.75% (95% CI: 84.54–90.96) had inadequate dietary intake (Table 1).

Table 1 Sociodemographic characteristics and dietary intake of the participants.

Parameter	Frequency ($N = 400$)	Percent
Age group		
<50 years	188	47
50 years or more	212	53
Family size		
3 or less	69	17.25
>3	331	82.75
Sex		
Male	142	35.5
Female	258	64.5
Education level		
No education	42	10.5
Primary education	134	33.5
Secondary education	150	37.5
Tertiary education	74	18.5
Occupation		
Unemployed	91	22.75
Employed (salaried)	164	41
Employed (self)	145	36.25
Marital status		
Married	298	74.5
Unmarried	102	25.5
Religion		
Catholic	162	40.5
Anglican	111	27.75
Muslim	88	22
Other	39	9.75
Dietary intake		
Adequate (DSS ≥ 78)	49	12.25
Inadequate (DSS < 78)	351	87.75

DSS Dietary Serving Score.

Dietary Serving Scores

Results from the DSS revealed that alcoholic beverages; fruit juices and dried fruit; vegetable fries; and red and processed meats had the highest mean DSS, ranging from 6.69 to 6.03 out the seven (7) days a week. This means that on at least 6 of the 7 week days, these food groups were consumed in their rightful and recommended servings. On the other hand, whole fruits; lean meats, poultry and fish; fat-free milk and dairy products had the lowest DSS within a mean range of 1.83–0.93 out of the seven (7) days of the week implying that these food groups were less frequently consumed in their rightful and recommended serving sizes within the 7 week days (Table 2). Further, results from DSS comparisons across any two food groups reveal no statistical significance (at 5% level) in mean DSS for any two groups with the same letter as shown in Table 2. For instance, mean DSS between Whole grains (cereals) and products vs. Lean meats, poultry and fish did not statistically differ. However, each of these two groups differed in their mean DSS with the rest of the food groups. This interpretation applies to any pair of food group comparisons (for mean DSS) across the table.

Distribution of dietary intake by participant sociodemographic and environmental factors

Results show that a higher proportion of individuals i.e. those coming from families with three family members or less (21.7%), Anglicans (18.0%) and the unemployed (18.7%) had an adequate diet which meets the recommended dietary servings for T2DM compared to counterparts within their respective categories. Table 3 presents the distribution of dietary intake by participant characteristics in detail.

Sociodemographic and environmental correlates of DSS among T2DM patients

This study examined the sociodemographic and environmental correlates of dietary intake (measured as DSS) among patients with T2DM attending diabetes clinics attached to health facilities in Kampala. Results from the simple linear regression showed that having any form of employment (whether salaried or self) was significantly associated with lower mean DSS among this T2DM population. Participants who had salaried and self-employment had a DSS of 3.9 and 4.4 lower compared to those who were unemployed, respectively, indicating that they were less likely to consume an adequate diet. Further, not being married was significantly associated with lower mean DSS. Compared to married participants, unmarried individuals had a 2.2 lower mean DSS [$\beta = -2.161$; 95% CI: −4.23, −0.09]. A correlation was also found between health facility attended and DSS in these T2DM patients. Results suggest that T2DM patients who attended Nsambya hospital had a 3.8 higher DSS compared to their counterparts in Lubaga hospital [$\beta = 3.759$; 95% CI: 0.60, 6.92]. The rest of the variables were not found to be significantly associated with DSS (Table 4).

In the multiple linear regression model, after adjusting for age, sex, occupation, marital status and health facility attended, the strength and direction of association between DSS and occupation, marital status and health facility attended was not considerably affected (Table 5). Results showed that even after adjustment, participants with any form of employment (salaried and self) had 3.2 and 4.2 lower DSS compared to those who were unemployed, respectively. Similarly, unmarried participants had significantly lower DSS in contrast with their married

Table 2 Comparison of DSS across the 15 food groups among type 2 diabetes patients in Kampala.

Food group	Mean DSS score	95% CI	Comparisons between mean DSS of any two food groups[a]					
Milk and dairy products (fat free)	0.93	0.74, 1.12	–	–	–	–	–	–
Whole grains (cereals) and products	1.52	1.30, 1.74	b	–	–	–	–	–
Lean meats, poultry and fish	1.84	1.65, 2.02	b	–	–	–	–	–
Whole fruits	3.93	3.72, 4.15	–	c	–	–	–	–
Breakfast and refined cereals	4.18	3.94, 4.42	–	c	d	–	–	–
Nuts, legumes and seeds	4.53	4.29, 4.78	–	–	d	e	–	–
Vegetables	4.88	4.66, 5.09	–	–	–	e	–	–
Fats and oils	5.11	4.86, 5.36	–	–	–	e	f	–
Starches and related foods	5.39	5.18, 5.61	–	–	–	–	f	–
Sweets and added sugars	5.43	5.18, 5.67	–	–	–	–	f	g
Milk and dairy products (full fat)	5.92	5.73, 6.11	–	–	–	–	–	g
Red and processed meats	6.03	5.88, 6.19	–	–	–	–	–	g
Vegetable fries	6.32	6.18, 6.47	–	–	–	–	–	h
Fruit juices and dried fruit	6.34	6.18, 6.50	–	–	–	–	–	h
Alcoholic beverages	6.69	6.59, 6.80	–	–	–	–	–	–

[a]The Wilcoxon signed-rank test was used with non-normal data and within-patient correlation structure. The Bonferroni's correction was applied to protect against inflated type 1 error rate arising from multiple independent group comparisons (105 comparison pairs).

[b,c,d,e,f,g,h]Any two DSS means sharing the same letter are not statistically different at the 5% level.

counterparts [$\beta = -2.3$; 95% CI: −4.42, −0.31]. Finally, patients attending Nsambya hospital were observed to have a DSS of almost 4 scores higher compared to those who are treated at Lubaga hospital [$\beta = 3.698$; 95% CI: 0.53, 6.85]. The rest of the sociodemographic factors including age and sex were not found to be correlated with DSS.

Discussion

This study was set out to determine the adequacy of dietary intake among adult patients with T2DM and sociodemographic and environmental factors associated with consuming an adequate diet. Out of the 400 participants, only 49 of them representing a prevalence of 12.25% (95% CI: 9.04–15.46%) had adequate dietary intake. The findings show a very low prevalence of adequate dietary intake among patients with T2DM attending diabetes clinics in Kampala. Few studies have established dietary intake among adult patients with T2DM especially using DSS which cannot guarantee a meaningful and feasible result comparison. However, a lower proportion of participants (2%) were able to consume the recommended serving from all food groups in Malaysian type 2 diabetes adults [8]. DSS have been evidenced to be good proxy for nutrient adequacy and diversity [16] and could therefore be helpful particularly to promote healthy eating in individuals with T2DM given that previous studies have reported a huge contribution of carbohydrate among this population [23], which is a threat to glycaemic control. This study highlights that adequate dietary intake for patients with T2DM should not only focus on the foods consumed but also on the adequacy of intake of each food group depending on its effect on glycaemic and lipid control.

This study shows that T2DM patients who were employed (either though salary or self-employment) had lower DSS and thus consumed a less adequate diet compared to their unemployed counterparts. According to the authors, this finding can be looked at in a way that salaried employees have a busy schedule at work and could therefore not be able to have properly prepared meals. They are likely to have feelings of exhaustion and time scarcity which could result into eating convenient fast foods, eat out, eating junk foods and skipping meals [8]. Eating out has been found to have negative effects on nutrient quality [24] for instance; consumption of high fat and calorie diets [25] and diets low in fibre, calcium, magnesium and potassium which are negatively correlated with glycaemic control [26, 27]. While salaried employees could have some income to buy the recommended foods and consume them in adequate amounts, it is possible that they could also not have appropriate and rightful food choices especially for foods that correlate positively with good glycaemic control like fat free/skimmed milk and dairy products, whole grains and products, whole fruits, vegetables among others. It is therefore necessary that salaried employees should be educated on appropriate food choices so as to encourage adequate dietary intake in this population category.

Table 3 Distribution of dietary intake among participants by sociodemographic and environmental factors.

Variable	Dietary intake	
	Adequate: *n* (%) *N* = 49	Inadequate: *n* (%) *N* = 351
Sociodemographic factors		
Age group		
<50 years	22 (11.7)	166 (88.3)
50 years or more	27 (12.7)	185 (87.3)
Family size (members)		
3 or less	15 (21.7)	54 (78.3)
>3	341 (10.3)	297 (89.7)
Sex		
Male	15 (10.6)	127 (89.4)
Female	34 (13.2)	224 (86.8)
Education level		
No education	4 (9.5)	38 (90.5)
Primary education	16 (11.9)	118 (88.1)
Secondary education	19 (12.7)	131(87.3)
Tertiary education	10 (13.5)	64 (86.5)
Occupation		
Unemployed	17 (18.7)	74 (81.3)
Employed (Salaried)	17 (10.4)	147 (89.6)
Employed (Self)	15 (10.3)	130 (89.7)
Marital status		
Married	43 (14.4)	255 (85.6)
Unmarried	6 (5.9)	96 (94.1)
Religion		
Catholic	16 (9.9)	146 (90.1)
Anglican	20 (18.0)	91(82.0)
Muslim	2 (2.3)	86 (97.7)
Others	11 (28.2)	28 (71.8)
Environmental factors		
Source of nutrition information		
Media	2 (15.4)	11(84.6)
Health worker	44 (12.0)	322 (88.0)
Friends/peers	3 (14.3)	18 (85.7)
Cultural influence on recommended diet		
Yes	2 (10.5)	17 (89.5)
No	47 (12.3)	334 (87.7)
Religious influence on diet		
Yes	2 (4.2)	46 (95.8)
No	47 (13.4)	305 (86.6)
Most frequent eating place		
Home	40 (11.8)	298 (88.2)
Eat out	9 (14.5)	53 (85.5)

Adequate dietary intake = DSS ≥ 78; inadequate dietary intake = DSS < 78.

Table 4 Correlates of DSS among type 2 diabetes adults attending diabetes clinics attached to health care facilities in Kampala[a].

Parameter	β coefficient (95% CI)	*P* value
Age (years)	0.040 (−0.04, 0.12)	0.328
Family size (members)	0.004 (−0.36, 0.38)	0.981
Sex (ref: male)	1.409 (−0.48, 3.30)	0.144
Education level (ref: no education)		
Primary	0.159 (−3.06, 3.37)	0.922
Secondary	0.080 (−3.09, 3.25)	0.96
Tertiary	−0.344 (−3.86, 3.16)	0.847
Occupation (ref: unemployed)		
Employed (salaried)	−3.876 (−6.21, −1.55)	0.001[b]
Employed (self)	−4.483 (−6.87, −2.09)	<0.001[b]
Marital status (ref: married)		
Unmarried	−2.161 (−4.23, −0.09)	0.041[b]
Religion (ref: catholic)		
Anglican	0.264 (−1.97, 2.49)	0.816
Moslem	−1.521 (−3.92, 0.88)	0.213
Other	1.133 (−2.09, 4.37)	0.491
Source of nutrition information (ref: media)		
Health workers	−0.087 (−5.21, 5.03)	0.973
Friends/peers	1.000 (−5.40, 7.40)	0.759
Cultural influence on recommended diet (ref: yes)		
No	−0.139 (−4.40, 4.12)	0.949
Religious influence on recommended diet (ref: yes)		
No	0.986 (−1.80, 3.77)	0.487
Most frequent eating place (ref: home)		
Eat out	−0.062 (−2.56, 2.44)	0.961
Health facility attended (ref: Lubaga Hospital)		
Naguru Hospital	1.015 (−2.03, 4.06)	0.513
Mulago NR Hospital	2.261 (−0.78, 5.30)	0.145
Kisenyi HC IV	1.293 (−2.40, 4.99)	0.492
Nsambya Hospital	3.759 (0.60, 6.916)	0.020[b]

HC Health Centre; *NR* National Referral.

[a]Data are for simple linear regression.

[b]Significant association.

Findings from the present study further suggest that unmarried participants had inadequate dietary intake and consequently lower DSS compared to their married counterparts. Being married could probably result in better and improved social support in regard to meal preparation and dietary choices compared to being single or unmarried. In their study, Kyokunzire and Matovu noted that family support especially from spouses can be a great way to foster diet adherence, better food choices and nutrient adequacy among diabetes patients [28]. These findings are further corroborated by those among older South African patients with T2DM which demonstrated a positive relationship between family support and self-management practices especially regarding the following of a diabetes meal plan [29].

In this study, T2DM patients attending Nsambya hospital diabetes clinic were found to have better dietary adequacy indicated by higher DSS compared to their counterparts in Lubaga hospital. Whereas both are private not for profit faith-based hospitals and offer good diabetes related care and treatment, Nsambya hospital diabetes clinic has received substantial diabetes related projects [30] and is considered one of the "hubs" of leadership in diabetes care and management [31]. The reason why patients at Nsambya hospital diabetes clinic exhibited better diet adequacy could

Table 5 Independent correlates of DSS among type 2 diabetes adults attending diabetes clinics attached to health care facilities in Kampala[a].

Parameter	Adjusted β coefficient (95% CI)	P value
Age	0.032 (−0.05, 0.11)	0.443
Sex (ref: male)	1.473 (−0.48, 3.42)	0.139
Occupation (ref: unemployed)		
Employed (salaried)	−3.162 (−5.63, −0.69)	0.012[b]
Employed (self)	−4.214 (−6.62, −1.80)	0.001[b]
Marital status (ref: married)		
Unmarried	−2.367 (−4.42, −0.31)	0.024[b]
Health facility attended (ref: Lubaga Hospital)		
Naguru Hospital	0.759 (−2.25, 3.77)	0.621
Mulago NR Hospital	2.188 (−0.86, 5.23)	0.159
Kisenyi HC IV	0.933 (−2.74, 4.61)	0.618
Nsambya Hospital	3.698 (0.53, 6.85)	0.022[b]

HC Health Centre; *NR* National Referral.

[a]Data are for multiple linear regression after adjustment for age, sex, occupation, marital status and health facility attended.

[b]Significant association; intercept (α) = 69.02.

be due to the fact that there is a better established diabetes care leadership and human resource capacity to provide adequate self-care knowledge including provision of a variety of diabetes education sessions and nutritional counselling. Seemingly, these arguments cannot entirely explain this association and therefore the authors recommend further studies to assess the health care delivery strategies in different type 2 diabetes clinics in Kampala especially focusing on delivery of nutritional education and counselling services to the patients.

Strengths

The greatest strength of this study is that it assessed dietary intake basing on dietary serving scores which is an adequate proxy for nutrient adequacy and therefore represents dietary intake of these patients putting in consideration the serving sizes for each of the food groups. Our methodology of assessing DSS highlights the need of prioritising foods that promote glycaemic and lipid control within the diets of T2DM patients, while giving less priority to those that negatively impact glycaemic control. This is crucial because it captures both the poor and good food consumption choices in an attempt to measure overall dietary intake adequacy. To the best of our knowledge, assessing diet adequacy using DSS among T2DM patients has not been previously exploited in Africa.

Limitations

The study was limited by the fact that it adopted use of the American Diabetic Association (ADA) recommended serving sizes to measure dietary serving scores due to lack of comparable dietary recommendations/ guidelines among the Ugandan population for which authors cannot guarantee their validity in the Ugandan setting as some of the foods in Ugandan diet are missing in the American diet. However, the authors made an estimation of serving sizes basing on locally used food portion measures (such as utensils) to compensate for this challenge. This study required patients to recall the foods they consumed in the past 7 days which could have introduced recall bias. Nonetheless, the authors believe that the estimations in food consumption provided by the participants were critically assessed to ensure accuracy by using equivalent measures such as food albums and models as discussed prior in the methodology which could elicit greater recall power.

Conclusion

The study found a very low prevalence of adequate dietary intake which is worrying if we are to achieve proper glycaemic control and prevent diabetes related complications among these T2DM patients. There is need for interventions that improve dietary intake among these patients. It also appears from this study that more support is needed especially in terms of self-care and decision making when it comes to consumption of adequate diets more so for patients without partners and those who live independently. Finally, salaried employees should also spare time to consume well prepared meals by specifically aiming to have diverse and adequate diets; taking advantage of the fact that they are employed and have the financial capacity to buy foods that can meet their recommended dietary intake.

Data availability

Datasets generated and analysed during the study are not publicly available due to terms of participant consent but are available in anonymised form from the corresponding author on reasonable request.

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Author contributions SK, DG and RK contributed to the conceptualisation and design of the study; SK and NM designed research tools and assisted in data collection; SK and NM analysed and interpreted the data. SK and NM wrote the first draft of the manuscript. DG and RK reviewed the manuscript for important intellectual content. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval Approval to conduct the study was sought from MakSPH Health Higher Degrees Research and Ethics Committee. Permission to collect data was sought from the five health facilities.

Informed consent Verbal and written informed consent in the local language was obtained from the respondents and collected information was kept confidential. The investigator provided an explanation of the purpose, risks and benefits of the study to the participants.

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