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Original article

Preference of sweeteners among Saudi diabetes patients from a tertiary health care centre in Riyadh, Saudi Arabia

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ABSTRACT

Background: Choice of sweetening options can influence glyceamic control among patients with diabetes. This study aims to investigate the preference of added sweeteners for Saudi patients with diabetes, factors associated with the choice of sweeteners and the attitude of the patients towards the use of artificial sweeteners.

Methods: This was a cross-sectional study conducted at King Saud University Medical City in Riyadh, Saudi Arabia and targeting Saudi patients with type 2 diabetes mellitus. Data was collected via personal interviews accessing medical records of interviewed patients. Patients were asked about consumption of sweeteners and types of consumed soft drinks on daily basis. Bi-variate analysis of the associations between choice of sweeteners and patients characteristics was performed and followed by binary logistic regression to adjust for potential confounders such as age, gender, and education level.

Results: A total of 302 Saudi diabetic patients were recruited in this investigation. Among this sample, frequency of patients reporting weekly consumption of white sugar was the highest (57%), followed by honey (26%) and artificial sweeteners (12% for powder form and 10.5% for tablets). Consumption of white sugar was significantly more frequent among patients with higher level of Body Mass Index (BMI) (P value < 0.05). The frequency of using honey was higher among females while consumption of either sugared or low calorie soft drinks was significantly higher among male patients (P values < 0.05). Upon asking the patients about their attitude towards artificial sweeteners, only 25% of the sample agreed that their use can aid in reduction of caloric intake while 35% of the sample agreed that artificial sweeteners can be harmful to the body.

Conclusions: Among this sample of type 2 diabetes patients, the frequency of white sugar and honey use as a sweetening option is high. These findings generate the need for further research to investigate the effectiveness of health education and nutritional advice among diabetes patients attending similar clinical settings in Saudi Arabia.

1. Introduction

Saudi Arabia is currently witnessing an epidemic of diabetes leading to multiple health and economic consequences. According to the International Diabetes Federation (IDF), Saudi Arabia has the highest age adjusted diabetes prevalence in the Middle East and North Africa region (MENA) (IDF, 2017a). With nearly four million Saudi adults diagnosed with diabetes, the overall prevalence of diabetes among adults is reaching 18% (IDF, 2017b). This increasing trend of diabetes is driven by the high prevalence of risk factors,

Abbreviations: BMI, Body Mass Index; IDF, International Diabetes Federation; MENA, Middle East and North Africa; MoH, Ministry of Health; PHCCs, Primary healthcare Clinics; WHO, World Health Organization.

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such as overweight, obesity and lack of physical activity (WHO, 2016). It has been estimated that healthcare expenses of diabetic patients in Saudi Arabia are costing around 14% of the overall health expenditure in the country (Robert et al., 2017).

Prevention of health consequences among diabetic patients requires competent glycaemic control. The magnitude of comorbidities induced by diabetes is likely to be augmented by poor glycaemic control. In a recent cross-sectional study performed in three major cities in Saudi Arabia and targeting 1111 participants diagnosed with diabetes, it was reported that 34% of patients had very poor glycaemic control (Alramadan et al., 2018b). A systematic review which investigated factors associated with poor glycaemic control in Gulf Cooperation Council Countries, including Saudi Arabia, revealed several factors influencing glycaemic control, such as poor dietary practices among patients (Alramadan et al., 2018a).

The choice of food items can aid in proper overall control of body weight and glycaemic index. According to the Saudi Guidelines for Prevention and Management of Obesity, consumption of fruits, vegetable, whole-grain products, and lower fat food items is recommended. Additionally, the consumption of a small amount of food items high in fat and/or sugar is advised (MoH, 2016). Nonetheless, studies measuring dietary habits among diabetes patients in Saudi Arabia are limited (Midhet et al., 2010, Mohamed et al., 2013). Furthermore, studies assessing choice of sweeteners used among Saudi diabetes patients are currently lacking.

According to the Saudi National Reference For Diabetes Mellitus Guidelines In Primary Health Care, low calorie sweeteners, such as sucrose, fructose and aspartame can be part of a balanced meal for patients with diabetes (MoH, 2014). Similarly, The British Dietetic Association and Canadian Department of Health reported the safety of artificial sweeteners and suitability for use by diabetes patients. Since artificial sweeteners can be of few calories or calorie free, this can aid in weight reduction and better glycaemic control among diabetes patients (BDA, 2016, CDH, 2008).

Although low-calorie sweeteners are recommended for patients with diabetes to improve body weight management and glycemic control, there is a controversy concerning potential harm of low-calorie sweeteners among healthy individuals and patients with diabetes. Animal studies reported harmful effects of low-calorie sweeteners related to induction of glucose intolerance via alteration of intestinal microbiota (Suez et al., 2014) and induction of metabolic alteration among different animal species (Shearer and Swithers, 2016). A systematic review and meta-analysis involving 7 trials and 30 cohort studies including healthy, overweight, obese and hypertensive participants was conducted to measure association between non-nutritive sweeteners and cardiometabolic health such as weight gain, incidence of metabolic syndrome and type 2 diabetes. The findings of this systematic review indicated potential presence publication bias and inconsistencies where Randomized Controlled Trials supported weight-loss effect among subjects with sustained low-calorie sweeteners consumption while observational studies provided contradicting findings (Azad et al., 2017). Therefore, further long-term studies have been suggested for better understanding of effect of different types of low-calorie sweeteners (Kim et al., 2019, Sylvetsky and Rother, 2018, Hunter et al., 2019).

There are several sweetening options available in the Saudi market that can be added to drinks or sweet dishes. These options include white sugar, brown sugar, honey and artificial sweeteners. Currently, the choice of added sweeteners to drinks and food among Saudi diabetes patients is not measured especially with the conflicting evidence of influence of artificial sweeteners on glycemic control and weight management. This study aims to investigate the preference of added sweeteners among patients with diabetes, factors associated with the choice of sweeteners and the attitude of the patients towards the use of artificial sweeteners.

2. Materials and methods

2.1. Study design and setting

This was a cross-sectional study conducted at King Saud University Medical City in Riyadh, Saudi Arabia. Participants were recruited upon their visit to primary healthcare clinics (PHCCs) between May and July 2017. Ethical approval to conduct this study was provided by the Institutional Review Board at the College of Medicine, King Saud University.

2.2. Study population

The study included Saudi patients with type 2 diabetes mellitus. Patients who were not Saudi, patients with type 1 diabetes mellitus, and patients who reported a history of bariatric surgery were excluded. Patients were randomly approached during their waiting time at the PHCCs, and those who consented to participate and met the study's inclusion criteria were included in the study.

Sample size was estimated using STATCAL function of EpiInfo software. Based on a previous study conducted in Riyadh to measure dietary habits of 222 Saudi patients with diabetes, the prevalence of moderate artificial sweetener consumption was 28.1% (Mohamed et al., 2013). A sample of 310 patients was estimated assuming a prevalence of 28.1% of the use of artificial sweeteners, 5% margin of error and 95% of confidence interval.

2.3. Data collection

Data was collected via personal interviews using a structured questionnaire and accessing medical records of interviewed patients. A questionnaire was developed to measure the consumption of sweeteners among type 2 diabetes patients, their attitude towards artificial sweetener consumption and patient demographics. Relevant literature of studies measuring dietary habits among diabetics and studies measuring dietary habits among Saudis was consulted to identify sweeteners frequently used by Saudis and the choice of soft drinks, such as sugar-sweetened and low calorie soft drinks (Gardner et al., 2012, Al-Kaabi et al., 2008, Mohamed et al., 2013, Gosadi et al., 2017). The choices of sweeteners identified were white sugar, brown sugar, honey, powder form of artificial sweeteners or tablet forms of artificial sweeteners.

The questionnaire was reviewed by a panel of experts that included two family physicians, one endocrinologist, one nutritionist and one research methodologist, then piloted on a sample of 20 subjects to test its clarity, time needed to complete the questionnaire, and to assess its comprehensiveness in terms of measuring preference of sweetening options and attitude toward artificial sweeteners. Participants' electronic medical records were accessed to retrieve their physical and laboratory measurements. Physical measurements included the latest recorded body mass index (BMI). Laboratory measurements included the latest serum HbA1C.

2.4. Data analysis

Data was analysed using the Statistical Package for the Social Sciences (SPSS), Version 21.0, Chicago, IL, USA. After testing normality of distribution of continuous variables, data means and standard deviations (SDs) were used to summarise normally distributed continuous variables, medians, and minimum and maximum values were provided to summarise skewed variables.

Frequencies and proportions were used to summarise binary and categorical variables.

To measure frequency and the amount of sweeteners consumed by patients, they were asked to report the type of sweetener and the number of teaspoons or tablets added to specific drinks or dishes. These food items included tea, coffee, other drinks such as hot chocolate, juices, sweet dishes, and a choice of sugar-sweetened soft drinks or low calorie soft drinks. Among those who reported consumption of these food items, they were asked about the number of teaspoons or tablets added to each drink or dish per each consumption or the number of cans of soft drink consumed on a daily basis. The number of teaspoons or tablets of sweetener added to drinks or sweet dishes on a daily basis was calculated and summed to report the weekly number of teaspoons or tablets consumed of each type of sweetener.

Due to the low consumption of specific types of sweeteners among this sample, the sample was grouped according to the consumption of each type of sweetener where the cut-off point of consuming seven teaspoons or tablets per week, or one can of soft drinks per week was used. Based on this cut-off point of weekly consumption, the sample was grouped to compare those who reported consumption of seven teaspoons or tablets of sweetener or one can per week to those who reported consumption of less than seven teaspoons or tablets of sweetener or less than one can per week. Similarly, continuous data such as age, level of BMI, number of years since diagnosis with type 2 diabetes and level of HbA1c was grouped using means as cut-off points to allow comparisons between sweetener consumption and study sample characteristics. Chi square test or Fisher exact test was used to investigate statistical difference of consumption of sweeteners according to sample characteristics. Binary logistic regression was performed to explore significant associations detected in the bi-variate analysis where adjusting for potential confounders such as age, gender, and education level was conducted. A p-value of 0.05 or less was designated as statistically significant for the applied statistical tests.

3. Results

A total of 302 Saudi diabetic patients were approached and agreed to participate in this investigation. Table 1 describes the characteristics of the study's sample. The average age of recruited patients was 55 years and the proportion of recruited female patients was relatively higher. Around 20% of the sample were illiterate and around 46% of the sample had high school education or above. The mean BMI of recruited patients was 32, the mean number of years since diagnosis with diabetes was 11.3 years and the mean level of HbA1c was 8.2%.

Table 2 describes the frequency of patients who reported consuming different types of sweeteners and choice of soft drink. Fifty-seven percent of patients reported consumption of white sugar on a weekly basis where the median of weekly consumption was seven teaspoons per week. The proportion of diabetes patients who reported consumption of honey on a weekly basis was 26%. The frequency of patients consuming either tablet or powder forms of artificial sweetener was smaller in comparison to white sugar and honey consumption. Observing the maximum number of teaspoons of white sugar or honey consumed on a weekly basis may indicate heavy dependence of some diabetic patients on white sugar and honey as sweetening options. Finally, the number of patients reporting weekly consumption of sugar-sweetened soft drinks is higher than those who reported consumption of low-calorie soft drinks.

Table 3 describes the frequency of consuming different types of added sweeteners among recruited patients. Among diabetes patients who reported consumption of tea, coffee, other drinks, and sweet dishes, the majority of them reported adding white sugar to all food items. Eighteen percent of tea consumers, 13% of coffee consumers and 14% of consumers of others drinks reported using artificial sweeteners as an additive. Among patients who reported consumption of sweet dishes, 19% of them reported using honey as the sweetening option. Only a minority of patients reported using brown sugar as a sweetening option.

Table 4 describes the frequencies and proportions of diabetes patients who reported a weekly consumption of a minimum of seven teaspoons of different types of sweeteners, weekly consumption of seven tablets of artificial sweeteners or weekly consumption of one can of either sugared or low-calorie soft drinks according to binary or categorical study characteristics. The frequency of patients reporting a minimum consumption of seven teaspoons of white sugar per week was significantly higher among patients with a BMI higher than 31 and among patients with less than 11 years since diagnosis (p values < 0.05). The frequency of consuming seven teaspoons of honey per week was significantly higher among females in comparison to males. The frequency of patients reporting consumption of a minimum of one can of either sugar-sweetened or low-calorie soft drinks was significantly higher among males in comparison to females (p values < 0.05).

The frequency of patients reporting weekly consumption of seven teaspoons of brown sugar, powder form of artificial sweeteners, or seven tablets of artificial sweetener was not statistically associated with any characteristics. Similarly, the level of education and level of HbA1c did not show any statistical association

Table 1
Characteristics of 302 type 2 diabetes patients attending a tertiary healthcare centre in Riyadh, Saudi Arabia:

Variables	
Age (years): mean [SD]	55 [10.2]
Gender: n [%]	
Male	129 [42.7%]
Female	173 [57%]
Education Level*: n [%]	
Illiterate	59 [19.5%]
Elementary school	54 [17.9%]
Intermediate school	44 [14.6%]
High school	80 [26.5%]
University and above	60 [19.9%]
BMI: mean [SD]*	32 [6.7]
Years since diagnosis with DM: mean [SD]*	11.3 [7.7]
HbA1c %: mean [SD]*	8.2 [1.8]

* 5 missing cases for education level, 17 missing cases for BMI, 4 missing cases for number of years since diagnosis with DM, and 41 missing cases for HbA1c.

Table 2
Weekly consumption of sweeteners and soft drinks among a sample of 302 type 2 diabetes patients attending a tertiary healthcare centre in Riyadh, Saudi Arabia:

	Frequency [%] of patients reporting weekly consumption	Medians amount of weekly consumption [minimum–maximum]*
White sugar [spoons]	173 [57%]	7 [0.25–105]
Brown sugar [spoons]	21 [7%]	7 [1.5–35]
Honey [spoons]	80 [26%]	7 [0.25–70]
Artificial sweeteners [tablets]	32 [10.5%]	7 [0.25–84]
Artificial sweeteners [powder: spoons]	37 [12%]	6 [0.5–30]
Sugar-sweetened soft drinks [cans]	32 [10.5%]	2 [1–7]
Diet soft drinks [cans]	11 [3.6%]	1 [1–4]

* Among consumers of each item.

Table 3
Choice of added sweeteners to drinks and food among a sample of 302 type 2 diabetes patients attending a tertiary healthcare center in Riyadh, Saudi Arabia.

Food items: frequency [percent]*	White sugar	Brown sugar	Honey	Artificial sweeteners	P value**
Tea	150 [55%]	15 [6%]	9 [3%]	48 [18%]	<0.001
Coffee	58 [40%]	6 [4%]	2 [1.4%]	19 [13%]	<0.001
Other drinks: eg. Hot chocolate, juice	71 [78%]	4 [4.4%]	13 [14%]	13 [14%]	<0.001
Sweet dishes	110 [49%]	7 [3%]	43 [19%]	5 [2%]	<0.001

* Percentages among patients who reported consumption of each food item.
** Chi Square test for the presence of statistical difference of choice of added sweeteners to each drink and food.

Table 4
Choices of sweeteners and soft drinks according to characteristics of 302 type 2 diabetes patients attending a tertiary healthcare center in Riyadh, Saudi Arabia:

	White sugar*	Brown sugar*	Honey*	Artificial sweeteners (tablets)**	Artificial sweeteners (powder)*	Sugar sweetened soft drinks***	Diet soft drinks***
Age							
50 years or less	75 [48%]	9 [6%]	23 [15%]	15 [10%]	10 [7%]	21 [14%]	4 [3%]
Older than 50 years	57 [39%]	5 [3%]	20 [14%]	9 [6%]	8 [5.4%]	11 [8%]	7 [5%]
P values	0.092[a]	0.32[a]	0.759[a]	0.254[a]	0.711[a]	0.087[a]	0.368[b]
Gender							
Males	54 [42%]	3 [2%]	**12 [9%]**	7 [5%]	9 [7%]	**22 [17%]**	**10 [8%]**
Females	78 [45%]	11[6%]	**31 [18%]**	17 [10%]	9 [5%]	**10 [6%]**	**1 [1%]**
P values	0.576[a]	0.165[b]	**0.034**[a]	0.162[a]	0.519[a]	**0.002**[a]	**0.001**[b]
Education Level							
Illiterate	28 [48%]	1 [2%]	9 [15%]	3 [5%]	1 [2%]	4 [7%]	1 [2%]
Elementary	22 [41%]	2 [4%]	8 [15%]	3 [6%]	2 [4%]	3 [6%]	2 [4%]
Intermediate	23 [52%]	4 [9%]	7 [16%]	4 [9%]	4 [9%]	5 [11%]	2 [5%]
Secondary	37 [46%]	1 [1%]	9 [11%]	8 [10%]	6 [8%]	15 [19%]	3 [4%]
University	21 [35%]	6 [10%]	10 [17%]	6 [10%]	5 [8%]	5 [8%]]	3 [5%]
P values	0.411[a]	0.09[b]	0.867[a]	0.837[b]	0.465[b]	0.169[b]	0.931[b]
BMI							
Less than 30	**45 [37%]**	6 [5%]	17 [14%]	11 [9%]	10 [8%]	10 [8%]	5 [4%]
30 and above	**80 [49%]**	8 {5%]	24 [15%]	11 [6.7%]	8 [5%]	19 [12%]	5 [3%]
P values	**0.04**[a]	0.997[a]	0.851[a]	0.478[a]	0.259[a]	0.339[a]	0.640[a]
Years since diagnosis							
Less than 11 years	**82 [50%]**	11[7%]	22 [13%]	10 [6%]	7 [4%]	22 [13%]	6 [4%]
11 years or more	**50 [37%]**	3 [2%]	21 [15%]	14 [10%]	11 [8%]	10 [7%]	5 [4%]
P values	**0.027**[a]	0.056[b]	0.741[a]	0.205[a]	0.223[a]	0.09[a]	0.995[a]
HbA1c %							
Less than 8	53 [43%]	9 [7%]	17 [14%]	11 [9%]	7 [6%]	11 [9%]	3 [2%]
8 and above	59 [43%]	5 [4%]	21 [15%]	10 [7%]	9 [7%]	15 [11%]	6 [4%]
P values	0.958[a]	0.196[a]	0.711[a]	0.641[a]	0.756[a]	0.576[a]	0.505[b]

* Frequency [percentage] of patients consuming a minimum 7 spoons weekly.
** Frequency [percentage] of patients consuming a minimum of 7 tablets per week.
*** Frequency [percentage] of patients consuming a minimum of 1 can per week.
[a] Pearson Chi-Square.
[b] Fisher's Exact Test.

with frequencies of patients reporting consumption of different types of sweeteners. Although age did not show any statistically significant association with the frequency of patients reporting consumption of different types of sweeteners, the frequencies of patients 50 years old or less was higher among those who reported consuming a minimum of seven teaspoons of white sugar per week or a minimum of one can of sugared soft drinks per week with marginal statistical significance (p values 0.092 and 0.087 consecutively). This may indicate a tendency of younger patients to consume white sugar or sugar sweetened drinks more frequently in comparison to older patients.

Statistically significant associations detected in the bi-variate analysis were further explored using logistic regression to test for the potential influence of confounders such as age, gender and education level (Table 5). Odds ratios of associations between consumptions of honey, and soft drinks remained statistically significant after adjusting for age and education level. However, It can be noted that the confidence intervals of the ratios are wide espe-

Table 5
Logistic regression to explore the association between choices of sweeteners and soft drinks according to gender, BMI, and years since diagnosis with diabetes among 302 type 2 diabetes patients attending a tertiary healthcare center in Riyadh, Saudi Arabia:

Associations [Reference group]	Unadjusted odds ratio	P value	Adjusted odds ratio	P value
Honey consumption according to gender [Males]	2.12 [1.04–4.3]	**0.037**	2.26 [1.005–49]	**0.049***
Soft drinks consumption according to gender [Females]	3.3 [1.5–7.3]	**0.003**	4.1 [1.6–10.1]	**0.002***
Diet soft drinks consumption according to gender [Females]	14.4 [1.8–114]	**0.01**	17.8 [2.1–155]	**0.009***
White sugar consumption according to BMI [BMI less than 30]	1.6 [1.02–2.6]	**0.04**	1.5 [0.9–2.5]	0.09**
White sugar consumption according to number of years since diagnosis [11 years or more]	1.7 [1.08–2.7]	**0.02**	1.4 [0.9–2.4]	0.11**

* Adjusting for age and education level.
** Adjusting for age, gender, and education level.

Table 6
Attitude of 302 type 2 diabetes patients attending a tertiary healthcare center in Riyadh, Saudi Arabia toward artificial sweeteners consumption:

Statement	Agreement frequency [percentage]
Artificial sweeteners use can help in weight reduction	43 [14%]
Artificial sweeteners use aids in glycemic control	56 [19%]
Artificial sweeteners use reduces caloric intake	74 [25%]
Artificial sweeteners can be harmful to the body	106 [35%]
Artificial sweeteners can cause heart diseases	50 [17%]
Artificial sweeteners can cause cancer	55 [18%]

cially for association between gender and diet soft drink consumption which is explained by the small number of patients who reported consumption of low-calorie soft drinks in our sample. Additionally, the associations between white sugar consumption and BMI level or number of years since diagnosis with diabetes became statistically non-significant after adjusting for age, gender and education level.

It can be noted that the frequency of patients who consume artificial sweeteners is lower than the frequency of those who reported consuming white sugar or honey. Table 6 summarises the attitude of recruited patients about statements related to the benefits and safety of artificial sweeteners that may explain the low frequency of using artificial sweeteners as an additive among this sample of patients. A minority of interviewed patients had a positive attitude toward artificial sweeteners where only 14% agreed that artificial sweeteners can help in weight reduction, 19% agreed that they can aid glycaemic control, and only 25% of patients agreed that using artificial sweeteners can reduce caloric values of consumed meals. Additionally, 35% of interviewed patients agreed that artificial sweeteners can be harmful to the body, 18% agreed that they may cause cancer and 17% agreed they can cause heart diseases.

4. Discussion

This cross-sectional study investigated choices of sweeteners among a sample of 302 diabetes patients in a tertiary health care setting in Riyadh, Saudi Arabia. White sugar was the most frequently used sweetening option among the patients, followed by honey and artificial sweeteners. Consumption of white sugar was significantly more frequent among patients with higher level of BMI and significantly more frequent among patients with a duration of 11 years or less since diagnosis with diabetes. The frequency of using honey was higher among females while consumption of either sugared or low calorie soft drinks was significantly higher among male patients. Upon asking the participants about their attitude towards artificial sweeteners, only 25% of the sample agreed that their use can aid in reduction of caloric intake while 35% of the sample agreed that they can be harmful to the body.

The findings of this study can be compared to other investigations conducted in Saudi Arabia to measure dietary habits among either Saudi patients with diabetes or the general Saudi population. In a study assessing dietary habits among 222 patients with type 2 diabetes, it was revealed that 47% of the patients reported use of sugar, 30% of them reported use of artificial sweeteners and 60% of the sample reported the use of low calorie soft drinks. Apart from the high proportion of patients reporting consumption of low calorie soft drinks and a higher frequency of artificial sweetener use in comparison to our study, their study did not provide a clear description of the amount of sweeteners used or number of cans consumed by the patients (Mohamed et al., 2013).

In 2013, the Saudi Health Interview Survey targeted 10,735 Saudis of 15 years or older. The survey recruited the participants via household visits where dietary habits among Saudis was one of the measured components. It was revealed that the average daily consumption of sugar-sweetened beverages among Saudis was 115.5 ml, and the consumption was significantly higher among males and those of a younger age (Moradi-Lakeh et al., 2017). These findings are similar to ours where consumption of soft drinks was higher among males and younger patients. Additionally, in a study assessing dietary habit among a limited sample of 50 patients involving type 1 and type 2 diabetes in the north of Saudi Arabia, it was reported that 28% of the sample were regular consumers of honey which is similar to our findings (Alharbi et al., 2016).

A longitudinal study conducted in a central region in Saudi Arabia assessed changes of lifestyle, including dietary habits among 1011 patients diagnosed with chronic diseases, including diabetes, hypertension, and coronary hearth diseases after receiving health education during their visits PHCCs. The study did not report overall consumption of sweetening options, but revealed that around 14% of their sample reported consumption of artificially sweetened beverages during the 24 h before interviews (Sharaf, 2010). While acknowledging the methodological differences, this proportion is similar to the frequency of patients reporting consumption of artificial sweeteners on a weekly basis in our sample.

Although artificial sweeteners can be a safe and beneficial sweetening option for patients with diabetes, the high frequency of patients opting to use white sugar and honey as sweetening choices can be alarming. Patients recruited in our study were drawn from a tertiary health care facility with available health education and clinical nutrition services. Nonetheless, it would be worth investigating why type 2 diabetes patients are exhibiting high usage of white sugar and honey and why around one third of the sample agree that artificial sweetener consumption can be harmful to patients.

This study has multiple areas of strengths and weaknesses. This study was able to quantify consumption of sweetening options with higher caloric value that can influence body weight and glycaemic index among patients with type 2 diabetes. The distribution of the study demographics of the sample might indicate reasonable representation of patients with diabetes in similar tertiary clinical settings. The clinical importance of this investigation stems from detecting possible limited influence of health education and nutritional advice on dietary practice among this sample of patients with diabetes. This limited influence may explain the high consumption of white sugar and honey and the unfavorable attitude toward artificial sweeteners among our sample.

Limitations of this investigation are dependent on the quality of medical records and number of missing cases, in particular for patients with recorded values pertaining to their BMI and HbA1c. Additionally, this sample is limited to a single tertiary health care centre and the ability to generalize the findings of this investigation to type 2 diabetes patients vising primary and secondary health care settings is limited. This limitation of generalizability might indicate an area for further research in other clinical settings.

5. Conclusion

Among this sample of type 2 diabetes patients, the frequency of white sugar and honey use as a sweetening option is high. Additionally, opting to use artificial sweeteners among this sample is low. Low consumption of artificial sweeteners can be explained by the negative attitude of the patients towards low calorie sweeteners. These findings generate a need for further research to inves-

tigate the effectiveness of health education and nutritional advice provided to type 2 diabetes patients.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Contributors

IG: Study concept and drafting of manuscript.
AA: Study design and analysis.
RS: Data analysis.
BA: Data collection and analysis.
MB: Drafting and revision of manuscript.
NA: Data collection and analysis.

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