

Meal Skipping among Patients with Type 2 Diabetes Mellitus (T2DM) and Its Associations with Glycaemic Control, Eating Out of Home and Binge Eating

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ABSTRAK

Tabiat langkau waktu makan adalah kaedah lazim untuk mengawal diet. Namun, amalan kaedah pemakanan ini oleh pesakit diabetes mellitus (T2DM) masih belum diketahui berikutan kekangan kajian. Matlamat utama kajian ini adalah untuk mengenal pasti selazim mana pesakit T2DM melangkau waktu makan. Kaitannya dengan faktor sosiodemografi dan klinikal, HbA1c, makan di luar rumah dan kecelaruan gaya pemakanan turut dikaji. Kajian keratan lintang ini telah dijalankan pada tahun 2015 dalam kalangan 203 pesakit di klinik kesihatan awam di Kuala Lumpur. Borang soal selidik yang diisi sendiri oleh subjek termasuk

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borang Skala Kecelaruhan Gaya Pemakanan dalam Bahasa Melayu. Seramai 41.4% subjek kerap melangkau waktu makan dan 61.6% subjek sering makan di luar. Hanya 2% sahaja yang mempunyai masalah kecelaruhan gaya pemakanan. Regresi logistik berbilang menunjukkan subjek berbangsa Cina mempunyai kaitan yang kuat dengan tabiat melangkau waktu makan berbanding dengan subjek berbangsa Melayu (nisbah ganjil selaras: 0.36; 95% sela keyakinan: 0.16-0.77; nilai p: 0.009) setelah mengambil kira faktor usia, status pekerjaan, tahap pendidikan, HbA1c, komplikasi, jenis rawatan, makan di luar dan kecelaruhan gaya pemakanan. Kesimpulannya, tabiat melangkau waktu makan merupakan satu amalan lazim begitu juga dengan makan di luar rumah. Namun, kecelaruhan gaya pemakanan jarang dijumpai. Tabiat melangkau waktu makan tiada kaitan dengan amalan pemakanan ini dan juga kawalan gula dalam darah. Faktor budaya dan keagamaan berkemungkinan mempengaruhi amalan pemakanan individu. Kajian lanjut perlu dijalankan bagi mengenal pasti tahap keselamatan dan penerimaan berkaitan dengan amalan ini. Walau bagaimanapun, kesannya daripada sudut klinikal perlu diperiksa dengan teliti untuk mengelakkan komplikasi kesihatan.

Kata kunci: diabetes mellitus, gaya pemakanan, gula darah, makanan

ABSTRACT

Meal skipping is a common way to restrict diet, but its practice by patients with type 2 diabetes mellitus (T2DM) remains undetermined due to the scarcity of the research. The main aim of this study was to assess how common patients with T2DM skipped meals. Its associations with sociodemographic and clinical characteristics, HbA1c, eating out of home and binge eating were examined too. This cross-sectional study was conducted in 2015 among 203 patients at a public healthcare clinic in Kuala Lumpur. A self-administered questionnaire including the Malay-version Binge Eating Scale was used. The proportions of participants who frequently skipped meals and ate out of home were 41.4% and 61.6%, respectively. Only 2% of them had binge eating disorder. Multiple logistic regression showed only Chinese was significantly associated with frequent meal skipping compared to Malay (adjusted odds ratio: 0.36; 95% confidence interval: 0.16-0.77; p value= 0.009) after controlling for age, employment status, educational status, HbA1c, presence of complication, type of treatment, eating out of home and binge eating. In conclusion, meal skipping was a frequently practised eating behaviour. Eating out of home was common too, but binge eating was rare. Meal skipping was not influenced by both eating practices and it had insignificant associations with glycaemic control. Cultural and religious factors may play an important role in defining their eating practice. Further studies are needed to assess the safety and acceptability of this practice, but clinically, its effects must be individually examined to prevent unwanted consequences on their health.

Keywords: blood glucose, diabetes mellitus, feeding behaviour, meals

INTRODUCTION

Eating behaviour is a complex human behaviour that involves making decisions on what to eat, how much, when and how frequently (LaCaille 2013; Meule & Vögele 2013). It is not only about food selection and consumption but encompasses meal planning and preparation, food preference, meal patterns and eating habits or practices, such as meal skipping, eating out of home, restrictive eating behaviour, emotional eating, overeating and bingeing (LaCaille 2013; Meule & Vögele 2013; Yannakoulia 2006). Taking three meals a day, which are breakfast, lunch and dinner, is commonly considered a norm worldwide. However, industrialisation and food availability have led to grazing eating behaviour and overeating in modern society (Fjellström 2004). In Malaysia, this eating behaviour is not unusual as Malaysia is famous as a food heaven. In most cities, 24-hour restaurants and food eateries are widely available on every corner and eating out of home at these premises is commonly observed (Ali & Abdullah 2012). However, once people are diagnosed with type 2 diabetes mellitus (T2DM), they have a challenging task to change their eating behaviour as diet plays an important role in optimising glycaemic control, maintaining body weight goals and preventing diabetes-related complications (Evert et al. 2019; Neblett et al. 2019; Nor et al. 2019; Buchmann et al. 2016). They must constantly monitor their eating behaviour through self-regulation and good discipline

(Meule & Vögele 2013).

Patients with T2DM are recommended to eat healthily through taking a variety of nutrient-dense foods with adequate intake of protein and fibre and controlling food portions (e.g. reduced fat and overall intake of carbohydrate, especially added sugar and refined grains) (Evert et al. 2019; Sievenpiper et al. 2018). Carbohydrate spacing, meal spacing and maintaining regularity in meal timing are also emphasised to optimise glycaemic control (Sievenpiper et al. 2018). Meal frequency and regularity are especially important for those who have increased risk for hypoglycaemia. However, many patients are unable to consistently comply with the recommended diet. Based on a systematic review, about half of patients with T2DM had poor or partial adherence to a healthy diet (Mogre et al. 2019). They only took the healthy diet for less than 5 days in a week (Mogre et al. 2019). In Malaysia, an almost similar level of dietary adherence has been observed among patients with T2DM (Tohid et al. 2017; Papo et al. 2019; Bariyyah et al. 2018; Tharek et al. 2018). However, their meal frequency and regularity are still poorly understood as studies in this area are still lacking. How their eating patterns affect the glycaemic control remains undetermined.

Meal frequency and its timing may significantly affect various cardiovascular markers including obesity, lipid profile, insulin resistance, and blood pressure (St-Onge et al. 2017). In T2DM, the practice of regular meal timing reflects discipline eating behaviour whereby consistent

carbohydrate intake and spacing can maintain good glycemic control (Sievenpiper et al. 2018). However, some of them tend to skip their meals as an effort to restrict their dietary intake. Among patients with T2DM in Malaysia, Turkey, India, Nigeria and Japan, the prevalence of skipping at least one main meal ranges between 9.6% and 59.0% (Ercan & Kiziltan 2013; Gunggu et al. 2016; Olatona et al. 2019; Chacko & Begum 2016; Gouda et al. 2018). The wide range of prevalence may indicate various practices between countries and possible underreporting of meal skipping due to social desirability biased response (McCrorry & Campbell 2011).

Previous studies have demonstrated the negative effects of less frequent daily meals and meal skipping, particularly breakfast, on healthy individuals and those with T2DM (McCrorry & Campbell 2011; Gouda et al. 2018; Iwasaki et al. 2019; Hutchison & Heilbronn 2016). It leads to poorer glycaemic control, reduced fat oxidation and higher body mass index (BMI) (McCrorry & Campbell 2011; Gouda et al. 2018; Iwasaki et al. 2019). Increased meal frequency has been shown to significantly improve glucose and lipid metabolism if the total daily calorie intake does not exceed energy requirement (Hibi et al. 2019; Paoli et al. 2019; Papakonstantinou et al. 2018; Hutchison & Heilbronn 2016; McCrorry & Campbell 2011). However, some studies support the practice of less frequent meals. Positive response on appetite hormones, gastrointestinal hormones and glucose metabolism

has been demonstrated with reduced meal frequency of fewer than three meals a day, leading to lower body weight, hepatic fat content and insulin resistance (Belinova et al. 2017; Kahleova et al. 2014). In line with this evidence, alternate-day fasting, intermittent fasting and restricted eating time within 4 to 13 hours through 1 to 2 day-time meals could also benefit patients with T2DM by improving glucose and lipid metabolism, and reducing weight (Paoli et al. 2019; Hutchison & Heilbronn 2016; Patterson & Sears 2017). Tolerability of fasting was also demonstrated by a local study done by Leow & Tong (2019), whereby 7 in 10 patients with T2DM in the study could successfully fast for about 14 hours every day in the whole month of Ramadan, without experiencing hypoglycaemia. Because of this available evidence, the effects of eating frequency on patients with T2DM are still conflicting, thus further studies are needed (Paoli et al. 2019; Hutchison & Heilbronn 2016).

The main aim of this study was to determine how common patients with T2DM at a public healthcare clinic in Malaysia skipped meals. Besides, the sociodemographic and clinical factors associated with frequent meal skipping were examined. These factors include HbA1c and other eating practices such as eating out of home and binge eating. As studies on meal skipping among patients with T2DM are still scarce, the findings of this study could provide further understanding about this eating behaviour and its associations with other factors, specifically glycaemic

control.

MATERIALS AND METHODS

This cross-sectional study was carried out among T2DM patients attending Cheras Health Clinic. All 302 T2DM patients who attended the clinic during the two-week data collection period in August 2015 were screened for their eligibility. The inclusion criteria were Malaysian citizens aged 18 years old and above with HbA1c done within the past 1 year and able to read and understand the Malay language. Patients who came for emergency treatment or with dementia, dependency on others for feeding or pregnancy were excluded from this study.

Only 203 patients who met the study criteria and agreed to participate in this study. The number of participants was more than the sample size required, which was 196, calculated using StatCalc Epi Info™ for population survey. Based on the available evidence, the prevalence of patients with T2DM who skipped at least one meal was estimated at 15% to calculate the sample size, in which precision of 5% and 95% confidence interval was set.

In this study, a self-administered questionnaire in the local Malay language was used. Those with problems in completing the questionnaire were assisted by researchers. The questionnaire contained four sections that assessed: (i) socio-demographic characteristics (7 items: age, gender, ethnicity, educational level, marital status, employment status and total

family income), (ii) meal skipping (3 items), (iii) eating out of home (3 items) and (iv) binge eating using the Malay version Binge Eating Scale (BES) (16 items) (Robert et al. 2013; Gormally et al. 1982). The clinical parameters of respondents (duration of diabetes, comorbidity, diabetic-related complications, types of treatment, HbA1c and BMI) were obtained by examining patients' diabetic record book by researchers. The first three sections of the questionnaire were developed based on the literature review and discussions with a Family Medicine Specialist (FMS) who is experienced in questionnaire development. Subsequently, content validation was carried out with another two FMS who examined the relevance of the content and its comprehensibility. Face validation was conducted among six patients with T2DM who had different gender, ethnicity and educational level.

The occurrence and frequency of meal skipping were assessed through two main questions: "Have you ever skipped meals?" (with 'Yes' and 'No' responses) and "If 'Yes', how frequently do you skip your meal(s)?" (5-Likert scale response: (i) Never within the last month, (ii) 1-2 times within the last month, (iii) 1-2 times within the last one week, (iv) Most of the days within the last one week, and (v) Every day). The frequency data were subsequently categorised into two groups: 'Frequent skipped meals' (Likert scale iv and v) and 'Never or seldom skipped meals' (Have never skipped meals in the past and those answered Likert scale i to iii). These are the two categories used for

the main dependent variable. The third question was to identify the meal(s) that they most frequently skipped (i.e. breakfast, lunch or dinner).

The practice of eating out of home was defined as eating non-homemade meals away from homes such as at restaurants, food eateries or workplaces. The definition was written before three items assessing this practice, which were: "Have you ever ate out of home (e.g. at restaurants, food eateries or others)?" and "If 'Yes', how frequently do you eat out of home?". Both items had the same response options as the above and the participants' answers were re-categorised similarly. The third question was to identify the type of food often taken during eating out of home which was either fast food (e.g. McDonald's®, KFC®, Pizza Hut) or non-fast food.

The BES is a validated widely used tool to identify those with binge eating disorder and measure its severity. The 16 items have 3 to 4 answer options that reflect a range of severity and the total score ranged from 0-46. The internal consistency of the Malay-version was 0.89. Although BES can categorise respondents into non-binge eater, moderate binge eater and severe binge eater, in this study, only two categories were used: non-binge eater (score of ≤ 17) and binge eater (≥ 18).

Ethical approval was obtained from the Research Ethics Committee Universiti Kebangsaan Malaysia (FF-2015-134) and the Medical Research Ethics Committee Ministry of Health (NMRR-15-363-24761). Permission to use the Malay-version BES and to conduct the study at the health clinic

was attained from the author and the Family Medicine Specialist in-charge respectively. All participants provided written consent before participating in the study.

Statistical analysis was conducted by using IBM SPSS® Statistic software version 22 (Armonk, NY, USA). The categorical data were described using frequency (n) and percentage (%), whereas the continuous data (all was not-normally distributed) was described as median and interquartile range (IQR). Simple logistic regression (SLR) was used to identify independent variables with a p-value of <0.25 for multiple logistic regression (MLR). In MLR, significant influencing factors for 'Frequent skipped meals' were identified by controlling other cofounding factors using enter mode. A p-value of <0.05 was statistically significant.

RESULTS

Among 203 participants, the majority were female (60.6%), unemployed (64.5%), married (87.2%) with secondary education or higher (60.1%) (Table 1). Their median (IQR) age and monthly household income were 62.0 (13.0) years and Ringgit Malaysia (RM) 1,500.00 (2,000.00), respectively. Chinese was the largest ethnicity in this study (46.8%), followed by Malays (36.0%) and others (17.2%). Most of them had diabetes for 5 to 10 years (46.3%) with the median (IQR) for diabetes duration of 7.0 (7.0) years. The majority had glycaemic control of 7% (60.1%) with the median (IQR) for HbA1c of 7.3 (2.6)%, at least one

Table 1: Sociodemographic and clinical characteristics of the participants (N=203)

Characteristics	n (%)	Median (IQR)
Age (years) (n=203)		62.0 (13.0)
Gender (n=203)		
Male	80 (39.4)	
Female	123 (60.6)	
Ethnicity (n=203)		
Malay	73 (36.0)	
Chinese	95 (46.8)	
Others	35 (17.2)	
Employment status (n=203)		
Unemployed	131 (64.5)	
Employed	72 (35.5)	
Education level (n=203)		
No formal / primary education	81 (39.9)	
Secondary education	107 (52.7)	
Tertiary education	15 (7.4)	
Marital status (n=226)		
Married	177 (87.2)	
Non-married	26 (12.8)	
Total household income (RM/month) (n=115)		1500.0 (2000.0)
Duration of diabetes (years)		7.0 (7.0)
< 5	57 (28.1)	
5 – 10	94 (46.3)	
> 10	52 (25.6)	
Control of diabetes (HbA1c) (n = 203)		7.3 (2.6)
Less than 7 %	81 (39.9)	
7 % and above	122 (60.1)	
Presence of diabetes-related complications (n = 203)		
Without complication	155 (76.4)	
With complication	48 (23.6)	
Presence of comorbidities (n = 203)		
Without comorbidity	41 (20.2)	
With co-morbidities	162 (79.8)	
Type of treatment (n = 203)		
Oral hypoglycemic agent (OHA) only	138 (68.0)	
Insulin with/without OHA	65 (32.0)	
Smoking status (n = 203)		
Non/ former smoker	185 (91.1)	
Current smoker	18 (8.9)	
Body Mass Index (BMI) (n = 223)		27.2 (6.7)
Underweight / Normal (< 22.9 kg/m ²)	38 (18.8)	
Overweight / Obese (> 23.0 kg/m ²)	164 (81.2)	

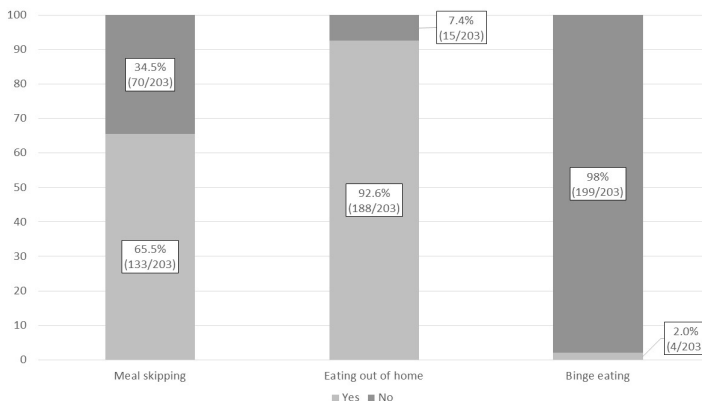


Figure 1: Proportions of participants who had meal skipping, eating out of home and binge eating (N=203)

co-morbidity (79.8%) and without diabetes-related complications (76.4%). They were mainly overweight or obese (81.2%) and used oral hypoglycaemic agent(s) (OHA) only (68.0%).

The proportion who had skipped meals in the past was 65.5% (Figure 1) and 41.4% frequently skipped meals at least almost every day in a week. The meal frequency was between 1 and 4 meals a day and 15.8% commonly took 2 meals per day (Figure 2). Even though lunch was the most commonly skipped by the participants (22.7%),

the proportion was almost similar to those who frequently skipped breakfast (19.7%) or dinner (20.2%) (Figure 3).

Almost all the participants (92.6%) had eaten away from home before (Figure 1), mainly non-fast food (94.1%). About 61.6% ate out of home at least almost every day. Only a minority were binge eaters (2%) (Figure 1).

In SLR (Table 2), only ethnicity was significantly associated with frequent meal skipping (Chinese versus Malay: $p=0.007$), but not HbA1c ($p=0.253$), BMI ($p=0.388$), eating out of home

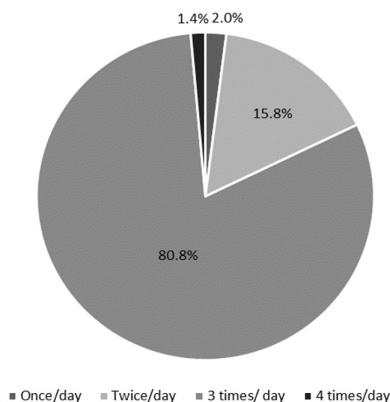


Figure 2: Frequency of meals taken in a day (N=203)

Table 2: Simple logistic regression (SLR): Factors associated with frequent meal skipping (N=203)

Variables	Meal skipping		Unadjusted OR	95% CI	p-value
	Never/ Seldom	Frequent			
Age (years) [Median (IQR)]	63.0 (12.0)	61.0 (12.0)	0.98	0.96-1.01	0.202
Gender [n (%)]					
Male	47 (58.8)	33 (41.3)	1		
Female	72 (58.5)	51 (41.5)	1.01	0.57-1.79	0.976
Ethnicity [n (%)]					
Malay	34 (46.6)	39 (53.4)	1		
Chinese	64 (67.4)	31 (32.6)	0.42	0.23-0.79	0.007*
Others	21 (60.0)	14 (40.0)	0.58	0.26-1.32	0.193
Employment status [n (%)]					
Unemployed	82 (62.2)	49 (37.4)	1		
Employed	37 (51.4)	35 (48.6)	1.58	0.88-2.83	0.122
Education level [n (%)]					
No / primary education	52 (64.2)	29 (35.8)	1		
Secondary education	61 (57.0)	46 (43.0)	1.35	0.75-2.45	0.319
Tertiary education	6 (40.0)	9 (60.0)	2.69	0.87-8.31	0.086
Marital status ([n (%)]					
Married	103 (58.2)	74 (41.8)	1		
Non-married	16 (61.5)	10 (38.5)	0.870	0.37-2.02	0.746
Total household income (RM/month) [Median (IQR)]	2000.0 (2005.0)	1500.00 (2175.0)	1.00	1.00-1.00	0.792
Duration of diabetes (years) [Median (IQR)]	8.0 (7.0)	7.0 (6.0)	0.99	0.94-1.03	0.473
HbA1c (%) [Median (IQR)]	7.3 (2.2)	7.4 (3.0)	1.08	0.95-1.24	0.253
Presence of diabetes-related complications [n (%)]					
Without complication	95 (61.3)	60 (38.7)	1		
With complication	24 (50.0)	24 (50.0)	1.58	0.83-3.04	0.167
Presence of comorbid [n (%)]					
Without comorbid	26 (63.4)	15 (36.6)	1		
With co-morbid	93 (57.4)	69 (42.6)	1.29	0.63-2.61	0.486
Type of treatment [n (%)]					
OHA only	86 (62.3)	52 (37.7)	1		
Insulin with/without OHA	33 (50.8)	32 (49.2)	1.60	0.88-2.91	0.120
Smoking status [n (%)]					
Non/ former smoker	110 (59.5)	75 (40.5)	1		
Current smoker	9 (50.0)	9 (50.0)	1.47	0.56-3.87	0.439
Body Mass Index [Median (IQR)]	26.9 (6.3)	27.7 (5.7)	1.02	0.97-1.08	0.388
Eating out of home [n (%)]					
Never/Seldom	47 (60.3)	31 (39.7)	1		
Frequent	72 (57.6)	53 (42.4)	1.12	0.63-1.99	0.709
Binge eating [n (%)]					
No	116 (58.3)	83 (41.7)	1		
Yes	3 (75.0)	1 (25.0)	0.47	0.05-4.56	0.512

*Significance: p<0.05

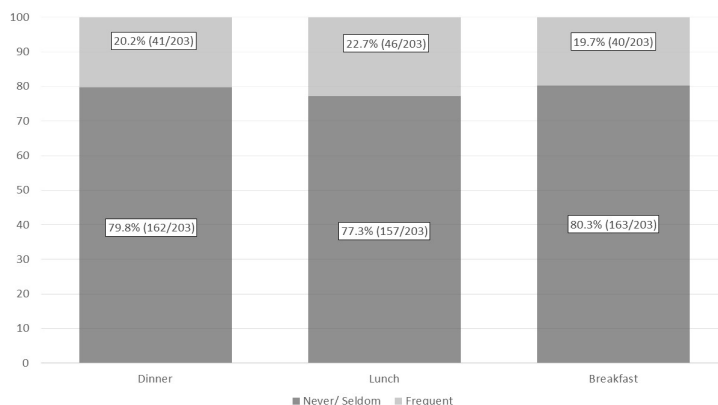


Figure 3: Proportions of participants who had frequent skipping breakfast, lunch and dinner.

($p=0.709$) and binge eating ($p=0.512$). To find factors that were significantly associated with frequent meal skipping when other confounding factors were controlled, variables with p -values of >0.25 (age, ethnicity, education status, employment status, HbA1c, presence of complication and type of treatment) and variables with clinical importance (frequent eating out of home and binge eating) were subjected to MLR. In MLR (Table 3), only Chinese race was significantly associated with frequent meal skipping, whereby Chinese were less likely to skip meals compared to Malays (adjusted odds ratio (AOR): 0.36; 95% confidence interval (CI): 0.16-0.77; p -value: 0.009). Meal skipping was not significantly associated with glycaemic control (AOR: 0.99; 95% CI: 0.84-1.18; p -value: 0.929) and other independent variables.

DISCUSSION

Meal skipping may cause detrimental effects on patients with T2DM, especially those who are at risk for hypoglycaemia (McCrary &

Campbell 2011; Gouda et al. 2018; Iwasaki et al. 2019). In this study, this practice among patients with T2DM at an urban public healthcare clinic in Malaysia was examined. Generally, this study found that meal skipping was common in which four in ten patients with T2DM frequently practised this eating behaviour. Eating out of home was prevalent too as two-thirds ate out of home at least almost every day, but only a small proportion of them had binge eating. Both eating out of home and binge eating had an insignificant influence on meal skipping. The only factor found to be significantly associated with meal skipping was ethnicity, whereby Chinese patients were less likely to frequently skip meals compared to Malays. There was no significant association between meal skipping and glycaemic control.

The characteristics of the participants in this study were comparable to the national registry of diabetes (MOH 2017) in terms of age, a predominance of females and those with overweight/obesity as well as glycaemic control. However, the pattern of ethnicity was

Table 3: Multiple logistic regression (MLR): Factors associated with frequent meal skipping (N=203)

Variables	β	Standard Error	Wald	Adjusted OR	95% CI	p-value
Age (years)	0.01	0.02	0.27	1.01	0.97-1.05	0.605
Chinese [ref.: Malay]	-1.03	0.40	6.83	0.36	0.16-0.77	0.009*
Other ethnicity [ref.: Malay]	-0.65	0.44	2.11	0.53	0.22-1.25	0.147
Employed [reference: Unemployed]	0.42	0.38	1.21	1.52	0.72-3.18	0.271
Secondary education [ref.: No /primary education]	0.05	0.34	0.02	1.05	0.54-2.07	0.878
Tertiary education [ref.: No / primary education]	0.83	0.65	1.65	2.30	0.65-8.16	0.199
HbA1c (%)	-0.01	0.09	0.01	0.99	0.84-1.18	0.929
Frequent eating out of home (ref: Never / seldom)	0.34	0.35	0.95	1.41	0.71-2.81	0.330
Binge eating (ref: No binge eating)	-0.62	1.25	0.25	0.54	0.05-6.22	0.621
With complications [ref.: Without complication]	0.46	0.37	1.58	1.59	0.77-3.25	0.208
OHA only [ref.: Insulin with/ without OHA]	0.36	0.40	0.83	1.44	0.66-3.13	0.362

*Significance: $p < 0.05$;

Variables included in MLR: Age, Ethnicity, Education status, Employment status, HbA1c, Eating out of home, Binge eating, Complications of diabetes, Types of treatment; R²: 0.104; MLR using enter method.

different. Unlike the national study that showed Malay predominance (58.9%), in our study, Malay was only 36.0% and Chinese was the major ethnicity of the participants (46.8%). The distribution of ethnicity in this study corresponds with the statistic of the population in Cheras district (Department of Statistics Malaysia 2016).

Meal skipping was a common practice among patients with T2DM in this study. The proportions of our participants who had skipped meals in the past or frequently skipped meals were higher than other similar studies in various parts of the world (Ercan & Kiziltan 2013; Gunggu et al. 2016; Olatona et al. 2019; Chacko & Begum

2016; Gouda et al. 2018). Even the local study in Kuching, Sarawak showed contrary findings (Gunggu et al. 2016). In the study, 86.3% of their patients with T2DM reported having regular mealtime every day (Gunggu et al. 2016). Various definitions and methods of assessing meal skipping used by previous studies may be the cause of the differences. For example, data were collected via face-to-face interviews in studies conducted in Sarawak, Turkey and Nigeria (Gunggu et al. 2016; Ercan & Kiziltan 2013; Olatona et al. 2019), thus the participants could provide answers that were viewed favourably by others and led to underreporting. A similar social desirability bias response

could occur in the Japan study where the respondents were asked about their dietary practice during the insurance medical check-ups. Nevertheless, cultural and religious factors may also cause a significant difference in the practice. As Chinese in our study were found to have less tendency to skip meals than Malays, it supports this hypothesis. Malays, who are usually Muslims, must perform Islamic rituals of fasting if they are able, thus meal skipping especially lunch is a common practice. Even though this study was conducted a month after Ramadan, Muslims often do non-obligatory fasting, called 'Sunnah' fasting. When Muslims fast, they usually never miss a meal before dawn (i.e. sahur) because it is considered as an important meal before they start fasting. As this is the first meal of the day, people may consider sahur as breakfast. In our study, skipping breakfast was the least practised by the participants, thus it supports our hypothesis that religious factor as one of the main reasons for meal skipping in our study. Furthermore, breakfast has been known as an important meal of the day to maintain glycaemic and lipid control, weight and satiety (Paoli et al. 2019).

Eating away from home was hypothesised to influence the practice of meal skipping. Those who plan to eat out of home may postpone any meal before going out for having a feast. Even though eating out of home was highly prevalent among our participants, it was not significantly associated with frequent meal skipping. Perhaps, the practice has

been considered as a part of their life routine to fulfil their needs. It was not regarded as feasting anymore. Due to the change in the food environment, social transformation and urbanisation in Malaysia, the traditional practice of women cook at home for the family is not ritualised by many, especially among working couples (Ali & Abdullah 2012). Besides, accessible food premises that sell a variety of affordable food may be more attractive for independent elderly to simply eat out of home than prepare their meals.

Binge eating is also known as episodes of overconsumption of a large quantity of food. It is another eating behaviour that is considered socially acceptable (Pereira & Alvarenga 2007). However, it is usually a symptom of binge eating disorder (BED), characterised by recurrent binge eating with inappropriate compensatory behaviour and negative feelings, such as disgust and guilt (Pereira & Alvarenga 2007). Those who had BED may skip their meals after the episodes of binge eating as a compensatory effort, thus it was hypothesised to have a significant association with frequent meal skipping. In this study, only 2% of the participants had BED which is consistent with the prevalence of BED (1.2-8.0%) found by a recent systematic review (Abbott et al. 2018). It was not significantly associated with meal skipping, but the finding should be interpreted cautiously due to the small number of those with BED.

Even though previous studies have demonstrated the effects of less frequent meals on glycaemic control (Gouda et al. 2018; Iwasaki et al.

2019; Hutchison & Heilbronn 2016), this study did not find any significant association between frequent meal skipping and HbA1c. The insignificant association maybe because of the complex mechanism of how eating frequency affects glucose metabolism (Hutchison & Heilbronn 2016; Paoli et al. 2019). Other important factors could influence metabolic outcomes and these factors were not examined in this study, such as total daily carbohydrate and calorie intake, the regularity of the meal timing, fasting duration between meals and meals matching diurnal rhythm (Hutchison & Heilbronn 2016; Paoli et al. 2019). There is a possibility that the total daily carbohydrate and calorie intake were similar between the participants who frequently skipped meals and those who never or seldom skipped meals, thus their HbA1c, as well as BMI, were not significantly different. Based on these findings, it was difficult to conclude whether frequent meal skipping was metabolically harmful. Furthermore, other metabolic parameters and negative outcomes of less frequent meals (e.g. hypoglycaemia) were not assessed in this study. One thing worth noted is that the risk of hypoglycaemia among our participants seems to be low because the majority of them had diabetes for less than 10 years with an average HbA1c of around 7.0%. More than two-thirds had no diabetes-related complications and only took OHA(s). Thus, frequent meal skipping appears to be an acceptable practice among most of them because of their low hypoglycaemic risk, but strong evidence to support this eating

behaviour is still lacking. Recent guidelines also do not recommend any specific eating pattern over another including meal skipping such as in the intermittent fasting or Ramadhan fasting (Evert et al. 2019; Sievenpiper et al. 2018). Further studies are needed to examine the safety and acceptability of this commonly practised eating behaviour among patients with T2DM.

Due to the scarcity of research on meal frequency, eating out of home and binge eating practised by patients with T2DM in Malaysia, our study provides essential information on how common the practices were. The use of a self-administered questionnaire may help to reduce underreporting of the eating practices, but socially desired response bias may still be present. The true prevalence of these eating behaviours may not be captured by our study as the participants were not sampled via random sampling and the data collection was only done at one centre over two weeks. Due to this, the generalisability of the findings is limited. Another limitation worth highlighting is related to the limited variables of the study that could show the harmful effects of meal skipping. Even though this study did not show significant associations of frequent meal skipping with glycaemic control and BMI, its safety should not be assumed as other potentially negative effects of this prevalent eating behaviour were not assessed. Nevertheless, the findings underline the importance of assessing meal frequency and eating out of home in clinical practice as these eating behaviours were prevalent. The effects of such behaviour should be

individually examined to determine its significance, particularly among those who are at high risk to have hypoglycaemia. Most importantly, patients with T2DM should be educated regarding eating practices that can improve their glycemic control and are safe. As meal skipping is common, most likely due to religious fasting, safe fasting practices such as adjustments of the dose, timing and frequency of diabetic medications and monitoring blood glucose levels, should be promoted to Muslim patients. Unfortunately, many Muslim patients with diabetes in Malaysia have poor knowledge of such practices (Leow & Tong, 2019). To ensure greater dissemination of the information, various platforms should be utilised, not only through healthcare providers and printed materials, but online platforms too (Leelavathi et al. 2018).

CONCLUSION

Meal skipping was frequently practised by patients with T2DM at an urban public healthcare clinic in Kuala Lumpur Malaysia. Eating out of home was common too, but binge eating was rare. Both eating behaviours and glycaemic control were not significantly associated with frequent meal skipping. As Chinese were found to have a lower tendency to frequently skipped meals compared to Malay, cultural and religious factors may play an important role in defining their eating practice. Further studies are needed to assess the safety and acceptability of this practice, but clinically, the effects of such common

eating behaviour must be individually examined to prevent unwanted consequences on their health.

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