Original Article

Impact of Knowledge and Attitudes on Lifestyle Practices in Preventing Type 2 Diabetes Mellitus

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Abstract

Introduction: Diabetes mellitus is a major public health issue in Singapore. To shape healthcare policies for the primary prevention of diabetes, it is crucial to understand Singaporeans' knowledge, attitudes and practices related to diabetes and its prevention. This study aimed to assess the knowledge, attitudes and lifestyles of individuals without diabetes. **Materials and Methods**: A cross-sectional household survey was performed between 31 January to 3 February 2019 to examine knowledge, attitudes and practices related to diabetes. Inclusion criteria of the participants included: 1) Singaporeans/permanent residents, 2) between 30 to 64 years old, and 3) who did not have a diagnosis of diabetes. Logistic and linear regression models were used to analyse the association of knowledge and attitudes with physical activity and diet habits, respectively. **Results**: Among 806 participants, 72.2% did not meet the Health Promotion Board's physical activity recommendation. Physical activity was associated with better diabetes knowledge (odds ratio [OR] 5.38, 95% confidence interval [CI] = 1.65-17.53, *P* = 0.049), stronger beliefs in diabetes prevention (OR 3.36, 95% CI = 1.02-11.12, *P* = 0.047) and lower levels of worry about diabetes (OR 0.41, 95% CI 0.17-1.00, *P* = 0.049). Neither knowledge nor beliefs or worries about diabetes was associated with diet. **Conclusion**: There is a need to reinforce the importance of physical activity and healthy diet in preventing diabetes. Although improving the knowledge level of diabetes may increase physical activity of the population, it is unlikely to improve dietary choices without effective behaviour change interventions.

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Key words: Healthy diet, Physical activity, Singapore, "War on Diabetes"

Introduction

Diabetes mellitus is a chronic disease that affects the body's metabolism of sugar. Type 2 diabetes involves insulin resistance and is preventable. Worldwide, type 2 diabetes accounts for the majority of diabetes cases.[1] It is a disease of multifactorial pathogenesis[2] and modifiable lifestyle factors include obesity,[3] physical inactivity,[4] diet[5] and alcohol consumption.[6] Diabetes leads to debilitating complications like chronic renal failure,[7] acute myocardial infarction and stroke.[8] It is a worldwide epidemic that affected 422 million adults (8.5% of the world's population) in 2014[9] and is listed as 1 of 4 priority non-communicable diseases by the World Health Organization (WHO).[9]

Diabetes also poses a significant burden in Singapore. It accounts for 10% of Singapore's disease burden[10] and cost Singapore over 1 billion dollars in 2010.[11] In fact, the prevalence of diabetes in Singapore is higher than that of the world's average.[10,12] The number of Singaporeans living with diabetes might surge from 440,000 in 2014 to 1 million by 2050,[12] with 1 in 3 Singaporeans having a lifetime risk of developing diabetes.[13]

In 2016, Singapore's Ministry of Health (MOH) declared a "War on Diabetes" (WoD) to address the magnitude of the problem, implementing preventive interventions targeting modifiable risk factors. These include primary preventive measures for diet control (e.g. Healthier Dining Programme,

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Healthier Choice Symbol identifier) and exercise (e.g. National Steps Challenge), as well as secondary preventive measures to increase screening uptake and early detection (e.g. Diabetes Risk Assessment Tool, Screen for Life subsidies). Since the start of the WoD, the 2018 National Nutrition Survey showed an overall improvement in Singapore's dietary practices compared to 2010, with Singaporeans consuming food with fewer calories and carbohydrates, though there was still high sugar and salt intake.[14] With regard to exercise, more than a third (36.5%) of Singaporeans still have insufficient physical activity.[15] However, there are no formal studies conducted to assess the effects of the WoD on the knowledge and attitudes of the population.

Hence, this study aimed to assess the knowledge, attitudes and lifestyles of diabetes-free Singaporeans and permanent residents, in an attempt to evaluate the early impact of the WoD on healthy lifestyle adoption, with the hope of informing the design of future primary preventive interventions against diabetes. The study objectives were: 1) to assess the current physical activity level and dietary habits and identify suboptimal practices despite ongoing awareness campaigns, and 2) to determine the association of knowledge and attitudes of diabetes with lifestyle practices.

Materials and Methods

Study Design, Case Definition and Data Collection

This study used data collected from a cross-sectional, questionnaire-based survey administered by trained interviewers between 31 January and 3 February 2019. Inclusion criteria were Singapore citizens or permanent residents without diabetes, aged 30-64 years and who could comprehend and communicate in English or Mandarin. The age group of 30-64 years old was chosen to represent the young and middle-aged population, with the age bracket of 30-39 years representing the first big jump in prevalence.[16] Ethical approval was obtained from the National University of Singapore (NUS) Institutional Review Board. Informed consent was obtained from each individual prior to participation.

Six Housing and Development Board (HDB) estates were selected via simple random sampling out of 23 HDB towns and 3 HDB estates.[17] Thirty blocks per estate and 50 units per block were randomly selected. Selected units were approached in order until 10 responses were obtained per block.

The survey was conducted over 2 weekdays from 5 pm to 9 pm and 2 weekends from 9 am to 6 pm to avoid underrepresentation of the employed. In households with multiple eligible individuals, the most willing individual was surveyed.

Interviewers were trained to ensure uniformity in questionnaire administration. Interviewers manually entered participants' responses with smartphones into a secure NUS MySurvey portal, in compliance with the Personal Data Protection Act.

Selected questions from the Diabetes Knowledge Questionnaire (DKQ)[18] and Diabetes Knowledge Test (DKT)[19,20] were modified to suit the local population to assess general knowledge on diabetes and its management. A total score for diabetes knowledge was calculated from the questionnaire: 16 items from DKQ and 8 items from DKT. Items were scored 1 for a correct response and 0 for incorrect and "I don't know" responses. Participants' scores were represented as a percentage of the total score of 24 (i.e. if a participant answered 16 items correctly, their total score is 16/24 x 100 = 66.7%).

To assess attitudes, the team generated questions about worries and beliefs regarding diabetes based on the Tripartite Model of Beliefs.[21] Questions assessing physical activity were adapted from the Health Promotion Board (HPB)'s Diabetes Risk Assessment Tool and WHO's Global Physical Activity Questionnaire.[22] Barriers to physical activity were sought using the Health, Knowledge & Practices Questionnaire 1999 by The Australian Diabetes, Obesity and Lifestyle Study.[23] To assess diets, questions were modified from the Dietary Screener Questionnaire[24] in the National Health and Nutrition Examination Survey (NHANES), and the Health at Work Questionnaire[25] by the British Heart Foundation. Sociodemographic information and past medical history were also collected.

To facilitate administration, the questionnaire was translated from English to Chinese. Both language versions of the questionnaire were tested with interviewers' families before data collection. Subsequently, questions were rephrased to reduce ambiguity and to omit medical jargon. The final questionnaire included a total of 47 questions (see Appendix: Questionnaire).

Statistical Analysis

Participants' knowledge, attitudes and diet habits were assessed using percentage scores based on their responses to relevant questions. For diet habits, its association with all sociodemographic and past medical characteristics was first examined using one-way analysis of variance (ANOVA). All statistically significant or borderline-significant variables (0.05 < P ≤0.10) in the univariate analyses were included in a multivariate linear regression analysis, with knowledge and attitudes scores (including beliefs and worries about diabetes) included as covariates.

Exercise was coded as a binary categorical variable (meets or does not meet HPB's recommendations for physical activity, which is defined as at least 150 minutes of moderate intensity exercise or 60 minutes of high intensity exercise per week). Its association with sociodemographic

and medical characteristics was first examined using simple logistic regression. Subsequently, all statistically significant or borderline significant variables were included in a multiple logistic regression model, together with knowledge and attitudes scores to identify factors independently associated with meeting recommended physical activity. Statistical Package for the Social Sciences (SPSS) version 23 was used for data analysis. A value of P <0.05 was considered statistically significant for univariate and multivariate analyses.

Results

Of the 5400 household units that had been approached, 3526 were contactable, of which 1541 residents were eligible. Of those eligible, 806 agreed to participate and completed all questions without missing responses, yielding a response rate of 52.3%.

The mean age (standard deviation [SD]) of the study sample was 57.2 ± 12.5 years. The majority of participants were females (60.7%), had qualifications above primary level (87.1%), monthly household incomes of less than S\$10,000 (88.0%) and lived in housing units of 4-room or smaller (78.0%); 35.1% of participants had a family history of diabetes and 19.7% had high blood pressure (Table 1).

Diabetes Knowledge and Attitudes

The mean knowledge score (SD) of the participants was $59.2 \pm 15.1\%$, with the minimum of 0.0%, maximum of 100.0% and median of 58.3%.

Generally, participants had good knowledge about the impact of diabetes mellitus on health. For example, 90.8% of participants answered correctly that "Cuts and abrasions on patients with diabetes heal more slowly". However, only 14.4% knew that "Eating too much sugar and sweet foods is a cause of diabetes" was false.

A total of 49.8% of participants were worried about a future diagnosis of diabetes. The majority of participants possessed strong beliefs about diabetes prevention (Fig. 1). For example, 86.1% and 87.1% of the participants (strongly) agreed that their risk of diabetes can be controlled by exercising regularly and maintaining healthier diets, respectively.

Practices

A total of 27.8% of participants met the HPB's recommendations for physical activity.[26] The majority of participants exercised for more than 60 minutes per week (63.4%) and most did light to moderate exercise (85.4%).

For dietary practices, responses were varied. Most participants chose not to "eat at western fast food outlets or quick-service restaurants" (92.8%), "consume sweetened beverages" (87.0%) or "consume sweet cakes, desserts, sweets, chocolates or confectionery" (87.1%) at least half the time. Most participants also chose wholemeal bread over white bread more than half the time (68.2%). However, a majority had suboptimal dietary practices regarding carbohydrates and fats, choosing to base their main meals around starchy foods at least half the time (64.3%). The distribution of responses to all diet questions are shown in Figure 2.

Factors Associated with Practices

Simple logistic regression analyses showed that Chinese (P = 0.052), females (P <0.001) and participants with primary or secondary qualifications (P = 0.043) exercised less. Participants living in Yishun exercised more (P = 0.093, OR 1.55, 95% CI 0.93-2.58) compared to those in Ang Mo Kio. In multivariate analysis, participants who had higher knowledge scores (P = 0.005, OR 5.38, 95% CI 1.65-17.53), stronger beliefs (P = 0.047, OR 3.36, 95% CI 1.02-11.12), or less worries (P = 0.049, OR 0.41, 95% CI 0.17-1.00) exercised more (Table 2).

In the analyses of dietary practices, we found that older participants (P = 0.002) and participants in Clementi (P = 0.020) and Yishun (P = 0.002) had healthier dietary practices. There was no statistically significant association of knowledge or attitudes with dietary practices (Table 3).

Race, marital status, household income, type of housing, family history of diabetes and personal history of hypertension were not significantly associated with physical activity or dietary practices (Tables 2 and 3).

Barriers to More Physical Activity and Healthier Diets

The 3 most commonly cited barriers to increasing physical activity were "work" (25.3%), "lack of time" (24.2%) and "other priorities" (15.0%). Common barriers to a healthier diet included "lack of time" (20.7%), "other priorities" (18.5%) and "lack of access from workplace" (15.5%). Participants' responses are shown in Figure 3.

Discussion

More Singaporeans had suboptimal exercise levels compared to a recent study published in "The Lancet Global Health" (2018) describing worldwide trends in insufficient physical acitvity,[15] which found that 33.3% of populations in South Asian countries had insufficient physical activity. This could be due to differences in their study population which included participants as young as 18 years old who would be more physically active. Singaporeans in our study are mostly from the working class, where lack of time was commonly cited as a barrier to more exercise. As overseas studies and trials have shown that workplace interventions significantly increase the level of physical activity[27] and overall physiological health,[28,29,30] quick and

easy activities

Table 1. Sociodemographics of Sample Population

Demographic	n	%	Singapore Population Distribution*
Age (years)			
30 – 44	299	37.1	42.7
45 – 64	507	62.9	57.3
Race			
Chinese	621	77.0	75.0
Malay	84	10.4	12.1
Indian	80	9.9	9.3
Others	21	2.6	3.6
Gender			
Male	317	39.3	48.7
Female	489	60.7	51.3
Marital status			
Single	131	16.3	15.5
Married	642	79.7	77.0
Divorced/widowed	33	4.1	4.7
Highest qualification			
Primary	104	12.9	21.1
Secondary	236	29.3	18.6
Postsecondary	199	24.7	25.7
University	267	33.1	34.6
Monthly household income			
<$2000	214	26.6	19.1
$2000 – $4999	242	30.0	15.8
$5000 – $7999	171	21.2	15.8
$8000 – $10,000	82	10.2	9.6
>$10,000	97	12.0	39.8
Type of housing			
2-room flat	61	7.6	4.7
3-room flat	200	24.8	19.1
4-room flat	368	45.7	43.0
5-room, executive, maisonette flats	177	22.0	33.1
Family history of type 2 diabetes			
Yes	283	35.1	
No	509	63.2	
I don't know	14	1.7	
Hypertension			
Yes	159	19.7	
No	638	79.2	
I don't know	9	1.1	
Area of Singapore			
Ang Mo Kio (north)	168	20.8	15.7
Bedok (east)	128	15.9	26.6
Bukit Merah (south)	130	16.1	14.3
Bukit Panjang (west)	128	15.9	13.6
Clementi (west)	126	15.6	8.8
Yishun (north)	126	15.6	21.0

*Department of Statistics, Singapore. Singapore Census Data. Available at: https://www.tablebuilder.singstat.gov.sg/publicfacing/createSpecialTable.action?refId=15454. Accessed on 22 February 2019.
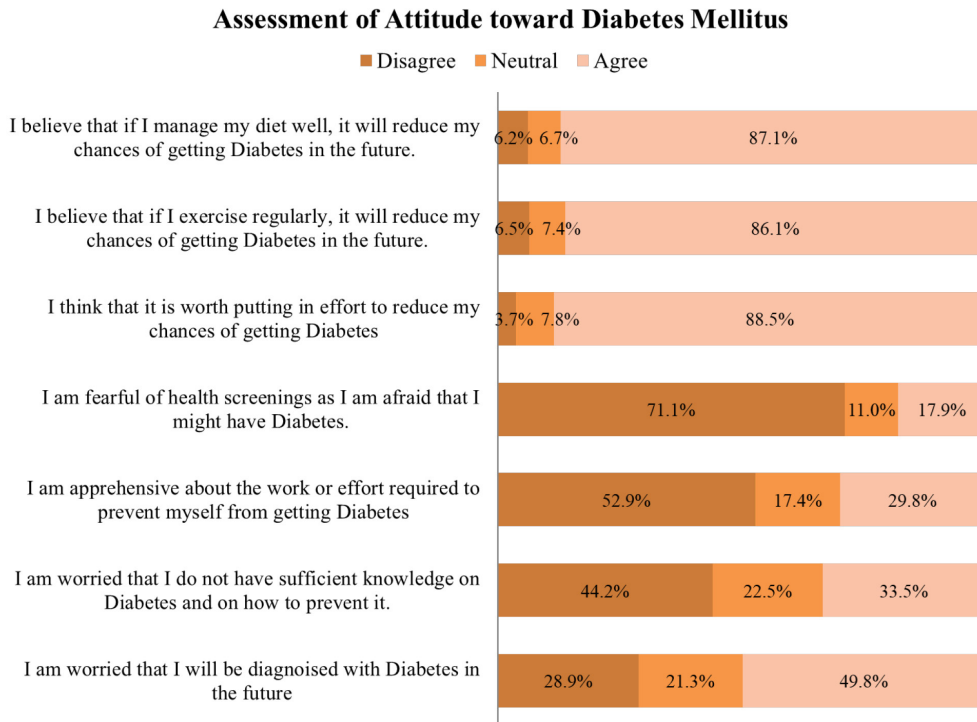
Assessment of Attitude toward Diabetes Mellitus

■ Disagree ■ Neutral ■ Agree

Statement	Disagree	Neutral	Agree
I believe that if I manage my diet well, it will reduce my chances of getting Diabetes in the future.	6.2%	6.7%	87.1%
I believe that if I exercise regularly, it will reduce my chances of getting Diabetes in the future.	6.5%	7.4%	86.1%
I think that it is worth putting in effort to reduce my chances of getting Diabetes	3.7%	7.8%	88.5%
I am fearful of health screenings as I am afraid that I might have Diabetes.	71.1%	11.0%	17.9%
I am apprehensive about the work or effort required to prevent myself from getting Diabetes	52.9%	17.4%	29.8%
I am worried that I do not have sufficient knowledge on Diabetes and on how to prevent it.	44.2%	22.5%	33.5%
I am worried that I will be diagnoised with Diabetes in the future	28.9%	21.3%	49.8%

Fig. 1. Participants' attitudes towards the prevention of diabetes mellitus.

Diet Practices Amongst Participants

■ "Occasionally" or "Never" ■ "Half the time" ■ "Most of the time" or "Always"

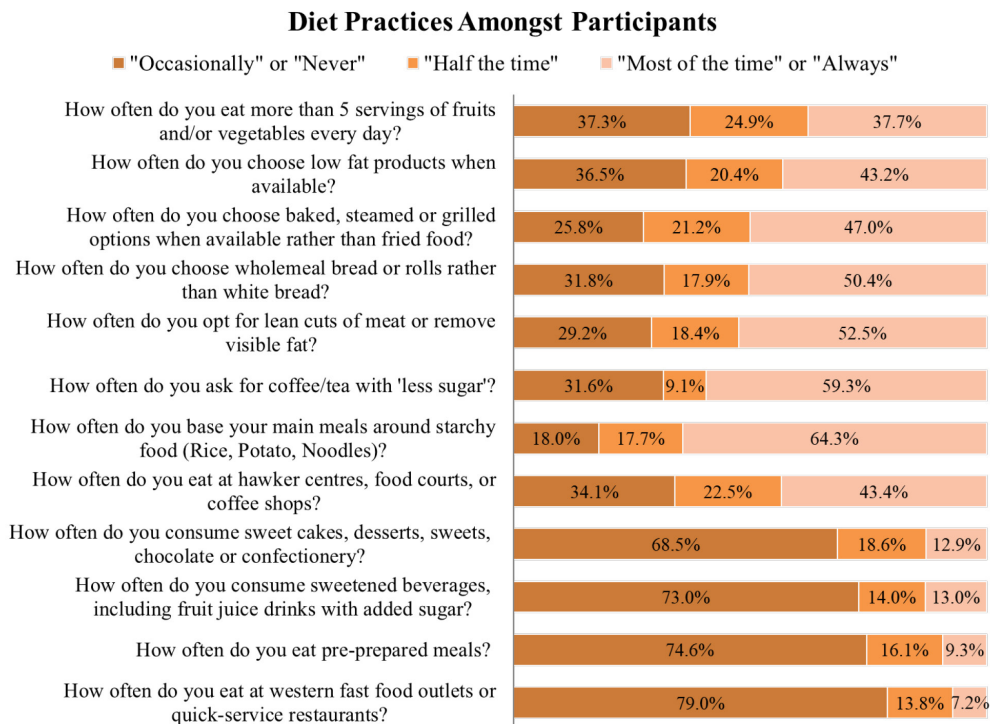| Question	"Occasionally" or "Never"	"Half the time"	"Most of the time" or "Always"
How often do you eat more than 5 servings of fruits and/or vegetables every day?	37.3%	24.9%	37.7%
How often do you choose low fat products when available?	36.5%	20.4%	43.2%
How often do you choose baked, steamed or grilled options when available rather than fried food?	25.8%	21.2%	47.0%
How often do you choose wholemeal bread or rolls rather than white bread?	31.8%	17.9%	50.4%
How often do you opt for lean cuts of meat or remove visible fat?	29.2%	18.4%	52.5%
How often do you ask for coffee/tea with 'less sugar'?	31.6%	9.1%	59.3%
How often do you base your main meals around starchy food (Rice, Potato, Noodles)?	18.0%	17.7%	64.3%
How often do you eat at hawker centres, food courts, or coffee shops?	34.1%	22.5%	43.4%
How often do you consume sweet cakes, desserts, sweets, chocolate or confectionery?	68.5%	18.6%	12.9%
How often do you consume sweetened beverages, including fruit juice drinks with added sugar?	73.0%	14.0%	13.0%
How often do you eat pre-prepared meals?	74.6%	16.1%	9.3%
How often do you eat at western fast food outlets or quick-service restaurants?	79.0%	13.8%	7.2%

Fig. 2. Responses to questions on dietary practices of participants.

Table 2. Association of Knowledge and Attitudes with Exercise

Demographic	% Meets Recommendation (n)	Univariate *P* Value	Odds Ratio (95% CI)	Multivariate *P* Value[*]
Age (years)		0.148		
30 – 44	31.4 (94)			
45 – 64	25.6 (130)			
Race		0.052		0.059
Chinese	26.9 (167)			
Malay	31.0 (26)		1.25 (0.73 – 2.13)	0.423
Indian	31.3 (25)		1.26 (0.74 – 2.15)	0.404
Others	28.6 (6)		3.39 (1.35 – 8.53)	0.009
Gender		<0.001		<0.001
Male	36.3 (115)			
Female	22.3 (109)		0.48 (0.34 – 0.66)	<0.001
Marital status		0.746		
Single	33.6 (44)			
Married	26.6 (171)			
Divorced/widowed	27.3			
Highest qualification		0.043		0.477
Primary	22.1 (23)			
Secondary	26.3 (62)		1.00 (0.55 – 1.80)	0.991
Postsecondary	26.1 (52)		1.39 (0.76 – 2.55)	0.281
University	32.6 (87)		1.27 (0.68 – 2.22)	0.500
Monthly household income		0.336		
<$2000	25.7 (55)			
$2000 – $4999	28.1(68)			
$5000 – $7999	31.6 (54)			
$8000 – $10,000	25.6 (21)			
>$10,000	26.8 (26)			
Type of housing		0.803		
2-room flat	32.8 (20)			
3-room flat	26.0 (52)			
4-room flat	28.5 (105)			
5-room, executive, maisonette flats	26.6 (47)			
Area of Singapore		0.057		0.054
Ang Mo Kio (north)	24.4 (41)			
Bedok (east)	18.0 (23)		0.65 (0.36 – 1.18)	0.156
Bukit Merah (south)	31.5 (41)		1.49 (0.87 – 2.53)	0.147
Bukit Panjang (west)	30.5 (39)		1.17 (0.68 – 2.01)	0.565
Clementi (west)	30.2 (38)		1.07 (0.62 – 1.84)	0.818
Yishun (north)	33.3 (42)		1.62 (0.94 – 2.79)	0.084
Family history of type 2 diabetes		0.853		
Yes	27.6 (78)			
No	27.3 (139)			
I don't know	50.0 (7)			

CI: Confidence interval

[*]Only variables that were statistically significant or borderline-significant in univariate analysis were included in the multivariate analysis.

Table 2. Association of Knowledge and Attitudes with Exercise (Cont'd)

Demographic	% Meets Recommendation (n)	Univariate P Value	Odds Ratio (95% CI)	Multivariate P Value*
Hypertension		0.190		
Yes	22.6 (36)			
No	29.2 (186)			
I don't know	22.2 (2)			
Knowledge			5.38 (1.65 – 17.53)	0.005
Worries			0.41 (0.17 – 1.00)	0.049
Beliefs			3.36 (1.02 – 11.12)	0.047

CI: Confidence interval

*Only variables that were statistically significant or borderline-significant in univariate analysis were included in the multivariate analysis.

Table 3. Association of Knowledge and Attitudes with Diet

Demographic	Mean Score (%)	Univariate P Value	Regression Coefficient	Multivariate P Value*
Age (years)		0.002	0.024 (0.009 – 0.040)	0.002
30 – 44	45.4			
45 – 64	47.9		0.024 (0.009 – 0.040)	0.002
Race		0.912		
Chinese	46.9			
Malay	47.7			
Indian	46.6			
Others	47.1			
Gender		0.503		
Male	47.3			
Female	46.7			
Marital status		0.509		
Single	46.0			
Married	47.1			
Divorced/widowed	48.0			
Highest qualification		0.481		
Primary	47.2			
Secondary	46.9			
Postsecondary	47.8			
University	46.2			
Monthly household income		0.335		
<$2000	47.5			
$2000 – $4999	46.5			
$5000 – $7999	45.8			
$8000 – $10,000	47.9			
>$10,000	48.1			
Type of housing		0.136		
2-room flat	44.1			
3-room flat	47.5			
4-room flat	46.8			
5-room, executive, maisonette flats	47.6			

*Only variables that were statistically significant or borderline-significant in univariate analysis were included in the multivariate analysis.

Table 3. Association of Knowledge and Attitudes with Diet (Cont'd)

Demographic	Mean Score (%)	Univariate *P* Value	Regression Coefficient	Multivariate *P* Value[*]
Area of Singapore		0.016	0.008 (0.003 – 0.012)	0.001
Ang Mo Kio (north)	45.4			
Bedok (east)	46.3		0.007 (-0.017 – 0.032)	0.562
Bukit Merah (south)	46.0		0.007 (-0.018 – 0.031)	0.580
Bukit Panjang (west)	46.8		0.015 (-0.010 – 0.039)	0.241
Clementi (west)	48.5		0.030 (0.005 – 0.055)	0.020
Yishun (north)	49.3		0.038 (0.014 – 0.063)	0.002
Family history of type 2 diabetes		0.591		
Yes	46.5			
No	47.1			
I don't know	48.8			
Hypertension		0.240		
Yes	46.9			
No	46.9			
I don't know	53.0			
Knowledge			0.021 (-0.030 – 0.072)	0.421
Worries			0.010 (-0.029 – 0.049)	0.610
Beliefs			<0.001 (-0.051 – 0.050)	0.997

[*]Only variables that were statistically significant or borderline-significant in univariate analysis were included in the multivariate analysis.

could be introduced to encourage more exercise among busy working adults. Workplace-focused exercise and fitness programmes with easy accessibility to exercise avenues such as gyms could be viable options to overcome this barrier and positively impact their practices. Additionally, a potential reason for females in our study to engage in less physical activity (compared to their male counterparts) could be due to the difference in societal gender roles where women are expected to bear greater responsibilities at home and with childcare,[31] and hence less time is dedicated to exercise. With regard to older participants making healthier choices, possible reasons for it include: 1) being more health conscious as they age, 2) having more family members/ friends diagnosed with diabetes, and 3) having more leisure time than younger people.

Our study showed that the majority of Singaporeans are making healthier diet choices regarding food high in sugar,[14] suggesting that HPB's "Life's Sweeter with Less Sugar" campaign launched in 2014[32] has been effective. Despite better choices, total sugar intake of Singaporeans increased to 60 g[14] which suggests that Singaporeans are consuming more sugars per serving from their food. There is thus a need to improve Singaporeans' food choices as they could have a misperception of the amount of sugar that they are consuming. Most Singaporeans still have suboptimal diet practices, choosing to base their main meals around carbohydrates most of the time. Lack of time,

lack of access from home and workplace, cost and other priorities are possible reasons for unhealthy diet choices.[33] Furthermore, rice and noodles are staples in Asian cuisine, making it harder to find alternatives. As such, cheaper and more convenient access to main meals without starchy food items could be introduced to overcome these barriers.

Singaporeans with better knowledge or stronger beliefs about diabetes prevention tend to exercise more as they could be more health conscious and motivated.[34] An Australian study reported that one of the main motivators for people to engage in physical activity is to improve overall health.[35] Therefore, efforts should be aimed at improving knowledge, which can potentially result in an increase in exercise at the population level.

This is further reinforced by HPB's campaigns promoting physical activity such as the "National Steps Challenge".[36] Additionally, due to the beliefs that they are taking active steps in preventing diabetes, these individuals also tended to worry less about developing diabetes as opposed to those who exercised less.

The lack of significant association between knowledge or attitudes towards diabetes and diet could be due to ingrained cultural food habits. HPB has implemented initiatives such as "Healthier Hawker Centre" and "Finest Food" programmes to increase provision of healthy food[37] and "My Healthier Plate", "Healthier Choice Symbol" and "Healthy 365" diet journal to promote healthy eating.

Barriers to a Healthier Diet
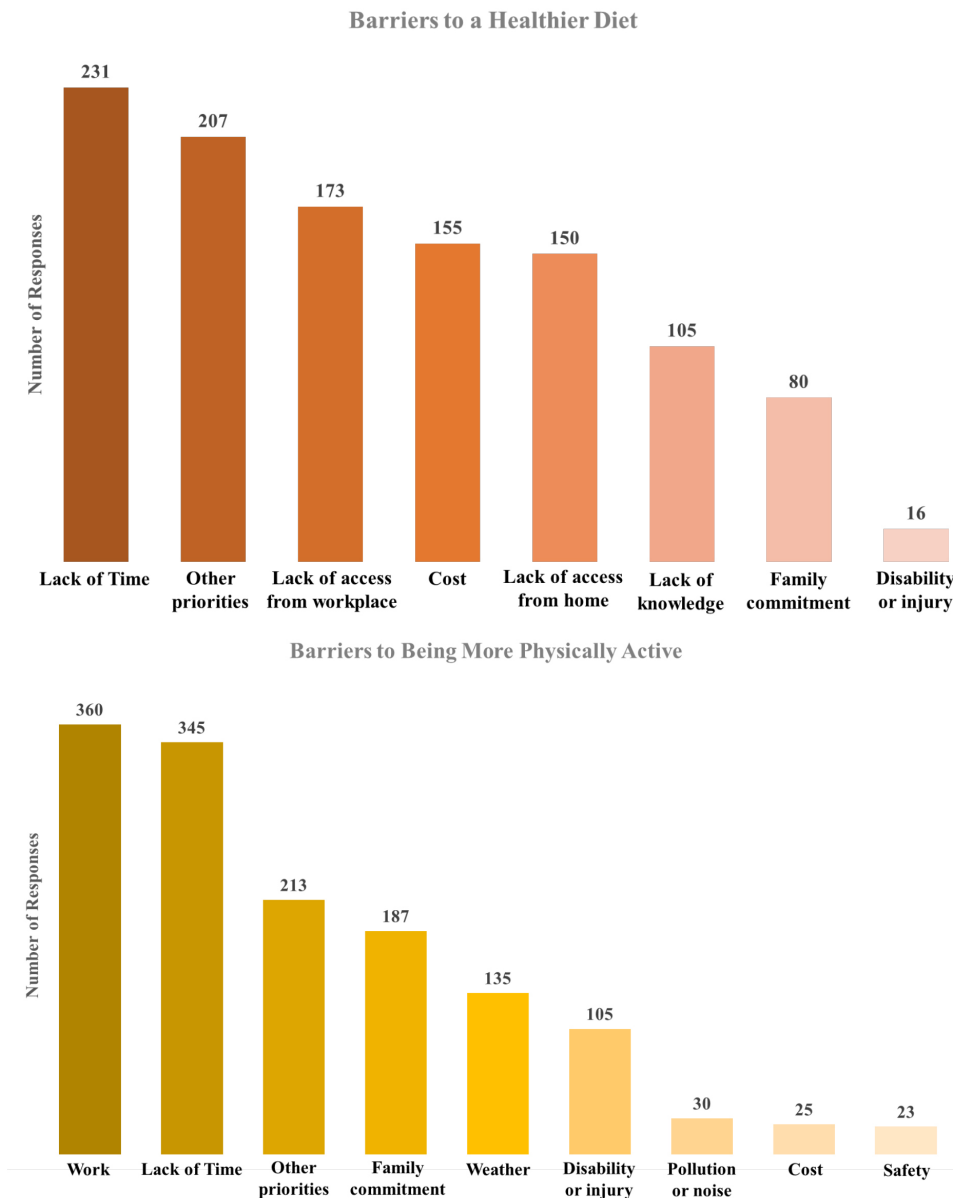

Barriers to Being More Physically Active

Fig. 3. Barriers to healthy practices.

However, more could be done to improve the accessibility and convenience of healthy eating options and to promote healthier eating habits. For the latter, some suggestions would be to host reality cooking television programmes or to create interactive videos on HPB's websites to reach out to a wider audience. Building on the success of switching to wholegrain food, more specific suggestions on food replacement options such as having fruits for dessert (instead of sweet soup) can be recommended through the abovementioned platforms.

Being a cross-sectional study, causalities between knowledge, attitudes and practices cannot be determined.

Residents living in private properties, institutions and the homeless were not sampled due to limited time and resources. Data collection was carried out only in English or Chinese due to the lack of Malay- and Tamil-speaking interviewers, excluding residents who could not converse in either language.

Residents living within the same unit were not randomly selected for participation. We had disproportionately more females as women were more likely to answer the door and agree to participate. Our survey questions were adapted from various validated sources and several new questions were crafted to assess the attitudes of Singaporeans.

Conclusion

This cross-sectional study assessed the association between diabetes knowledge and attitudes, and the preventive practices among middle-aged people without diabetes in Singapore. Our findings suggest that Singapore is headed in the right direction following the declaration of the WoD in 2016. However, individual commitment to healthier lifestyle for diabetes prevention needs to be further strengthened. It is pertinent to encourage both policymakers and researchers to design and implement more effective interventions that are directed towards healthier dietary practices and higher physical activity levels among Singaporeans.

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Appendix: Questionnaire

A.   Inclusion Criteria

Are you a Singapore Citizen or a Permanent Resident?	Yes / No
Have you been diagnosed with Diabetes Mellitus by a Healthcare Professional?	Yes / No
Are you between 30 years old and 64 years old?	Yes / No

B.   Demographics

Area:		**Date:**	
Gender	Male / Female	**Race**	Chinese / Malay / Indian / Others
Age:		**Marital Status**	Single / Married / Divorced / Widowed
Education Level	Primary / Secondary / Tertiary / University / Others		
Monthly Household Income	Below 2k / 2k to 5k / 5k to 8k / 8k to 10k / Above 10k		
Type of Housing	2-Room Flat / 3-Room Flat / 4-Room Flat / 5-Room Flat / Mansionette / Executive Flat		

C.   Past Medical History

1. **Do you have a parent, sibling and/or child diagnosed with Type 2 Diabetes?**
   您是否有父母，兄弟姐妹和/或孩子被诊断患有 2 型糖尿病？
   a.   Yes 是
   b.   No 否
   c.   I do not know. 我不知道

2. **Have you been told by your doctor that you have high blood pressure?**
   您是否被医生诊断过有高血压吗？
   a.   Yes 是
   b.   No 否
   c.   I do not know. 我不知道

D.   Diabetes Knowledge

Part 1

Note to Interviewer:

The following section is for the purpose of evaluating the participant's knowledge regarding diabetes. Go through the following questions with the participants and record down their response.

Instructions to Participant:

We would like to know how much you know about diabetes. I will be asking you a series of questions regarding Diabetes. Please answer "Yes" if you agree with the statement, "No" if you do not agree with the statement. If you are unsure of the answer, answer "I Don't Know".

	Question	Options		
1	**Eating too much sugar and other sweet foods is a cause of diabetes.** 过量的甜食会造成糖尿病。	Yes 是	No 否	I Don't Know 不知道
2	**In untreated diabetes, the amount of sugar in the blood usually increases.** 如果糖尿病患没治疗，血液中的糖含量通常会增加。	Yes 是	No 否	I Don't Know 不知道
3	**If I am diabetic, my children have a higher chance of being diabetic.** 父母如有糖尿病，孩子患糖尿病的风险通常会增加。	Yes 是	No 否	I Don't Know 不知道
4	**Diabetes can be cured.** 糖尿病是可以治好的。	Yes 是	No 否	I Don't Know 不知道
5	**A fasting blood sugar level of 11.6 mmol/L is too high.** 如果某人的空腹血糖是 11.6 mmol/L，可算是过高的血糖水平。	Yes 是	No 否	I Don't Know 不知道
6	**The best way to check my diabetes is by testing my urine.** 检查糖尿病的最好方式是检测尿液。	Yes 是	No 否	I Don't Know 不知道
7	**There are two main types of diabetes: Type 1 (insulin dependent) and Type 2 (noninsulin dependent).** 有两种主要类型的糖尿病：1 型（胰岛素依赖型糖尿病）和 2 型（非胰岛依赖型糖尿病）。	Yes 是	No 否	I Don't Know 不知道
8	**Medication is more important than diet and exercise to control my diabetes.** 如要控制糖尿病，药物治疗比饮食治疗和运动治疗重要。	Yes 是	No 否	I Don't Know 不知道
9	**Diabetes often causes poor circulation.** 糖尿病往往导致血液循环不良。	Yes 是	No 否	I Don't Know 不知道
10	**Cuts and abrasions on diabetics heal more slowly.** 糖尿病患者的伤口往往需要更多时间愈合。	Yes 是	No 否	I Don't Know 不知道
11	**The way I prepare my food is as important as the foods I eat.** 食物煮的方法（列如：蒸，油炸，烤） 与吃的食物种类一样重要。	Yes 是	No 否	I Don't Know 不知道
12	**Diabetes can damage my kidneys.** 糖尿病若控制不好，可能会损伤肾脏。	Yes 是	No 否	I Don't Know 不知道
13	**Diabetes can cause loss of feeling in my hands, fingers and feet.** 糖尿病若控制不好，可能导致手，手指和脚失去感觉。	Yes 是	No 否	I Don't Know 不知道
14	**Shaking and sweating are signs of high blood sugar.** 发抖和出冷汗是高血糖的症兆。	Yes 是	No 否	I Don't Know 不知道
15	**Frequent urination and thirst are signs of low blood sugar.** 尿频和口渴是低血糖的症兆。	Yes 是	No 否	I Don't Know 不知道
16	**A diabetic diet consists mostly of special foods.** 为糖尿病患者准备的饮食主要是特别的食物。	Yes 是	No 否	I Don't Know 不知道

Part 2

Note to Interviewer:

The following section consists of multiple choice questions evaluating the participant's knowledge of diabetes. Go through the following questions with their corresponding options with the participants and record their response.

Instructions to Participant:

I will now ask you a few multiple-choice questions. Please choose the most suitable answer for each question.

	Question
17	**The diabetes diet is:** 为糖尿病患者准备的饮食： a. a healthy diet for most people 对大多数人来说，是健康的饮食。 b. too high in carbohydrate for most people 对大多数人来说，碳水化合物过高。 c. too high in protein for most people 对大多数人来说，蛋白质过高。 d. I do not know 我不知道。
18	**What does 'sugar-free' on a food label indicate?** 食物标签上的'无糖' 表示什么？ a. No added sugar or unsweetened food 产品无加糖份。 b. Contains 0g of sugar 产品无含糖。（0 克） c. Contains equal or less than 0.5g of sugar per 100g or 100mL 每 100g/100mL 产品里含有 0.5 克 一下的糖份。 d. Low calorie food 产品是低卡路里。 e. I do not know 我不知道。
19	**Which is the best method for home glucose testing?** 一下哪个选择是在家测试血糖最佳方法？ a. Urine testing 尿液检测 b. Blood testing 血液检测 c. Both are equally good 尿液检测或血液检测都一样好 d. I do not know 我不知道
20	**What effect does unsweetened fruit juice have on blood glucose?** 不加糖的果汁对血糖有什么影响？ a. Lowers it 降低血糖 b. Raises it 升高血糖 c. Has no effect 没有影响 d. I do not know 我不知道
21	**What effect does exercise have on a person's blood glucose?** 运动对与某人的血糖有什么影响？ a. Lowers it 降低血糖 b. Raises it 升高血糖 c. Has no effect 没有影响 d. I do not know 我不知道
22	**Eating foods lower in fat decreases your risk for:** 食用低脂肪食物可降低患下以下风险： a. Nerve disease 神经系统疾病 b. Kidney disease 肾脏疾病 c. Heart disease 心脏病 d. Eye disease 眼病 e. I do not know 我不知道
23	**Numbness and tingling may be symptoms of:** 麻木和刺痛可能是什么的症状？ a. Kidney disease 肾脏疾病 b. Nerve disease 神经系统疾病 c. Eye disease 眼病 d. Liver disease 肝病 e. I do not know 我不知道

| 24 | **Which of the following is usually not associated with Diabetes:**
哪一种问题通常跟糖尿病无关？
a. Vision problems 眼视影响
b. Kidney problems 肾脏影响
c. Nerve problems 神经系统影响
d. Lung problems 肺影响
e. I do not know 我不知道 |

E. Attitude & Practices

Part 1: Diabetes Perspective & Attitude

Note to Interviewer:
The following section consists of questions evaluating the participant's perspective and attitude on Diabetes. Go through the following questions with the participants and record their response on a scale of 1 to 5.

Instructions to Participant:
I would like to know more about your views and feelings towards Diabetes. Please let me know how much you disagree or agree with the following statements.

Part A: Feelings or Emotions linked to Diabetes Mellitus

	Questions 1) Strongly Disagree 强烈反对 2) Somewhat Disagree 不太同意 3) Neutral 中性 4) Somewhat Agree 有点同意 5) Strongly Agree 非常同意	**Options**				
25	**I am worried that I will be diagnosed with Diabetes in the future.** 我担心将来会被诊断出患有糖尿病。	1	2	3	4	5
26	**I am fearful of health screenings as I am afraid that I might have Diabetes.** 我害怕健康检查，因为我担心我可能患有糖尿病。	1	2	3	4	5
27	**I am apprehensive about the work or effort required to prevent myself from getting Diabetes.** 我对防止自己患糖尿病所需的工作或努力感到担忧。	1	2	3	4	5
28	**I am worried that I do not have sufficient knowledge on Diabetes and on how to prevent it.** 我担心我对糖尿病以及如何预防糖尿病的知识不足。	1	2	3	4	5

Part B: Beliefs or thoughts associated with Diabetes Mellitus

	Questions 1) Strongly Disagree 强烈反对 2) Somewhat Disagree 不太同意 3) Neutral 中性 4) Somewhat Agree 有点同意 5) Strongly Agree 非常同意	**Options**				
29	**I believe that if I manage my diet well, it will reduce my chances of getting Diabetes in the future.** 我相信如果我能很好地管理我的饮食，它将减少我将来患糖尿病的机会。	1	2	3	4	5
30	**I believe that if I exercise regularly, it will reduce my chances of getting Diabetes in the future.** 我相信，如果我经常运动，它将减少我将来患糖尿病的机会。	1	2	3	4	5

31	**I think that it is worth putting in effort to reduce my chances of getting Diabetes.** 我认为值得投入努力减少患糖尿病的机会。	1	2	3	4	5

Part 2: Physical Activity
Note to Interviewer:
The following section consists of multiple-choice questions evaluating the participant's level of physical activity. Go through the following questions with the participants and record their responses.
Instructions to Participant:
I would like to know more about how much physical activity you do every week. Please answer the following questions and choose the option that best represents your current level of physical activity.

	Questions
32	**On average, how much time do you spend on physical activity in a week?** 您平均每个星期花在运动上的时间有多少？ **1.** Less than 30 minutes 少过 30 分钟 **2.** Between 30 minutes to 60 minutes 30 到 60 分钟 **3.** Between 60 minutes to 100 minutes 60 到 100 分钟 **4.** Between 100 minutes to 150 minutes 100 到 150 分钟 **5.** More than 150 minutes. 150 分钟以上
33	**On average, how strenuous are your physical activities in a week?** 您每个星期所做的运动有多剧烈？ 1. Light Intensity 轻度 Example: Cooking, Mopping/Sweeping, Leisure Stroll 例如：烹饪，拖地/清扫，休闲漫步 2. Moderate Intensity 中等强度 Example: Brisk walking (6km/h or 400m in 4 minutes), Light effort cycling, Recreational Badminton 例如：轻快步行（6 公里/小时或 4 分钟走 400 米），轻松骑行，休闲羽毛球 3. High Intensity 高强度 Example: Jogging/Running (9km/h or 400 m in 3 minutes), Heavy effort cycling, Football, Basketball, Tennis 例如：慢跑/跑步（9 公里/小时或 3 分钟跑 400 米），重体力骑车，足球，篮球，网球

Part 3: Diet
Note to Interviewer:
The following section consists of questions evaluating the dietary habits of the participants. Go through the following questions and record their response on a scale of 1 to 5.
Instructions to Participant:
I would like to know more about your diet. Please answer the following questions and choose the option that best represents your current diet.

	Questions 1) Never 从来没有 2) Occasionally 偶尔 3) Half the time 一半时间 4) Most of the time 大多数时候 5) Always 每次都有	**Options**				
34	**How often do you eat more than 5 serving of fruits and/or vegetables every day?** 您多经常每天吃 5 份以上的水果和/或蔬菜？ Example of 1 Serving: 一份量的例子： **One serving of fruit** • 1 small apple, orange, pear or mango (130g) • 1 wedge of papaya, pineapple or watermelon (130g) • 10 grapes or longans (50g) • 1 medium banana • ¼ cup dried fruit (40g) **One serving of vegetables** • 100g raw non-leafy vegetables • ¾ mug⁺ cooked vegetables (100g) • ¼ plate^ cooked vegetables (100g) ⁺ 250 ml ^ 25 cm plate	1	2	3	4	5
35	**How often do you ask for coffee/tea with 'less sugar'?** 您会不会时常要求 "少糖" 的咖啡/茶？	1	2	3	4	5
36	**How often do you base your main meals around starchy food (Rice, Potato, Noodles)?** 您会不会经常以淀粉类物（米饭，马铃薯，面条）作为主要食物？	1	2	3	4	5
37	**How often do you choose low fat products when available?** 您是否经常选择低脂肪产品？	1	2	3	4	5
38	**How often do you choose baked, steamed or grilled options when available rather than fried food (such as crisps and snacks, or fish and chips)?** 您是否经常选择烤制，蒸制或烤制选择而不是油炸食品（如薯片和零食，或鱼柳薯条）？	1	2	3	4	5
39	**How often do you consume sweet cakes, desserts, sweets, chocolate or confectionery? For example, Kueh, Chendol, Cheng Teng?** 你多常吃甜食，例如蛋糕，甜点，糖果，巧克力？（如 粿，珍多， <u>清汤</u>）	1	2	3	4	5
40	**How often do you eat pre-prepared meals? For example, pre-prepared sandwiches, ready meals or canned soups.** 你多经常吃加工食物？例如：三明治，即食食品或罐头汤。	1	2	3	4	5

41	**How often do you opt for lean cuts of meat or remove visible fat?For example, removing the skin on chicken or the fats on bacon?** 您多久选择一次瘦肉或去除可见脂肪？ 例如：去除鸡肉上的皮肤或培根上的脂肪？	1	2	3	4	5
42	**How often do you choose wholemeal bread or rolls rather than white bread?** 你是否经常选择全麦面包或面包卷而不是白面包？	1	2	3	4	5
43	**How often do you consume sweetened beverages, including fruit juice drinks with added sugar？ For example, cola, bubble tea, ribena, water chestnut drinks, sweetened ice tea.** 您多常饮用糖分过高的饮料，包括添加糖份的果汁饮料？例如：可乐，泡泡茶，马蹄水等.	1	2	3	4	5
44	**How often do you eat at hawker centres, foods courts or coffee shops?** 你是否经常在小贩中心，美食广场或咖啡馆用餐吗？	1	2	3	4	5
45	**How often do you eat at western fast food outlets or quick-service restaurants?** 您是否经常在西式快餐连锁店或其他快餐店用餐吗？	1	2	3	4	5

F.   Exploring Reasons

Note to Interviewer:
The following section consists of questions exploring the possible reasons behind the participant's lifestyle and their outlook on Diabetes.
Instructions to Participant:
I would like to know about what is preventing from being more physically active or eating healthier food. Please select the options that best represents the current challenges you are facing.

46.   **Please indicate which of the following are the barriers you face in trying to be more physically active. (can circle none or >1)**
请说明您在尝试更积极运动时所遇到的障碍。 （可以圈无或＞1）

a.   Other Priorities 其他更重要的事情
b.   Disability or Injury 残疾或伤势
c.   Young children or family needs 小孩或家庭需要
d.   Work 工作
e.   Weather 天气
f.   Pollution or noise 污染或噪声
g.   Lack of time 缺乏时间
h.   Cost 花费
i.   Safety 安全

47.   **Please indicate which of the following are the barriers you face in incorporating a healthy diet into your lifestyle. (can circle none or >1)**
请说明您在把健康饮食习惯融入生活当中所遇到的挑战。 （可以圈无或＞1）

a.   Cost 花费
b.   Lack of time 缺乏时间
c.   Lack of access from home 住家周围缺乏资源
d.   **Lack of access from work place 工作地点周围缺乏资源**
e.   **Lack of knowledge 缺乏学问**
f.   **Other priorities 其他优先事项**
g.   **Young children or family needs 儿童或家庭需要**
h.   **Disability or injury 残疾或伤势**