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## Study protocol for a nationwide Knowledge, Attitudes and Practice (KAP) Survey on Diabetes in Singapore's General Population

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3 **Study protocol for a nationwide Knowledge, Attitudes and Practice (KAP) Survey on**  
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5 **Diabetes in Singapore's General Population**  
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## Abstract

## Introduction

This study aims to establish the knowledge, attitude, and practices (KAP) of the general population (people with and without diabetes) to identify gaps in knowledge pertaining to the prevention and detection of diabetes. It will also examine the beliefs and practices that lead to poor glycemic control in diabetics.

## Methods and Analysis

The study is a nationwide cross-sectional study of Singapore's general population aged 18 years and above (n=3000), comprising Chinese, Malay, Indian and other ethnic groups, who can understand English, Chinese, Malay or Tamil language. The sample was derived using a disproportionate stratified sampling using age and ethnicity. The proportion of respondents in each ethnic group (Chinese, Malay and Indian) was set to approximately 30% while the proportion of respondents in each age group was set around 20% in order to ensure sufficient sample size. The respondents will be administered questionnaires on diabetes knowledge, attitudes and practices, stigma towards diabetes, lifestyle, diet, and awareness of local diabetes campaigns. The analysis will include descriptive statistics, and multiple logistic and linear regression analyses to determine the socio-demographic correlates of correct recognition of diabetes, help-seeking preferences, as well as overall knowledge and attitudes among those with and without diabetes. All significance tests will be evaluated at p value <0.05 with two-sided test.

## Ethics and Dissemination

This study protocol has been reviewed by the Institutional Research Review Committee (IRRC) and the National Healthcare Group Domain Specific Review Board (NHG DSRB Ref

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3 2018/00430). The results of the study will be shared with the policy makers and other  
4 stakeholders. There will be a local mass media briefing to disseminate the findings online, in  
5 print, and on television and radio. The results will be published in peer reviewed journals and  
6 presented in scientific meetings.  
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### 13 **Strengths and Limitations of the study**

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- 15
- 16 • This is the largest nationwide survey conducted till date to track the KAP pertaining to  
17 diabetes  
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- 19 • The protocol includes strict quality controls to ensure the accuracy and integrity of the  
20 data  
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- 22 • Multiple methodological considerations such as disproportionate sampling, cognitive  
23 testing of survey questionnaire and recruitment of supplementary groups to improve the  
24 quality of the design.  
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33 **Key words:** diabetes, knowledge, attitudes, lifestyle, diet, diabetics, KAP survey  
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## BACKGROUND

Diabetes is one of the most prevalent metabolic diseases in the world. The prevalence of diabetes worldwide among adults over 18 years has doubled from 4.7% (equivalent to 108 million) in 1980 to 8.5% (equivalent to 422 million) in 2014 [1] and is projected to increase to 693 million in 2045.[2] The social and financial implications due to this disease are complex and include higher rates of mortality, morbidity and economic costs. In 2017, 5 million deaths worldwide were attributable to diabetes or diabetes-related complications among people aged 20 to 99 years. [2] The complications of diabetes include neuropathy, nephropathy, retinopathy and myocardial infarction. [3] Diabetes and the complications arising from it not only affect the individuals and their family, but also impact the healthcare system and the national economy, due to the higher medical costs and loss of productivity that follows the condition. The cost of diabetes treatment was estimated to be USD 727 billion for people aged 20 to 79 years old in 2017 and is predicted to increase to USD 776 billion in 2045 globally. [2]

Singapore is a highly developed country in South-east Asia with a competitive economy ranked number one in the world. [4] It has a multi ethnic population comprising mainly Chinese, Malays and Indians. Despite its efficient healthcare system, [5] it has a higher prevalence of diabetes compared to the global prevalence rate, with 1 in 9 Singaporeans (11.3%) suffering from the disease. [6] Diabetes was the seventh leading cause of disability adjusted life years in Singapore in 2017.[7] In 2010, the total economic costs of diabetes per working-age patient in Singapore was estimated to be US\$5,646, of which 42 % were excess direct medical costs and 58 % indirect productivity-related losses. [8] Thus, diabetes is a significant public health concern in Singapore. The Ministry of Health, Singapore declared a 'War on Diabetes' campaign in 2016 to mobilise citizens to promote 1) healthy lifestyle thereby preventing diabetes, 2) early detection and intervention to reduce the complications associated with diabetes and 3) effective management of diabetes. The Ministry of Health, Singapore recruited

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3 a citizen's jury of 76 volunteers belonging to diverse backgrounds, comprising those living  
4 with/without diabetes, care givers or healthcare providers who came up with the following  
5 recommendations: a) to improve awareness regarding diabetes through education, b) to  
6 promote healthy living through exercise, healthy diet habits, etc., c) peer /community support  
7 initiatives d) enhancing the skills of healthcare providers and e) to improve funding for medical  
8 costs. The 'War on Diabetes' was further strengthened when the recommendations for  
9 advertisement ban on drinks with very high sugar content were unveiled recently along with  
10 recommendations to colour code the drinks to indicate the sugar content. [9]  
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13 Knowledge, Attitude and Practices (KAP) studies collect information on what is known,  
14 believed and done in relation to a particular topic in a specific community. Understanding the  
15 levels of knowledge, personal attitudes and practices can enable a more efficient process of  
16 awareness creation by identifying specific gaps, which allow programmes to be tailored to the  
17 needs of the community. [10] KAP surveys thus reveal misconceptions among the population  
18 and diabetics that may represent obstacles to the activities that agencies would like to  
19 implement, and potential barriers to behaviour change.  
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22 *The current study aims to:*  
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- 25 (i) Conduct a nationwide survey to examine the knowledge, attitudes and practices  
26 pertaining to diabetes among Singapore's general population, supplemented with a diabetic  
27 patient population from polyclinic (primary care) and specialised (secondary) diabetes clinic  
28 settings.  
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30 (ii) Examine the differences in lifestyle and preventive health behaviours of Singapore  
31 residents (Singapore citizens and Permanent Residents) with and without diabetes as well as to  
32 explore specific treatment-related behaviours of those diagnosed with diabetes.  
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3 (iii) Identify the knowledge gaps and behavioural patterns that may hamper diabetes  
4 prevention and control in Singapore's resident population which in turn can lead to more  
5 informed and relevant health promotion/preventive strategies as well as diabetes education  
6 programmes.  
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13 (iv) Identify socio-demographic correlates of diabetes knowledge, attitudes and practices,  
14 to enable targeted diabetes education programmes.  
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18 (v) Examine diabetes related stigma from the perspective of those with diabetes (self-  
19 stigma) and those without diabetes (public stigma).  
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24 (vi) Elucidate facilitators and barriers for adoption of a healthy lifestyle in the population.  
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## 26 **METHODS**

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29 This cross-sectional study is being conducted among 3000 respondents who are randomly  
30 selected from across the country. A flow chart of the study processes is presented in Figure 1.  
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32 The study is currently in the data collection phase with field work actively ongoing. All the  
33 study related activities were initiated after obtaining the relevant approval from Institutional  
34 and Ethics Committee(s) and only persons capable of providing written informed consent are  
35 included in the study. Parental consent is sought for those who are 18-21 years of age as the  
36 official age of adulthood in Singapore is 21 years and above. As this survey assesses knowledge  
37 including the subject's ability to recognise the symptoms of diabetes, the study is not  
38 introduced as a KAP study of diabetes in the consent form or in any other information material  
39 given to the respondent before answering the specific knowledge related questions. Instead, the  
40 term 'chronic physical condition' is used. The actual disease they are being asked about is  
41 revealed after they are administered the diabetes recognition questionnaire. The purpose of this  
42 "blinding" is explained to the subjects during the consent phase with the assurance to unblind  
43 them later during the study.  
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**[Figure 1]*****Study design***

This nationwide cross-sectional study includes Singapore Citizens and Permanent Residents (PRs) aged 18 years and above, comprising Chinese, Malay, Indian and Other ethnic groups, who are able to understand English, Chinese, Malay or Tamil. The inclusion and exclusion criteria are included in table 1.

**Table 1:** Inclusion and Exclusion criteria

<b>Inclusion criteria</b>	<b>Exclusion criteria</b>
Singapore citizens and PRs residing in Singapore	Non-Singapore citizens and non-PRs
Age $\geq 18$ years	
Ethnicity: Chinese, Malay, Indian and Other ethnic groups	Incapable of doing an interview
Can speak English, Mandarin, Malay or Tamil	Living out of the country throughout the field period.
	Long-term hospitalisation or institutionalisation

***Study population, recruitment strategy and training of interviewers******Sampling and sample release***

The sample was drawn from a national administrative database of all residents in Singapore which served as a sampling frame. A total sample of 10,000 individuals was drawn which will be released during the active survey period (1-1.5 years) in 5-10 replicates while closely monitoring the recruitment to ensure a good response rate and inclusion of hard-to-reach population. We intend to achieve a response rate of 65-70% and a final recruitment target of 3000 respondents. The size and number of the replicates are estimated based on the finalisation

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3 and response rates of the previous releases. Finalisation rates are calculated based on the  
4 ineligible cases and refusals. We foresee approximately 15-20% ineligible cases and 10-15%  
5 refusals, based on our previous national surveys. [11-12] An overview of the sampling strategy  
6 and processes are indicated in Figure 2.  
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### 13 [Figure 2]

#### 14 *Recruitment strategy and interviewer training*

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16 The field work for the survey is being conducted by a survey firm which was selected following  
17 the institutional guidelines. All the interviewers (30-40 interviewers) involved in the field work  
18 are aged more than 21 years and experienced in door-to-door surveys. All field interviewers  
19 undergo training over two weeks on the study methodology and field work which included  
20 lectures and hands-on sessions on ethics, techniques on approaching a household, initial self-  
21 introduction/communication with the respondent, consent taking, questionnaire administration,  
22 maintaining visitation records, and other administrative tasks. All the interviewers underwent  
23 an evaluation and those who did not pass the requirements set by the study team were not  
24 allowed to conduct the survey. The training was conducted in English followed by language-  
25 specific training for interviewers who are conversant in one of the three local languages –  
26 Chinese, Malay and Tamil. The field supervisors and/or members from the research team  
27 accompany the interviewers during the initial weeks to identify and resolve any problems  
28 during the survey. The interview is administered via a computer assisted personal interview  
29 (CAPI) which allows real time data collection. This method is an effective method for data  
30 collection and has been used in our previous national surveys. [11] This innovative application  
31 is available in dual language-English together with Chinese, Malay or Tamil. The dual  
32 language interface aids standardisation across languages and allows interviewers to easily  
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3 rephrase hard to understand questions. The real-time data capture protects confidential content  
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5 against loss and theft, and data are available for analysis instantaneously.  
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8 The selected respondents receive an invitation letter one to two weeks before the actual  
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10 household visit by trained interviewers. The invitation letters include the details of the study,  
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12 contact number they could approach to get more information about the survey, provide  
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14 feedback or register their refusal for the survey. A maximum of 10 visits are made per  
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16 household at different days and times before finalising the case. For cases where the respondent  
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18 is not at home during the visit, “*while you were out*” cards are dropped in the letter box or at  
19  
20 their doorstep to allow the respondent to contact the survey firm. Upon completion of the  
21  
22 survey, the participants are given \$40 inconvenience fee in cash.  
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### 26 27 *Quality Assurance* 28

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30 Quality control is ensured at different phases of the study starting from the interviewer selection  
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32 and training, where interviewers are selected if they have at least secondary level education,  
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34 are proficient in one of the main local languages, have basic computer skills and prior  
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36 experience in door-to-door surveys. The training for the interviewers is intense and the  
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38 evaluation involves simulation of the entire survey setting using a lay respondent, starting from  
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40 the first contact with the respondent till the final administration procedures after payment of  
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42 the inconvenience fee. Only those interviewers who pass this evaluation are allowed to conduct  
43  
44 the survey. The initial visits and interviews are done in the presence of the trained team member  
45  
46 or field supervisors. The details of the quality assurance procedures that are followed in all our  
47  
48 surveys are reported elsewhere. [12]  
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54 A trained team constantly monitors the progress of replicates, aging cases and visitation records  
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56 to monitor the trends and highlight the discrepancies to the team for clarification and resolution.  
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58 Around 10% of the interviews per interviewer are selected for routine quality checks (QC)  
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3 which involve verification of the survey and responses for the selected questions over phone,  
4 on site during the interview or by visiting the respondent's house. Apart from the QC, regular  
5 monitoring is conducted to verify that the consent process, visitation records and payment of  
6 inconvenience fee follow approved procedures. Quality is assured at the data processing stages  
7 where logic checks are in place for data verification. Trained staff closely monitor the data  
8 influx to identify and highlight any errors occurring in this phase.  
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### 16 17 *General Population Sample*

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20 The sample size estimates for the general population sample were produced by running  
21 statistical power calculations for binary proportions to determine what sample sizes are  
22 necessary overall, as well as for sub-groups, to produce a precise estimate with a margin of  
23 error equal to 0.05. It was assumed that a statistical power of 0.80 is required, while the Type  
24 1 error rate is controlled at  $\alpha = 0.05$ , as is standard. Power calculations were generated based  
25 on prevalence rates of general knowledge on diabetes and its risk factors. Data from the study  
26 by Wee *et al.*, [13] revealed that on average about 60% of respondents interviewed had correct  
27 responses to the questions related to the general knowledge on diabetes and its risk factors. The  
28 sample size was adjusted to account for deviations from simple random sampling. These  
29 deviations are known as design effect (DEFF). The estimated DEFF after over-sampling on  
30 age and race was 2.029. In this study, the sample was derived using a disproportionate stratified  
31 sampling design. Sampling was done based on a total of twelve strata: combination of 3 strata  
32 for ethnicities (Chinese, Malay and Indian) and 4 strata for age (18-34 yrs, 35-49 yrs, 50-64  
33 yrs and 65 yrs and above) were employed. The proportion of respondents in each ethnic group  
34 (Chinese, Malay and Indian) was set to approximately 30% while the proportion of respondents  
35 in each age group was set around 20% in order to ensure that sufficient sample size for these  
36 population subgroups could be achieved to improve the reliability of our estimates. We have  
37 incorporated all DEFF values in the calculation. In our calculation, realistic sample sizes were  
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3 assumed (e.g., n=2,500 and 3,000) and margin of error was then computed. A target sample  
4 size of 3,000 was estimated to be adequate to determine the general knowledge on diabetes in  
5 the population. The margin of error for the overall prevalence estimate was 2.5%, while the  
6 margin of error for the sub-groups defined by age and ethnic groups was between 4.5% and  
7 5%. Note that as the margin of error (or precision) of a binary proportion depends on the  
8 estimate, we also computed the relative standard error (RSE), which is acceptable if < 30%. It  
9 was noted that RSE was excellent for overall estimate (2.1%) and for sub-groups (age and  
10 ethnicity group) estimates which range between 3.9% and 4.21%.

### 21 22 *Supplementing the general population sample with patients with diabetes*

23  
24 Although previous studies have shown that the prevalence of diabetes in Singapore is 11%,  
25 many were not diagnosed. [6] It is therefore expected that only a limited number of respondents  
26 (approximately n=165) diagnosed with diabetes will be recruited from the general population,  
27 which would therefore reduce the power to detect differences between those with and without  
28 diabetes in the general population. Hence, we are supplementing this group with patients  
29 already diagnosed with diabetes who are seeking care from either primary care or specialist  
30 care settings with 1:2 allocation ratios. We will recruit approximately 330 (330=2x165)  
31 additional patients already diagnosed with diabetes, who are matched to those with diabetes in  
32 the general population by age group, gender and ethnicity. Both the populations i.e. those with  
33 and without diabetes are administered a similar set of questionnaires with some key differences.  
34 The subjects in the general population who indicate that they are not seeking treatment for their  
35 diabetes will not be included in the diabetes group. Depending upon the numbers, we will  
36 consider a separate analysis for this group.

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38 The study population is represented in Figure 3.

### 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 *Screening for diabetes in the general public*

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3 Since a significant proportion of the population is likely to be unaware of their diabetes status,  
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6 <sup>6</sup> those without a history of diabetes are offered a blood test to measure their fasting blood  
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8 glucose glycosylated hemoglobin (HbA1c). Among those who provide consent for the blood  
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10 test, a maximum of 300 respondents will be randomly chosen to undergo the test. The selection  
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12 of the respondents is indicated in Figure 3. The results will provide information on the extent  
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14 of ‘undiagnosed’ diabetes in the population. This group is considered as undiagnosed diabetes  
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16 and their KAPs will be compared against those with and without diabetes.  
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20 **[Figure 3]**

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23 ***Questionnaires***

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26 The following questionnaires are included in the survey. The details of the questionnaire are  
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28 included in the supplementary section.  
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31 i) *Socio-demographic information*  
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33 ii) *Diabetes recognition and knowledge using vignettes*  
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35 iii) *Diabetes KAP questionnaire*  
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37 iv) *Diabetes Stigma Questionnaire:*  
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39 v) *Chronic conditions checklist:*  
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41 vi) *Health related quality of life*  
42  
43 vii) *Global Physical Activity Questionnaire*  
44  
45 viii) *Brief Health Literacy Screen*  
46  
47 ix) *Marlowe-Crowne Social Desirability Scale*  
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49 x) *Lepore’s Social Constraints scale*  
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51 xi) *Diet screener*  
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53 xii) *Barriers and facilitators of diabetes health screen*  
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59 xiii) *Disability screening questionnaire*  
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3       xiv) *Barrier to physical activity questionnaire*  
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5       xv) *Awareness towards diabetes programme*  
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7       xvi) *Lifestyle questionnaire*  
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9       xvii) *E-Health*  
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11       xviii) *The Diabetes Mellitus Disease Severity Index (DCSI)*  
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#### ***Additional Data collected among patients with diabetes***

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The flow of the questionnaires between those with and without diabetes is represented in Figure 4. Those with diabetes are asked additional questions on diabetes knowledge (care and management), self-stigma and social constraints. The DCSI data are captured for diabetes patients by the attending clinician or a researcher supervised by the clinician.

[Figure 4]

#### ***Translation and cognitive interviews (CIs)***

All survey measures were available or translated into the three local languages – Chinese, Malay and Tamil using a professional translating firm. The translation procedure undertaken was aimed at achieving conceptual equivalence using a four-step process that was adapted from the WHO method: 1) forward translation, 2) expert panel review, 3) pre-testing and cognitive interviewing and 4) development of a final version. 1) Forward translation, the initial translation of the original English version into the three main local languages spoken in Singapore (Chinese, Malay and Tamil) by professional translators. 2) An expert panel review, in which members who acted as expert consultants in various fields pertinent to the study, as well as a lay person, offered advice and possible solutions to problems identified in the first draft of the translation. Issues were resolved by critical evaluation of the considerations and recommendations by each expert in their respective fields. 3) Pre-testing and cognitive interviews (CI)s were undertaken to assess how well the measures were likely to be received



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3 by the lay members of public, the target audience for the survey, in each of the specified  
4 languages. Around 25 CIs were conducted to ensure that the vignette, and questionnaires would  
5 be well understood by lay respondents for comprehension, retrieval, decision-making and  
6 response processes. The questionnaires were modified based on the CI taking it to account the  
7 respondent's feedbacks and suggestions.  
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### 15 ***Data Analysis Plan***

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18 Descriptive statistics will be used to describe the socio-demographic characteristics of the  
19 sample. Since majority of the questionnaires are being used for the first time in the local  
20 population, they will be validated. To evaluate reliability, Cronbach's alpha for each of the  
21 questionnaires will be calculated. Internal consistency of the knowledge questionnaire,  
22 including items related to diabetes care principles, will be measured. Similarly, the reliability  
23 of other questionnaires for attitude, diet and physical activity behaviour and stigma will be  
24 calculated. Construct validity of the KAP questionnaire will also be assessed with exploratory  
25 factor analysis.  
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37 Cross tabulation will be used to determine the findings relating to recognition, knowledge,  
38 attitudes and practice across the two groups. Significant differences in the proportions of people  
39 endorsing various KAPs will be determined using Chi-Square test. Beliefs about causes of and  
40 treatment options for diabetes as well as the expected outcomes for someone with diabetes will  
41 also be similarly described.  
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49 Multiple logistic and linear regression analyses will be carried out to determine the socio-  
50 demographic correlates of correctly recognizing diabetes, help-seeking preferences, as well as  
51 overall knowledge and attitudes among those with and without diabetes. Practices and attitudes  
52 regarding treatment and stigma will be investigated for important subgroups. In order to ensure  
53 that the findings from the household survey represents of the Singapore adult population, all  
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3 estimates will be analysed using survey weights to adjust for oversampling, non-response, and  
4 post stratification according to age and ethnicity of the Singapore population. Sampling errors  
5 will be assessed by estimated 95% confidence intervals around the estimates and performing  
6 relevant sensitivity analyses. All significance tests will be evaluated at p value <0.05 with two-  
7 sided test.  
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## 14 **Discussion**

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18 This is one of the first few population-wide studies that aims to explore diabetes knowledge,  
19 attitude and practice among the resident population in Singapore. Majority of the studies  
20 conducted in Asia and southeast Asia have focused mainly on either patient with a known  
21 diagnosis of diabetes or general public who are not representative of the overall population of  
22 the country. [14-18] The methodology, which includes the use of a vignette-based approach,  
23 has been used previously in Singapore to capture recognition, knowledge and attitudes towards  
24 people with mental illness in a recently completed national mental health literacy study in  
25 Singapore. [19-20] The current study will serve as a baseline measure of diabetes knowledge  
26 for the Singapore's general population and will be used to inform future health policies and as  
27 part of on-going efforts in the 'War on Diabetes'. More specifically, it will identify whether  
28 people are able to recognise the signs and symptoms of diabetes and whether they know where  
29 to seek help or treatment for diabetes. It will also identify sub-groups of the population who  
30 may have poor recognition or knowledge of diabetes, which will then allow for targeted efforts  
31 to improve their knowledge.  
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51 While the concept of stigma has been largely examined in association with mental illness, there  
52 are very few studies done elsewhere which have examined stigma among those with diabetes.  
53 An online survey of over 5000 people with diabetes in the USA found that 61% of people with  
54 type 2 diabetes on intensive insulin therapies and 51% of people taking pills reported feeling  
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3 stigmatised [21] possibly due in part to the therapy's visibility such as finger pricks and shots,  
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5 as people without diabetes may not fully understand it leading to awkwardness or questions  
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7 which may lead to self-stigma. Schabert *et al.* [22] highlighted the adverse consequences of the  
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9 stigma e.g., distress, poorer psychological well-being, and sub-optimal self-care; and they  
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11 emphasised the need for strategies to reduce diabetes-related stigma. This study would be the  
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13 first in Singapore to explore the components of stigma and their association with knowledge,  
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15 attitudes as well as practices among those with diabetes – a hitherto neglected area which would  
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17 have important implications in the management of diabetes.  
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23 The study will also capture and compare the dietary and lifestyle practices of the respondents  
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25 with and without diabetes. Several studies have shown that a large proportion of cases of type  
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27 2 diabetes can be prevented. The results of meta-analysis of the evidence from cohort studies  
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29 suggest that high glycaemic index diets may increase the risk of diabetes [23,24] while a diet  
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31 rich in dietary fibre may reduce the risk. [25] Pan *et al.* [26] conducted a cluster randomised  
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33 trial that showed through healthy diet, exercise and a combination of diet and exercise can all  
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35 substantially reduce risk of diabetes. A 20-year follow up study combining the three lifestyle  
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37 intervention groups showed a 43% lower diabetes risk compared with the control group. [27]  
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39 Similarly, multiple studies conducted in Japan, Finland and the Middle East have shown  
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41 decrease in diabetes incidence through active intervention. [28-31] The information gathered  
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43 in our study will help us to understand the current lifestyle, factors contributing to unhealthy  
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45 lifestyle, reasons for the choice of lifestyle practices, current physical activity, and barriers and  
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47 facilitators of physical activity of the general population with and without diabetes. This  
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49 knowledge is helpful to estimate the effectiveness of ongoing public lifestyle campaigns and  
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51 to identify areas of improvement.  
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57 We acknowledge several challenges with our study design. As the survey pertains to lifestyle  
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59 and health practices it is possible that the respondents will provide socially desirable answers  
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3 leading to social desirability bias, this will however be controlled through the scores on the  
4 Marlowe-Crowne social desirability questionnaire that has been embedded in the survey. This  
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7 being a cross-sectional study we will not be able to rule out the intrinsic risk of reverse  
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10 causation.

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13 In summary, this study will form the first nationwide survey representative of the entire  
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15 Singapore population, conducted in the last 10-year period to understand the Singapore  
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17 residents' knowledge, attitudes and practices towards diabetes. This study will further our  
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19 understanding towards the current lifestyle of Singapore residents, as well as preventive and  
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21 management strategies adopted by the residents towards diabetes. This study will also shed  
22  
23 light on to the awareness of the public towards ongoing "war on diabetes" and other  
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25 government initiatives to tackle diabetes and thus help the policy makers to design meaningful  
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27 and suitable programmes that have better penetration and are aligned with the expectations of  
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29 the public.  
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### 33 **Dissemination of results and ethics**

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37 Following the analysis, the study findings will be disseminated to the relevant stakeholders.  
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39 This will include a press briefing informing the local mass media of the study findings and  
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41 using this platform to disseminate the findings to the general population, via online, television,  
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43 print and radio. A structured dissemination plan has been developed and will encompass  
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45 various forms and will occur via multiple platforms including publishing in academic journals,  
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47 presentations at scientific meetings and conferences, presentation of the key findings to key  
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49 stakeholders e.g. Ministry of Health, Health Promotion Board, Diabetes Society of Singapore,  
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51 general practitioners and other health care providers involved in the care of people with  
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53 diabetes.  
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### **Author contributions**

MS, CSA, RMVD, LES and SCF were involved in the conceptualization of the study. AR wrote and revised the manuscript. JV, KR, FDSK, AJ, AR, MS, CSA, RMVD, LES, SCF and SS were involved in the questionnaire design. MS, AR, FDSK and KPR conducted cognitive testing of the survey questionnaire. EA provided the statistical design and sampling strategy. CBY designed and supports the database. All the authors reviewed and approved the manuscript. MS takes full responsibility of the protocol design.

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### **Conflict of Interest**

The authors declare no conflict of interest.

### **Patient Consent**

Not Required

### **Ethics approval**

This study protocol has been reviewed and approved by the Institutional Research Review Committee (IRRC) and the National Healthcare Group Domain Specific Review Board (NHG DSRB Ref 2018/00430).

### **Footnotes**

The article includes online supplementary materials.

## Figure Legends

**Figure 1:** Flow chart of the KAP study

**Figure 2: Sampling and procedure:** The sample was drawn from a national administrative database of all residents in Singapore which served as a sampling frame. Household surveys is being conducted among those who provide written informed consent.

**Figure 3: Study sample and Recruitment plan:** The study population involved in this national survey includes general public who do not have diabetes and those who self-report a diagnosis of diabetes. The diabetes population will be supplemented with age, gender and ethnicity matched treatment seekers (n=330) for a robust analysis.

**Figure 4:** Flow chart of the questionnaires

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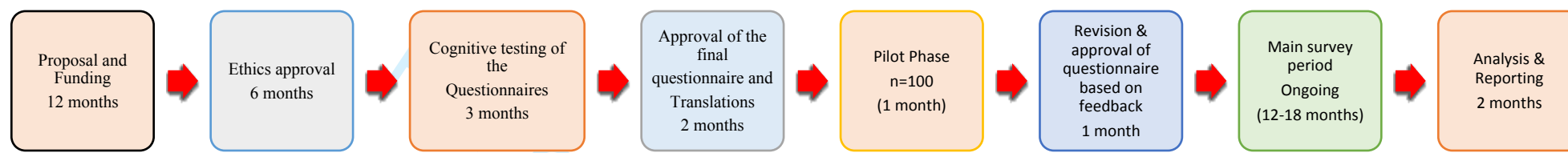
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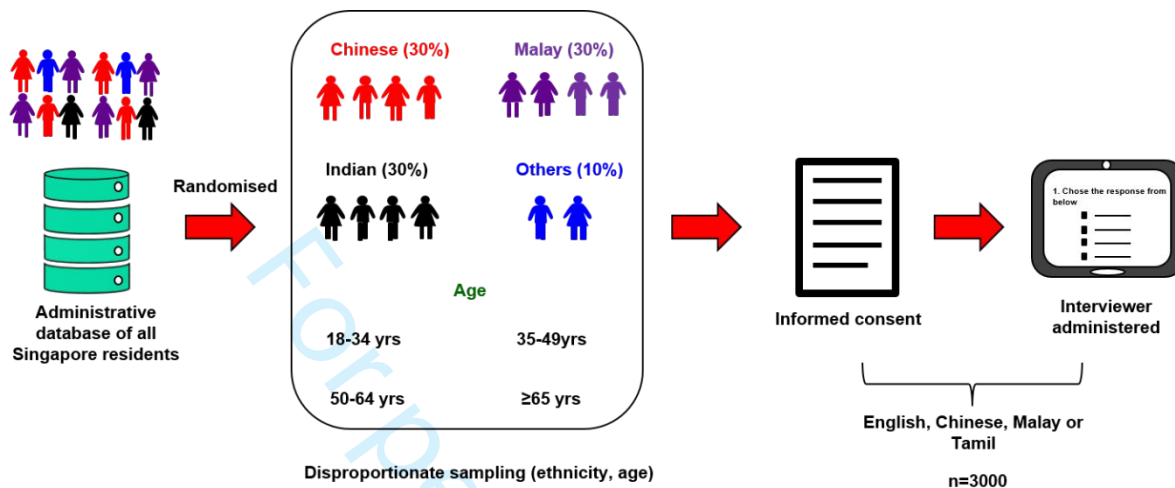
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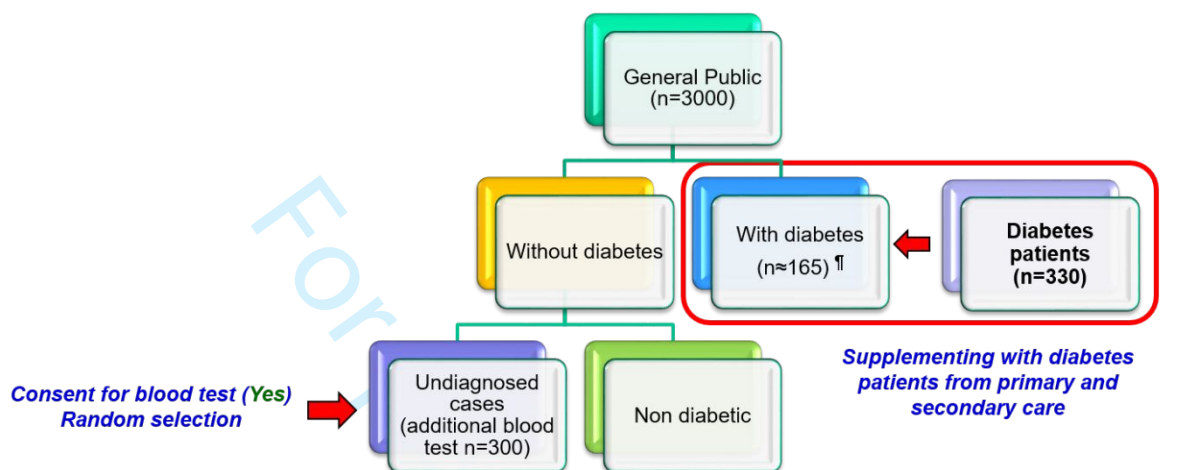
**Figure 1:** Flow chart of the KAP study



**Figure 2: Sampling and procedure:** The sample was drawn from a national administrative database of all residents in Singapore which served as a sampling frame. Household surveys is being conducted among those who provide written informed consent.

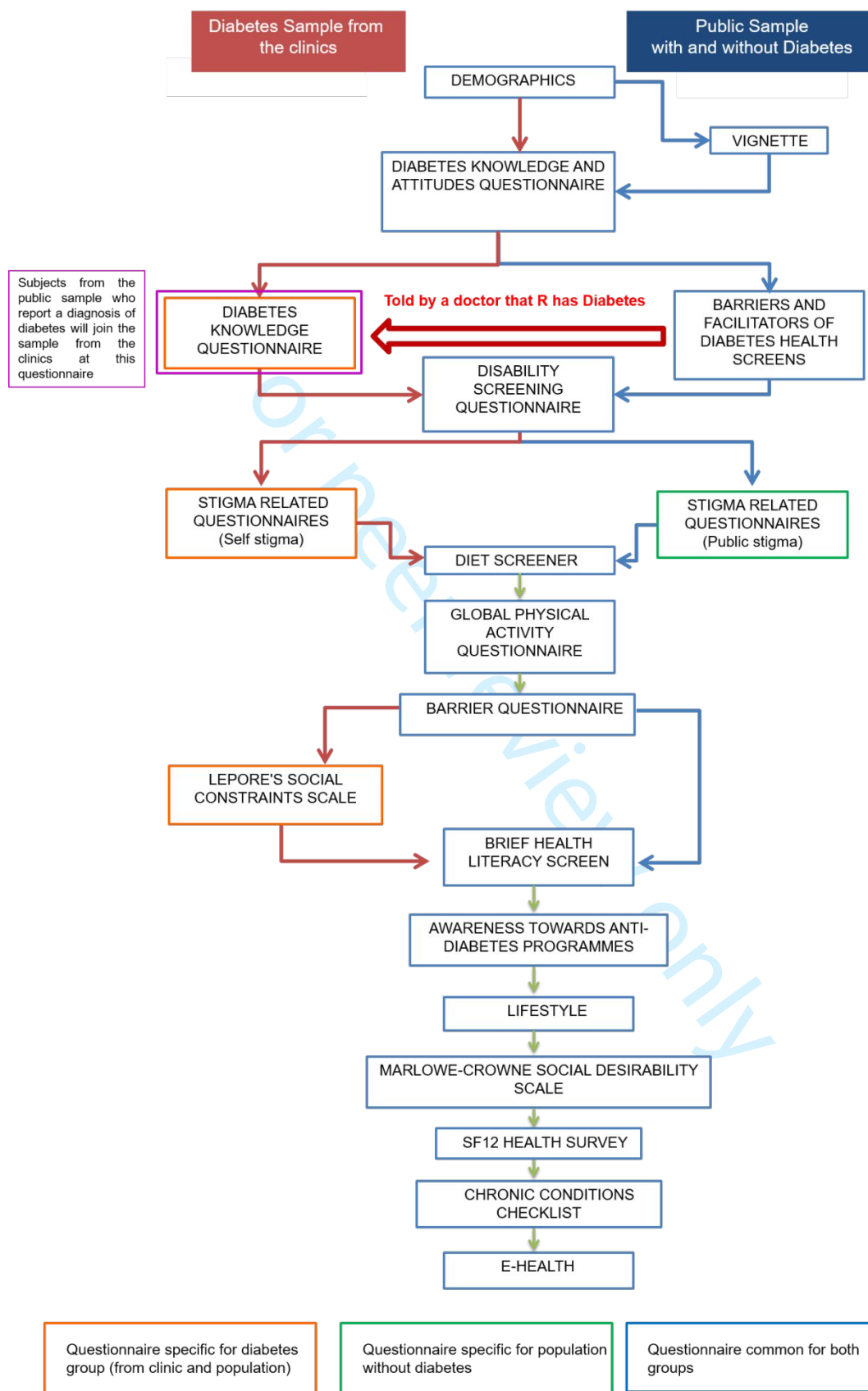


**Figure 3: Study sample and Recruitment plan:** The study population involved in this national survey includes general public who do not have diabetes and those who self-report a diagnosis of diabetes. The diabetes population will be supplemented with age, gender and ethnicity matched treatment seekers (n=330) for a robust analysis.



†† Diagnosed by a clinician and seeking treatment (Estimated based on the reported prevalence rates <sup>6</sup>)

Figure 4: Flow chart of the questionnaires



## Supplementary file: Questionnaire used in the KAP study

No	Outcome	Questionnaire	Reference	Description
1	<i>Socio-demographics</i>	<i>Socio-demographic information</i>	Developed in house	A structured questionnaire will be used to collect information on questions relating to age, gender, ethnicity, religion, marital status, education level and employment status, occupation, family composition, personal and household income, housing type and area of residence. The study will obtain self-reported information on height and weight.
2	<i>Diabetes recognition &amp; knowledge</i>	<i>Diabetes recognition and knowledge using vignettes</i>	Developed in house	<p>Diabetes knowledge will be assessed via two methods: the use of a vignette describing someone with diabetes and KAP questionnaires. Vignettes are “short stories about hypothetical characters in specified circumstances, to whose situation the interviewee is invited to respond”. Vignettes can be generated from a range of sources including previous research, consultation with experts in the fields and real-life case histories. The vignette will then be used to elicit perceptions, opinions, beliefs and attitudes about diabetes. To ensure the respondent can best relate to this person in the vignette, we will match their gender and ethnicity with that of the person described in the vignette and will use a local name to describe the person in the vignette.</p> <p>An example of the vignette is:</p> <p>“Mr. Tan is a 68-year old male who has found activities like oil painting to fill his days since retiring from his job three years ago. Mr. Tan keeps himself busy in the mornings by looking after his plants looking after his plants in the corridor of his HDB apartment. He notices that he seems to be going to the bathroom (urinating) quite often. After eating lunch with his wife, Mr. Tan takes a walk around the block. He feels extremely tired and very thirsty upon returning home. He also notices that the wound on his foot is taking a long time to heal. He does not work on his painting sometimes because his vision is blurry.”</p> <p>(The name of the character will change according to the ethnicity of the respondent)</p>
3	<i>Knowledge, attitudes and practices towards diabetes</i>	<i>Diabetes KAP questionnaire</i>	Eigenmann <i>et al.</i> , 2011	Overall, questions will focus on all three levels of diabetes prevention:

			Tanamas <i>et al.</i> , 2013 (questionnaire were adapted for local context)	<p>1) Primary prevention: Are healthy lifestyles adopted to prevent diabetes?</p> <p>2) Secondary prevention: Are people motivated to attend screening for diabetes and are they motivated to change their lifestyle / take part in a lifestyle program if they have pre-diabetes or seek adequate treatment if they have undiagnosed diabetes?</p> <p>3) Tertiary prevention: Adherence to doctor's visits and treatments after people have been diagnosed with diabetes to prevent complications</p>
4	<i>Stigma (self, public)</i>	<i>Diabetes Stigma Questionnaire:</i>	In house	<p>Those with diagnosed diabetes will be asked questions on perceived/self-stigma i.e. whether they feel stigmatised by others or whether they are embarrassed by their condition.</p> <p>Those without diabetes will be asked both about their stigmatising attitudes towards those with diabetes (public stigma) as well as the concerns they may have about being diagnosed with diabetes. Response options range from 1 to 4, from “definitely willing, probably willing, probably unwilling, definitely unwilling</p>
5	<i>History of Chronic medical conditions</i>	<i>Chronic conditions checklist:</i>	Subramaniam <i>et al.</i> , 2019	A brief medical history will be obtained using a self-report chronic conditions checklist where respondents will be asked to report being diagnosed with any of the listed 18 physical conditions in their lifetime. For those conditions which the respondents indicate they have a lifetime diagnosis, they will then be asked about the age of diagnosis and whether they received treatment for those specific conditions in the past 12 months. Responses are captured as Yes or No.
6	<i>Quality of Life</i>	<i>Health related quality of life (HRQoL)</i>	Ware <i>et al.</i> , 1996	This will be assessed using Short Form (SF)-12 questionnaire which is a multi-purpose, generic, short-form health survey with 12 items. It yields physical and mental health summary measures and a preference-based health utility index
7	<i>Physical activity</i>	<i>Global Physical Activity Questionnaire (GPAQ)</i>	Chua <i>et al.</i> , 2015 Bull <i>et al.</i> , 2009	The GPAQ consists of 16 questions designed to estimate an individual's level of physical activity in three domains (work, transport and leisure time) and time spent engaging in sedentary



				behaviour. This questionnaire has been validated in Singapore. Responses are captured as yes or no
8	<i>Health literacy</i>	<i>Brief Health Literacy Screen (BHLS)</i>	Chew et al., 2004, Peterson et al., 2011	This has been used widely to measure health literacy in diverse populations. This instrument is short, comprising three items and can be administered by the interviewer with minimal training. Responses include “all of the time, most of the time some of the time, a little of the time, none of the time”.
9	<i>Social desirability</i>	<i>Marlowe-Crowne Social Desirability Scale (MC-SDS)</i>	(Crowne et al., 1960).	This scale measures and controls for social desirability. The scale represents culturally acceptable items that are unlikely to happen. The scale comprises 33 statements to which respondents are asked to answer "true" or "false" with true answers given a score of 1 and false scored 0. Higher scores indicate more social desirability. This scale is useful in surveys to assess the degree of bias in the responses, in a socially desirable direction than actual behaviour.
10	<i>Social constraints</i>	<i>Lepore's Social Constraints scale</i>	Lepore et al., 1996, Braitman et al., 2008	The scale measures the cognitive processing of those with diabetes via sharing the diabetes-related experiences to others. Talking about the disease to someone who is supportive is believed to aid in coping, to promote self-care and to desensitise people from disease-related thoughts. A higher score indicates higher social constraints. The scale consists of 15 items with response options that range from “never”, “rarely”, “sometimes” and “often”.
11	<i>Dietary habits</i>	<i>Diet screener</i>	Whitton et al., 2017, 2018	The diet screener includes a list of 37 items developed to meet the dietary style of the local population with a 10-point frequency scale. The scale was developed and validated locally and includes healthy food items recognised internationally and locally. Frequencies of “never or rarely, once a month, 2-3 a month, once a week, 2-3 a week, 4-6 a week, once a day, 2-3 a day, 4-5 a day, 6+ a day are captured for each item.
12	<i>Barriers and enablers of diabetic screen</i>	<i>Barriers and facilitators of diabetes health screen</i>	In house	The questionnaire includes questions on diabetes health screening frequency, factors that facilitate attendance to health screens and barriers to regular health screening. It also includes items to measure the motivators to facilitate regular health screening. Responses

				include “strongly agree, agree neutral, disagree and strongly disagree”
13	<i>Disability</i>	<i>Disability screening questionnaire</i>	CDC, 2016	This questionnaire is meant to understand the health problems or impairment due to physical, mental or emotional health conditions. Responses include “not really a barrier, somewhat of a barrier, very much a barrier”.
14	<i>Barriers to physical activity</i>	<i>Barrier to physical activity questionnaire</i>	In house	This question lists down common factors that could potentially act as barriers to become physically active in the local contest. It includes 12 items that are relevant locally captures under the response options “not really a barrier, somewhat of a barrier, very much a barrier”
15	<i>Awareness towards on-going anti-diabetes campaigns</i>	<i>Awareness towards diabetes programme</i>	In house	This section includes questions to understand the public’s awareness towards the ongoing anti-diabetes campaigns. It also captures their perceived effectiveness of these campaigns and feedback for improvements.
16	<i>Lifestyle</i>	<i>Lifestyle questionnaire</i>	In house	The questionnaire carries various domains to measure the current lifestyle of the respondent, reasons for adopting healthy lifestyle (25 items), factors that can promote healthy lifestyle (25 items) and guidelines/regulation that could help people to achieve healthy lifestyle (8 items). The response options include “strongly agree, agree neutral, disagree and strongly disagree”.
17	<i>Acceptability and readiness towards E-health</i>	<i>E-Health</i>	Wootton et al., 2011 Klein et al., 2010 (questions were modified and adapted)	The questionnaire measures readiness for e-health, acceptability, perceived advantages and disadvantages of e-health services for diabetes care.
18	<i>Diabetes disease severity</i>	<i>The Diabetes Mellitus Disease Severity Index (DCSI)</i>	Glasheen et al., 2017 (adapted)	This scale is a refined and validated version of the DCSI according to ICD-10 criteria. Based on 7 dimensions and scores 0-2, described by Glasheen <i>et al</i> (2017) a specific grading criteria for individual dimensions to match the local clinical cases was developed by the diabetologists in the study team. The data will be extracted by clinicians and research officers trained and supervised by the clinicians. Associations of these categories with both socio-demographic characteristics as well as KAP will be examined. Scores are given from 0-2 for 7 severity dimensions (retinopathy,

				nephropathy, neuropathy, cerebrovascular, cardiovascular, peripheral vascular disease, and metabolic)
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# BMJ Open

## Study protocol for a nationwide Knowledge, Attitudes and Practice (KAP) Survey on Diabetes in Singapore's General Population

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3 **Study protocol for a nationwide Knowledge, Attitudes and Practice (KAP) Survey on**  
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5 **Diabetes in Singapore's General Population**  
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## Abstract

### Introduction

This study aims to establish the knowledge, attitude, and practices (KAP) of the general population (people with and without diabetes) towards diabetes. The study will examine (a) recognition and understanding of causes, prevention and treatment strategies of diabetes (b) identify the knowledge gaps and behavioural patterns that may hamper diabetes prevention and control (c) stigma towards and stigma perceived by people with diabetes and (d) awareness of anti-diabetes campaigns.

### Methods and Analysis

The study is a nationwide cross-sectional study of Singapore's general population aged 18 years and above (n=3000), comprising Chinese, Malay, Indian and other ethnic groups, who can understand English, Chinese, Malay or Tamil language. The sample was derived using a disproportionate stratified sampling using age and ethnicity. The proportion of respondents in each ethnic group (Chinese, Malay and Indian) was set to approximately 30% while the proportion of respondents in each age group was set around 20% in order to ensure sufficient sample size. The respondents will be administered questionnaires on diabetes KAP, stigma towards diabetes, lifestyle, diet, and awareness of local anti-diabetes campaigns. The analysis will include descriptive statistics, and multiple logistic and linear regression analyses to determine the socio-demographic correlates of correct recognition of diabetes, help-seeking preferences, as well as overall knowledge and attitudes among those with and without diabetes. All significance tests will be evaluated at p value  $\leq 0.05$  with two-sided tests.

### Ethics and Dissemination

This study protocol has been reviewed by the Institutional Research Review Committee (IRRC) and the National Healthcare Group Domain Specific Review Board (NHG DSRB Ref



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3 2018/00430). The results of the study will be shared with the policy makers and other  
4 stakeholders. There will be a local mass media briefing to disseminate the findings online, in  
5 print, and on television and radio. The results will be published in peer reviewed journals and  
6 presented in scientific meetings.  
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### 13 **Strengths and Limitations of the study**

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16 • This is the largest nationwide survey conducted till date to track the KAP pertaining to  
17 diabetes  
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20 • The protocol includes strict quality controls to ensure the accuracy and integrity of the  
21 data  
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24 • Multiple methodological considerations such as disproportionate sampling, cognitive  
25 testing of survey questionnaire and recruitment of supplementary groups have been  
26 adopted to improve the quality of the study.  
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29 • The limitation of this household survey is that it excludes people who are  
30 institutionalised (hospitalised, long term care, imprisoned, etc.) during the entire field  
31 period of the survey.  
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40 **Key words:** diabetes, knowledge, attitudes, lifestyle, diet, diabetics, KAP survey  
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## BACKGROUND

Diabetes Mellitus (DM) is one of the most prevalent metabolic diseases in the world. The prevalence of diabetes worldwide among adults over 18 years has doubled from 4.7% (equivalent to 108 million) in 1980 to 8.5% (equivalent to 422 million) in 2014 [1] and is projected to increase to 693 million in 2045. [2] The social and financial implications due to this disease are complex and include higher rates of mortality, morbidity and economic costs. In 2017, 5 million deaths worldwide were attributable to diabetes or diabetes-related complications among people aged 20 to 99 years. [2] Significant complications of diabetes include microvascular complications (neuropathy, nephropathy, retinopathy), macrovascular complications (cardiovascular, cerebrovascular, peripheral vascular diseases) and miscellaneous complications (cardiomyopathy, metabolic crisis, etc). [3] Diabetes and the complications arising from it not only affect the individuals and their family, but also impact the healthcare system and the national economy, due to the higher medical costs and loss of productivity resulting from the condition. The cost of diabetes treatment was estimated to be USD 727 billion for people aged 20 to 79 years old in 2017 and is predicted to increase to USD 776 billion in 2045 globally. [2]

Singapore is a highly developed country in South-east Asia with a competitive economy ranked number one in the world. [4] It has a multiethnic population comprising mainly Chinese, Malays and Indians. Despite its efficient healthcare system, [5] it has a higher prevalence of diabetes compared to the global prevalence rate, with 1 in 9 Singaporeans (11.3%) suffering from the disease. [6] Diabetes was the seventh leading cause of disability adjusted life years in Singapore in 2017.[7] In 2010, the total economic costs of diabetes per working-age patient in Singapore was estimated to be US\$5,646, of which 42 % were excess direct medical costs and 58 % indirect productivity-related losses. [8] Thus, diabetes is a significant public health concern in Singapore. The Ministry of Health, Singapore declared a ‘War on Diabetes’

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3 campaign in 2016 to mobilise citizens to promote 1) healthy lifestyle thereby preventing  
4 diabetes, 2) early detection and intervention to reduce the complications associated with  
5 diabetes and 3) effective management of diabetes. The Ministry of Health, Singapore recruited  
6 a citizen's jury of 76 volunteers belonging to diverse backgrounds, comprising those living  
7 with/without diabetes, care givers or healthcare providers who came up with the following  
8 recommendations: a) to improve awareness regarding diabetes through education, b) to  
9 promote healthy living through exercise, healthy diet habits, etc., c) peer /community support  
10 initiatives d) enhancing the skills of healthcare providers and e) to improve funding for medical  
11 costs. The 'War on Diabetes' was further strengthened when the recommendations for  
12 advertisement ban on drinks with very high sugar content were unveiled recently along with  
13 recommendations to colour code the drinks to indicate the sugar content. [9]  
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29 KAP studies collect information on what is known, believed and done in relation to a particular  
30 topic in a specific community. Understanding the levels of knowledge, personal attitudes and  
31 practices can enable a more efficient process of awareness creation by identifying specific gaps,  
32 which allows programmes to be tailored to the needs of the community. [10] KAP surveys thus  
33 reveal misconceptions among the population and diabetics that may pose obstacles to the  
34 activities that agencies would like to implement, as well as potential barriers to behaviour  
35 change. Previous studies have shown the utility of such KAP surveys in determining the need  
36 for tailored preventive and educational initiatives. [11,12]  
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48 Although 3 broad classes of diabetes are observed at the population level (type 1 (T1DM), type  
49 2 (T2DM) and gestational diabetes), T1DM forms a very small proportion (5-10%) of the total  
50 diabetes cases and gestational diabetes occurs transiently. Moreover, T2DM is more amenable  
51 to prevention through lifestyle and dietary changes, therefore, the current study mainly targets  
52 T2DM in Singapore. For the purposes of this study diabetes thus refers to T2DM.  
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3 *The current study aims to:*  
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- 6 (i) Conduct a nationwide survey to examine the KAP pertaining to the prevention and early  
7 detection of diabetes (Type 2) among Singapore's general population,  
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11 (ii) Examine the differences in lifestyle and preventive health behaviours of Singapore  
12 residents (Singapore citizens and Permanent Residents) with and without diabetes as well as to  
13 explore specific treatment-related behaviours of those diagnosed with diabetes.  
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16 (iii) Identify the knowledge gaps and behavioural patterns that may hamper diabetes  
17 prevention and control in Singapore's resident population  
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20 (iv) Identify socio-demographic correlates of diabetes KAP.  
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23 (v) Examine diabetes related stigma from the perspective of those with diabetes (self-  
24 stigma) and those without diabetes (public stigma).  
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27 (vi) Explore lifestyle factors and elucidate facilitators and barriers for adoption of a healthy  
28 lifestyle in the population.  
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32 (viii) Understand the awareness of the population towards anti-diabetes campaigns.  
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#### 40 **METHODS**

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43 This cross-sectional study will be conducted among 3000 respondents who will be randomly  
44 selected from across the country. A flow chart of the study processes is presented in Figure 1.  
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46 The study is currently in the data collection phase with field work actively ongoing. All the  
47 study related activities were initiated after obtaining the relevant approval from the Institute of  
48 Mental Health's Institutional Research Review Committee (IMH, IRRC) as well as the Ethics  
49 Committee (National Healthcare Group Domain Specific Review Board (NHG DSRB Ref  
50 2018/00430). and only persons capable of providing written informed consent will be included  
51 in the study. Parental consent will be sought for those who are 18-21 years of age as the official  
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3 age of adulthood in Singapore is 21 years and above. As this survey assesses knowledge  
4 including the subject's ability to recognise the symptoms of diabetes, the study is not  
5 introduced as a KAP study of diabetes in the consent form or in any other information material  
6 given to the respondent before answering the specific knowledge related questions. Instead, the  
7 term 'chronic physical condition' is used. The actual disease they are being asked about is  
8 revealed after they are administered the diabetes recognition questionnaire. The purpose of this  
9 "blinding" is explained to the subjects during the consent phase with the assurance to unblind  
10 them later during the study. The survey (data collection) was launched in February 2019 and  
11 is expected to conclude by December 2020.  
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### 23 [Figure 1]

#### 24 *Patient and public involvement*

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27 Patient and members of public were involved in the development of the research questions and  
28 outcome measures. Prior to the commencement of the survey, the questionnaires were  
29 cognitively tested among members of the general public and diabetes patients to improve the  
30 quality of the questionnaire and to adapt it to the local population. This step helped to identify  
31 questions, words or phrases that were difficult to understand or unacceptable to them. The  
32 participants were also asked to provide feedback on the mode of administering the  
33 questionnaires as well as suggest domains/questions that may be important to assess the KAP  
34 but had been missed out by the researchers. Patients with diabetes were especially asked about  
35 the acceptability and relevance of the stigma related questions and social constraints scale.  
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37 There was no patient/public involvement in the recruitment and conduct of the study at this  
38 stage. The results of the study will be shared with the public through media releases, public  
39 sharing sessions and open access publications.  
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### ***Study design***

This nationwide cross-sectional study includes Singapore Citizens and Permanent Residents (PRs) aged 18 years and above, comprising Chinese, Malay, Indian and Other ethnic groups, who are able to understand English, Chinese, Malay or Tamil. The inclusion and exclusion criteria are included in table 1.

**Table 1:** Inclusion and Exclusion criteria

<b>Inclusion criteria</b>	<b>Exclusion criteria</b>
Singapore citizens and PRs residing in Singapore	Non-Singapore citizens and non-PRs
Age $\geq 18$ years	
Ethnicity: Chinese, Malay, Indian and Other ethnic groups	Incapable of doing an interview
Can speak English, Mandarin, Malay or Tamil	Living out of the country throughout the field period.
	Long-term hospitalisation or institutionalization throughout the field period

### ***Study population, recruitment strategy and training of interviewers***

#### *Sample size calculations, Sampling and sample release*

The sample size estimates for the general population sample were produced by running statistical power calculations for binary proportions to determine what sample sizes are necessary overall, as well as for sub-groups, to produce a precise estimate with a margin of error less than or equal to 0.05. It was assumed that a statistical power of 0.80 is required, while the Type 1 error rate is controlled at  $\alpha = 0.05$ , as is standard. Power calculations were generated based on prevalence rates of general knowledge on diabetes and its risk factors. Data from the study by Wee *et al.*, [13] revealed that on average about 60% of respondents

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3 interviewed had correct responses to the questions related to the general knowledge on diabetes  
4 and its risk factors. The sample size was adjusted to account for deviations from simple random  
5 sampling. These deviations are known as design effect (DEFF). The estimated DEFF after  
6 over-sampling on age and race was 2.029. In this study, the sample was derived using a  
7 disproportionate stratified sampling design. Sampling was done based on a total of twelve  
8 strata: combination of 3 strata for ethnicities (Chinese, Malay and Indian) and 4 strata for age  
9 (18-34 yrs, 35-49 yrs, 50-64 yrs and 65 yrs and above) were employed. The proportion of  
10 respondents in each ethnic group (Chinese, Malay and Indian) was set to approximately 30%  
11 while the proportion of respondents in each age group was set around 20% in order to ensure  
12 that sufficient sample size for these population subgroups could be achieved to improve the  
13 reliability of our estimates. We have incorporated all DEFF values in the calculation. In our  
14 calculation, realistic sample sizes were assumed (e.g., n=2,500 and 3,000) and margin of error  
15 was then computed. A target sample size of 3,000 was estimated to be adequate to determine  
16 the general knowledge on diabetes in the population. The margin of error for the overall  
17 prevalence estimate was 2.5%, while the margin of error for the sub-groups defined by age and  
18 ethnic groups was between 4.5% and 5%. Note that as the margin of error (or precision) of a  
19 binary proportion depends on the estimate, we also computed the relative standard error (RSE),  
20 which is acceptable if  $< 30\%$ . It was noted that RSE was excellent for overall estimate (2.1%)  
21 and for sub-groups (age and ethnicity group) estimates which range between 3.9% and 4.21%.  
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23 The sample was drawn from a national administrative database of all residents in Singapore  
24 which served as a sampling frame. A total sample of 10,000 individuals was drawn which will  
25 be released during the active survey period (1-1.5 years) in 5-10 replicates while closely  
26 monitoring the recruitment to ensure a good response rate and inclusion of hard-to-reach  
27 population. We intend to achieve a response rate of 65-70% and a final recruitment target of  
28 3000 respondents. The size and number of the replicates are estimated based on the finalisation  
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3 and response rates of the previous releases. Finalisation rates will be calculated based on the  
4 ineligible cases and refusals. We foresee approximately 15-20% ineligible cases and 10-15%  
5 refusals, based on our previous national surveys. [14-15] An overview of the sampling strategy  
6 and processes are indicated in Figure 2.  
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### 13 [Figure 2]

#### 14 *Recruitment strategy and interviewer training*

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17 The field work for the survey will be conducted by a survey firm which was selected following  
18 the institutional guidelines. All the interviewers (30-40 interviewers) involved in the field work  
19 are aged more than 21 years and experienced in door-to-door surveys. All field interviewers  
20 undergo training over two weeks on the study methodology and field work which included  
21 lectures and hands-on sessions on ethics, techniques on approaching a household, initial self-  
22 introduction/communication with the respondent, consent taking, questionnaire administration,  
23 maintaining visitation records, and other administrative tasks. All the interviewers underwent  
24 an evaluation and those who did not pass the requirements set by the study team were not  
25 allowed to conduct the survey. The training was conducted in English followed by language-  
26 specific training for interviewers who are conversant in one of the three local languages –  
27 Chinese, Malay and Tamil. The field supervisors and/or members from the research team will  
28 accompany the interviewers during the initial weeks to identify and resolve any problems  
29 during the survey. The interviews will be administered via a computer assisted personal  
30 interview (CAPI) which allows real time data collection. This method is an effective method  
31 for data collection and has been used in our previous national surveys. [14] This innovative  
32 application is available in dual language-English together with Chinese, Malay or Tamil. The  
33 dual language interface aids standardisation across languages and allows interviewers to easily  
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3 rephrase hard to understand questions. The real-time data capture protects confidential content  
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5 against loss and theft, and data are available for analysis instantaneously.  
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9 The selected respondents will receive an invitation letter one to two weeks before the actual  
10 household visit by trained interviewers. The invitation letters include the details of the study,  
11 contact number they could approach to get more information about the survey, provide  
12 feedback or register their refusal for the survey. A maximum of 10 visits will be made per  
13 household at different days and times before finalising the case. For cases where the respondent  
14 is not at home during the visit, “*while you were out*” cards will be dropped in the letter box or  
15 at their doorstep to allow the respondent to contact the survey firm. Upon completion of the  
16 survey, the participants will be given \$40 inconvenience fee in cash.  
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### 26 27 *Quality Assurance* 28

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30 Quality control is ensured at different phases of the study starting from the interviewer selection  
31 and training, where interviewers are selected only if they have at least secondary level  
32 education, are proficient in one of the main local languages, have basic computer skills and  
33 prior experience in door-to-door surveys. The training for the interviewers is intense and the  
34 evaluation involves simulation of the entire survey setting using a lay respondent, starting from  
35 the first contact with the respondent till the final administration procedures after payment of  
36 the inconvenience fee. Only those interviewers who pass this evaluation will be allowed to  
37 conduct the survey. The initial visits and interviews will be done in the presence of the trained  
38 team member or field supervisors. The details of the quality assurance procedures that are  
39 followed in all our surveys are reported elsewhere. [15]  
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54 A trained team will constantly monitor the progress of replicates, aging cases and visitation  
55 records to monitor the trends and highlight the discrepancies to the team for clarification and  
56 resolution. Around 10% of the interviews per interviewer will be selected for routine quality  
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3 checks (QC) which involve verification of the survey and responses for the selected questions  
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5 over phone, on site during the interview or by visiting the respondent's house. Apart from the  
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7 QC, regular monitoring will be conducted to verify that the consent process, visitation records  
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9 and payment of inconvenience fees follow approved procedures. Quality will be assured at the  
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11 data processing stages where logic checks are in place for data verification. Trained staff will  
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13 closely monitor the data influx to identify and highlight any errors occurring in this phase.  
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### 16 17 *Supplementing the general population sample with patients with diabetes*

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20 Although previous studies have shown that the prevalence of diabetes in Singapore is 11%,  
21  
22 many were not diagnosed. [6] It is therefore expected that only a limited number of respondents  
23  
24 (approximately n=165) diagnosed with diabetes will be recruited from the general population,  
25  
26 which would therefore reduce the power to detect differences between those with and without  
27  
28 diabetes in the general population. Hence, we are supplementing this group with patients  
29  
30 already diagnosed with diabetes who are seeking care from either primary care or specialist  
31  
32 care settings with 1:2 allocation ratios. We will recruit approximately 330 ( $330=2 \times 165$ )  
33  
34 additional patients already diagnosed with diabetes, who are matched to those with diabetes in  
35  
36 the general population by age group, gender and ethnicity. Both the populations i.e. those with  
37  
38 and without diabetes are administered a similar set of questionnaires with some key differences.  
39  
40 The subjects in the general population who indicate that they are not seeking treatment for their  
41  
42 diabetes will not be included in the diabetes group. Depending upon the numbers, we will  
43  
44 consider a separate analysis for this group.  
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51 The study population is represented in Figure 3.

### 52 53 *Screening for diabetes in the general public*

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56 Since a significant proportion of the population is likely to be unaware of their diabetes status,  
57  
58 [6] those without a history of diabetes are offered a blood test to measure their fasting blood  
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3 glucose glycosylated hemoglobin (HbA1c). Among those who provide consent for the blood  
4 test, a maximum of 300 respondents will be randomly chosen to undergo the test. The selection  
5 of the respondents is indicated in Figure 3. The results will provide information on the extent  
6 of 'undiagnosed' diabetes in the population. This group is considered as undiagnosed diabetes  
7 and their KAPs will be compared against those with and without diabetes.  
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### 15 [Figure 3]

#### 16 *Questionnaires*

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21 The following questionnaires are included in the survey. The details of the questionnaire are  
22 included in the supplementary section.  
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24

- 25 i) *Socio-demographic information*
  - 26 ii) *Diabetes recognition and knowledge using vignettes*
  - 27 iii) *Diabetes KAP questionnaire*
  - 28 iv) *Diabetes Stigma Questionnaire:*
  - 29 v) *Chronic conditions checklist:*
  - 30 vi) *Health related quality of life*
  - 31 vii) *Global Physical Activity Questionnaire*
  - 32 viii) *Brief Health Literacy Screen*
  - 33 ix) *Marlowe-Crowne Social Desirability Scale*
  - 34 x) *Lepore's Social Constraints scale*
  - 35 xi) *Diet screener*
  - 36 xii) *Barriers and facilitators of diabetes health screen*
  - 37 xiii) *Disability screening questionnaire*
  - 38 xiv) *Barrier to physical activity questionnaire*
  - 39 xv) *Awareness towards diabetes programme*
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xvi) *Lifestyle questionnaire*

xvii) *E-Health*

xviii) *The Diabetes Mellitus Disease Severity Index (DCSI)*

#### ***Additional Data collected among patients with diabetes***

The flow of the questionnaires between those with and without diabetes is represented in Figure 4. Those with diabetes will be asked additional questions on diabetes knowledge (care and management), self-stigma and social constraints. The DCSI data are captured for diabetes patients by the attending clinician or a researcher supervised by the clinician.

#### **[Figure 4]**

#### ***Translation and cognitive interviews (CIs)***

All survey measures were available or translated into the three local languages – Chinese, Malay and Tamil using a professional translating firm. The translation procedure undertaken was aimed at achieving conceptual equivalence using a four-step process that was adapted from the WHO method: 1) forward translation, 2) expert panel review, 3) pre-testing and cognitive interviewing and 4) development of a final version. 1) Forward translation, the initial translation of the original English version into the three main local languages spoken in Singapore (Chinese, Malay and Tamil) by professional translators. 2) An expert panel review, in which members who acted as expert consultants in various fields pertinent to the study, as well as a lay person, offered advice and possible solutions to problems identified in the first draft of the translation. Issues were resolved by critical evaluation of the considerations and recommendations by each expert in their respective fields. 3) Pre-testing and cognitive interviews (CI)s were undertaken to assess how well the measures were likely to be received by the lay members of public, the target audience for the survey, in each of the specified languages. Around 25 CIs were conducted to ensure that the vignette, and questionnaires would

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2  
3 be well understood by lay respondents for comprehension, retrieval, decision-making and  
4 response processes. The questionnaires were modified based on the CI taking it to account the  
5 respondent's feedbacks and suggestions.  
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### 10 ***Data Analysis Plan***

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13 Descriptive statistics will be used to describe the socio-demographic characteristics of the  
14 sample. Since majority of the questionnaires are being used for the first time in the local  
15 population, they will be validated. To evaluate reliability, Cronbach's alpha for each of the  
16 questionnaires will be calculated. Internal consistency of the knowledge questionnaire,  
17 including items related to diabetes care principles, will be measured. Similarly, the reliability  
18 of other questionnaires for attitude, diet and physical activity behaviour and stigma will be  
19 calculated. Construct validity of the KAP questionnaire will also be assessed with exploratory  
20 factor analysis.  
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33 Cross tabulation will be used to determine the findings relating to recognition, and KAP across  
34 the two groups. Significant differences in the proportions of people endorsing various KAPs  
35 will be determined using Chi-Square test. Beliefs about causes of and treatment options for  
36 diabetes as well as the expected outcomes for someone with diabetes will also be similarly  
37 described. We will use list wise deletion to deal with missing data when analysing the dataset.  
38 However, if the proportion of missing data is significantly high, we will examine the missing  
39 data pattern to determine if it is missing at random (MAR), missing completely at random  
40 (MCAR), or missing not at random (MNAR) before performing imputations on the dataset.  
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54 Multiple logistic and linear regression analyses will be carried out to determine the socio-  
55 demographic correlates of correctly recognizing diabetes, help-seeking preferences, as well as  
56 overall knowledge and attitudes among those with and without diabetes. Practices and attitudes  
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3 regarding treatment and stigma will be investigated for important subgroups. In order to ensure  
4 that the findings from the household survey represents of the Singapore adult population, all  
5 estimates will be analysed using survey weights to adjust for oversampling, non-response, and  
6 post stratification according to age and ethnicity of the Singapore population. Sampling errors  
7 will be assessed by estimated 95% confidence intervals around the estimates and performing  
8 relevant sensitivity analyses. All significance tests will be evaluated at p value  $\leq 0.05$  with two-  
9 sided test.  
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## 20 **Discussion**

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23 This is one of the first few population-wide studies that aims to explore diabetes KAP among  
24 the resident population in Singapore. Majority of the studies conducted in Asia and southeast  
25 Asia have focused mainly on either patients with a known diagnosis of diabetes or general  
26 public who are not representative of the overall population of the country. [17-21] The  
27 methodology, which includes the use of a vignette-based approach, has been used previously  
28 in Singapore to capture recognition, knowledge and attitudes towards people with mental  
29 illness in a recently completed national mental health literacy study. [22-23] The current study  
30 will serve as a baseline measure of diabetes knowledge for the Singapore's general population  
31 and will be used to inform future health policies and as part of on-going efforts in the 'War on  
32 Diabetes'. More specifically, it will identify whether people are able to recognise the signs and  
33 symptoms of diabetes and whether they know where to seek help or treatment for diabetes. It  
34 will also identify sub-groups of the population who may have poor recognition or knowledge  
35 of diabetes, which will then allow for targeted efforts to improve their knowledge.  
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53 While the concept of stigma has been largely examined in association with mental illness, there  
54 are very few studies done elsewhere which have examined stigma among those with diabetes.  
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56 An online survey of over 5000 people with diabetes in the USA found that 61% of people with  
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3 type 2 diabetes on intensive insulin therapies and 51% of people taking pills reported feeling  
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5 stigmatised [24] possibly due in part to the therapy's visibility such as finger pricks and shots,  
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7 as people without diabetes may not fully understand it leading to awkwardness or questions  
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9 which may lead to self-stigma. Schabert *et al.* [25] highlighted the adverse consequences of the  
10  
11 stigma e.g., distress, poorer psychological well-being, and sub-optimal self-care; and they  
12  
13 emphasised the need for strategies to reduce diabetes-related stigma. This study would be the  
14  
15 first in Singapore to explore the components of stigma and their association with KAP among  
16  
17 those with diabetes – a hitherto neglected area which would have important implications in the  
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19 management of diabetes.  
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24 The study will also capture and compare the dietary and lifestyle practices of the respondents  
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26 with and without diabetes. Several studies have shown that a large proportion of cases of type  
27  
28 2 diabetes can be prevented. The results of meta-analysis of the evidence from cohort studies  
29  
30 suggest that high glycaemic index diets may increase the risk of diabetes [26-27] while a diet  
31  
32 rich in dietary fibre may reduce the risk. [28] Pan *et al.* [29] conducted a cluster randomised  
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34 trial that showed through healthy diet, exercise and a combination of diet and exercise can all  
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36 substantially reduce risk of diabetes. A 20-year follow up study combining the three lifestyle  
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38 intervention groups showed a 43% lower diabetes risk compared with the control group. [30]  
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40 Similarly, multiple studies conducted in Japan, Finland and the Middle East have shown  
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42 decrease in diabetes incidence through active intervention. [31-34] The information gathered  
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44 in our study will help us to understand the current lifestyle, factors contributing to unhealthy  
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46 lifestyle, reasons for the choice of lifestyle practices, current physical activity, and barriers and  
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48 facilitators of physical activity of the general population with and without diabetes. This  
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50 knowledge is helpful to estimate the effectiveness of ongoing public lifestyle campaigns and  
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52 to identify areas of improvement.  
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3 We acknowledge several challenges with our study design. As the survey pertains to lifestyle  
4 and health practices it is possible that the respondents will provide socially desirable answers  
5 leading to social desirability bias, this will however be controlled through the scores on the  
6 Marlowe-Crowne social desirability questionnaire that has been embedded in the survey. This  
7 being a cross-sectional study we will not be able to rule out the intrinsic risk of reverse  
8 causation.  
9

10  
11 In summary, this study will form the first nationwide survey representative of the entire  
12 Singapore population, conducted in the last 10-year period to understand the Singapore  
13 residents' KAP towards diabetes. This study will further our understanding towards the current  
14 lifestyle of Singapore residents, as well as preventive and management strategies adopted by  
15 the residents towards diabetes. This study will also shed light on to the awareness of the public  
16 towards ongoing "War on Diabetes" and other government initiatives to tackle diabetes and  
17 thus help the policy makers to design meaningful and suitable programmes that have better  
18 penetration and are aligned with the expectations of the public.  
19

### 20 21 22 **Ethics and Dissemination** 23

24 Following the analysis, the study findings will be disseminated to the relevant stakeholders.  
25 This will include a press briefing informing the local mass media of the study findings and  
26 using this platform to disseminate the findings to the general population, via online, television,  
27 print and radio. A structured dissemination plan has been developed and will encompass  
28 various forms and will occur via multiple platforms including publishing in academic journals,  
29 presentations at scientific meetings and conferences, presentation of the key findings to key  
30 stakeholders e.g. Ministry of Health, Health Promotion Board, Diabetes Society of Singapore,  
31 general practitioners and other health care providers involved in the care of people with  
32 diabetes.  
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## Acknowledgements

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## Author contributions

MS, CSA, RMVD, LES and SCF were involved in the conceptualization of the study. AR wrote and revised the manuscript. JV, KR, FDSK, AJ, AR, MS, CSA, RMVD, LES, SCF and SS were involved in the questionnaire design. MS, AR, FDSK and KPR conducted cognitive testing of the survey questionnaire. EA provided the statistical design and sampling strategy. CBY designed and supports the database. All the authors reviewed and approved the manuscript. MS and CSA take full responsibility of the protocol design.

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## Conflict of Interest

The authors declare no conflict of interest.

## Patient Consent

Not Required

## Ethics approval

This study protocol has been reviewed and approved by the Institutional Research Review Committee (IRRC) and the National Healthcare Group Domain Specific Review Board (NHG DSRB Ref 2018/00430).

## Footnotes

The article includes online supplementary materials.

## Figure Legends

**Figure 1:** Flow chart of the KAP study

**Figure 2: Sampling and procedure:** The sample was drawn from a national administrative database of all residents in Singapore which served as a sampling frame. Household surveys is being conducted among those who provide written informed consent.

**Figure 3: Study sample and Recruitment plan:** The study population involved in this national survey includes general public who do not have diabetes and those who self-report a diagnosis of diabetes. The diabetes population will be supplemented with age, gender and ethnicity matched treatment seekers (n=330) for a robust analysis.

**Figure 4:** Flow chart of the questionnaires

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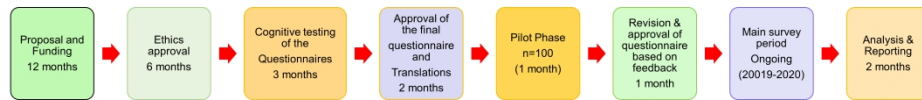


Figure 1: Flow chart of the KAP study

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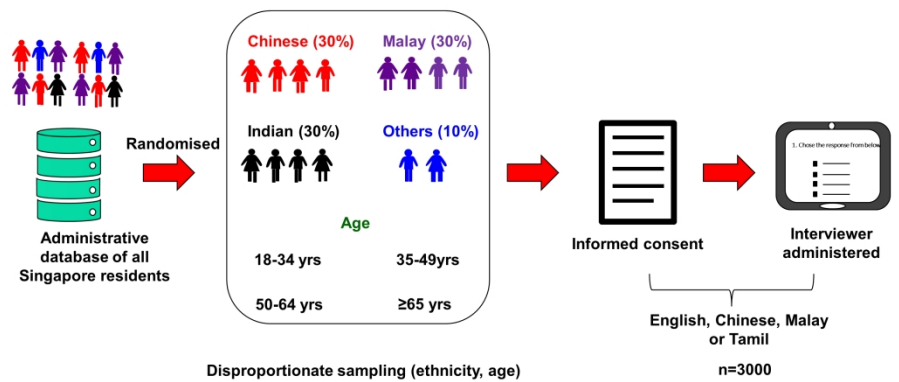


Figure 2: Sampling and procedure: The sample was drawn from a national administrative database of all residents in Singapore which served as a sampling frame. Household survey is being conducted among those who provide written informed consent.

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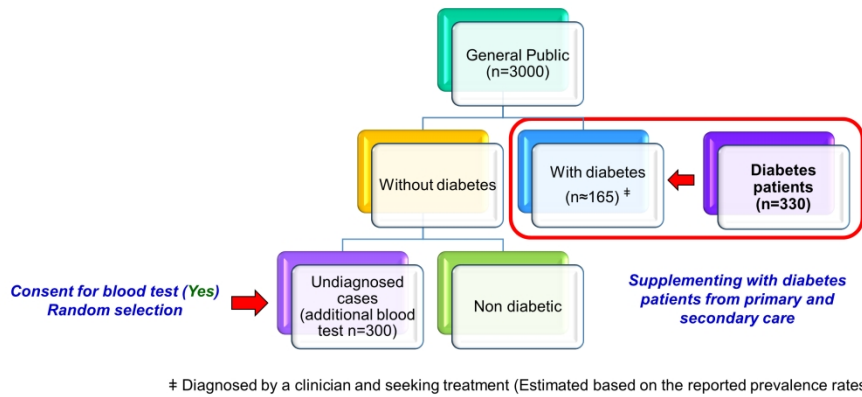


Figure 3: Study sample and Recruitment plan: The study population involved in this national survey includes the general public who do not have diabetes and those who self-report a diagnosis of diabetes. The diabetes population will be supplemented with age, gender and ethnicity matched treatment seekers (n=330) for a robust analysis.

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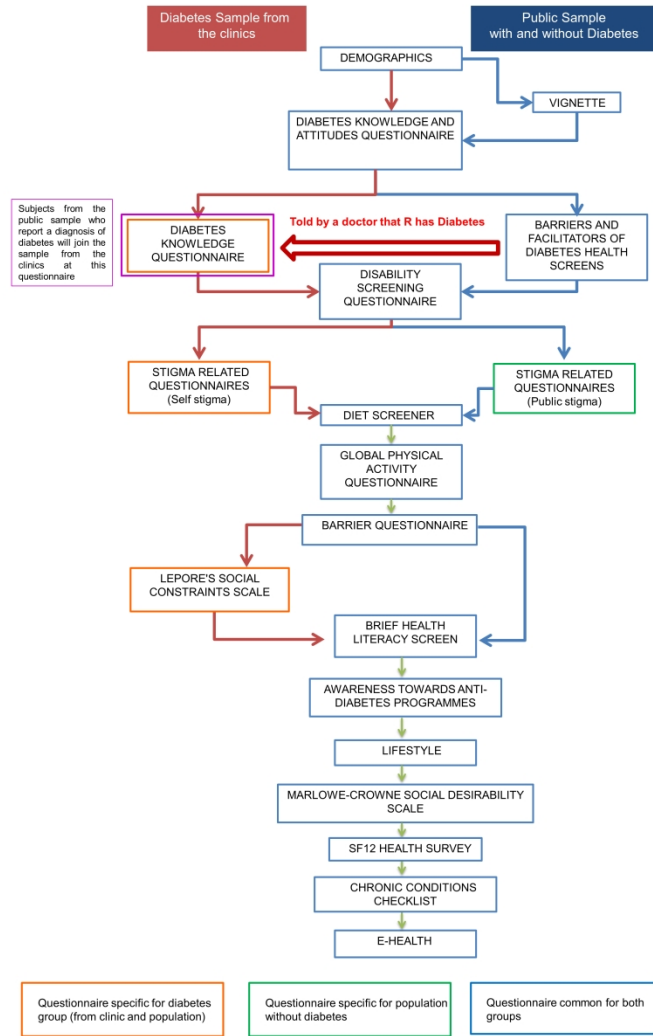


Figure 4: Flow chart of the questionnaires

250x450mm (300 x 300 DPI)

## Supplementary file: Questionnaire used in the KAP study

No	Outcome	Questionnaire	Reference	Description
1	<i>Socio-demographics</i>	<i>Socio-demographic information</i>	Developed in house	A structured questionnaire will be used to collect information on questions relating to age, gender, ethnicity, religion, marital status, education level and employment status, occupation, family composition, personal and household income, housing type and area of residence. The study will obtain self-reported information on height and weight.
2	<i>Diabetes recognition &amp; knowledge</i>	<i>Diabetes recognition and knowledge using vignettes</i>	Developed in house	<p>Diabetes knowledge will be assessed via two methods: the use of a vignette describing someone with diabetes and KAP questionnaires. Vignettes are “short stories about hypothetical characters in specified circumstances, to whose situation the interviewee is invited to respond”. Vignettes can be generated from a range of sources including previous research, consultation with experts in the fields and real-life case histories. The vignette will then be used to elicit perceptions, opinions, beliefs and attitudes about diabetes. To ensure the respondent can best relate to this person in the vignette, we will match their gender and ethnicity with that of the person described in the vignette and will use a local name to describe the person in the vignette.</p> <p>An example of the vignette is:</p> <p><i>“Mr. Tan is a 68-year old male who has found activities like oil painting to fill his days since retiring from his job three years ago. Mr. Tan keeps himself busy in the mornings by looking after his plants looking after his plants in the corridor of his HDB apartment. He notices that he seems to be going to the bathroom (urinating) quite often. After eating lunch with his wife, Mr. Tan takes a walk around the block. He feels extremely tired and very thirsty upon returning home. He also notices that the wound on his foot is taking a long time to heal. He does not work on his painting sometimes because his vision is blurry.”</i></p> <p><i>(The name of the character will change according to the ethnicity of the respondent)</i></p>
3	<i>Knowledge, attitudes and practices towards diabetes</i>	<i>Diabetes KAP questionnaire</i>	Eigenmann <i>et al.</i> , 2011	Overall, questions will focus on all three levels of diabetes prevention:

			Tanamas <i>et al.</i> , 2013 (questionnaire were adapted for local context)	<p>1) Primary prevention: Are healthy lifestyles adopted to prevent diabetes?</p> <p>2) Secondary prevention: Are people motivated to attend screening for diabetes and are they motivated to change their lifestyle / take part in a lifestyle program if they have pre-diabetes or seek adequate treatment if they have undiagnosed diabetes?</p> <p>3) Tertiary prevention: Adherence to doctor's visits and treatments after people have been diagnosed with diabetes to prevent complications</p>
4	<i>Stigma (self, public)</i>	<i>Diabetes Stigma Questionnaire:</i>	In house	<p>Those with diagnosed diabetes will be asked questions on perceived/self-stigma i.e. whether they feel stigmatised by others or whether they are embarrassed by their condition.</p> <p>Those without diabetes will be asked both about their stigmatising attitudes towards those with diabetes (public stigma) as well as the concerns they may have about being diagnosed with diabetes. Response options range from 1 to 4, from “definitely willing, probably willing, probably unwilling, definitely unwilling</p>
5	<i>History of Chronic medical conditions</i>	<i>Chronic conditions checklist:</i>	Subramaniam <i>et al.</i> , 2019	A brief medical history will be obtained using a self-report chronic conditions checklist where respondents will be asked to report being diagnosed with any of the listed 18 physical conditions in their lifetime. For those conditions which the respondents indicate they have a lifetime diagnosis, they will then be asked about the age of diagnosis and whether they received treatment for those specific conditions in the past 12 months. Responses are captured as Yes or No.
6	<i>Quality of Life</i>	<i>Health related quality of life (HRQoL)</i>	Ware <i>et al.</i> , 1996	This will be assessed using Short Form (SF)-12 questionnaire which is a multi-purpose, generic, short-form health survey with 12 items. It yields physical and mental health summary measures and a preference-based health utility index
7	<i>Physical activity</i>	<i>Global Physical Activity Questionnaire (GPAQ)</i>	Chua <i>et al.</i> , 2015 Bull <i>et al.</i> , 2009	The GPAQ consists of 16 questions designed to estimate an individual's level of physical activity in three domains (work, transport and leisure time) and time spent engaging in sedentary

				behaviour. This questionnaire has been validated in Singapore. Responses are captured as yes or no
8	<i>Health literacy</i>	<i>Brief Health Literacy Screen (BHLS)</i>	Chew et al., 2004, Peterson et al., 2011	This has been used widely to measure health literacy in diverse populations. This instrument is short, comprising three items and can be administered by the interviewer with minimal training. Responses include “all of the time, most of the time some of the time, a little of the time, none of the time”.
9	<i>Social desirability</i>	<i>Marlowe-Crowne Social Desirability Scale (MC-SDS)</i>	(Crowne et al., 1960).	This scale measures and controls for social desirability. The scale represents culturally acceptable items that are unlikely to happen. The scale comprises 33 statements to which respondents are asked to answer "true" or "false" with true answers given a score of 1 and false scored 0. Higher scores indicate more social desirability. This scale is useful in surveys to assess the degree of bias in the responses, in a socially desirable direction than actual behaviour.
10	<i>Social constraints</i>	<i>Lepore’s Social Constraints scale</i>	Lepore et al., 1996, Braitman et al.,2008	The scale measures the cognitive processing of those with diabetes via sharing the diabetes-related experiences to others. Talking about the disease to someone who is supportive is believed to aid in coping, to promote self-care and to desensitise people from disease-related thoughts. A higher score indicates higher social constraints. The scale consists of 15 items with response options that range from “never”, “rarely”, “sometimes” and “often”.
11	<i>Dietary habits</i>	<i>Diet screener</i>	Whitton et al., 2017, 2018	The diet screener includes a list of 37 items developed to meet the dietary style of the local population with a 10-point frequency scale. The scale was developed and validated locally and includes healthy food items recognised internationally and locally. Frequencies of “never or rarely, once a month, 2-3 a month, once a week, 2-3 a week, 4-6 a week, once a day, 2-3 a day, 4-5 a day, 6+ a day are captured for each item.
12	<i>Barriers and enablers of diabetic screen</i>	<i>Barriers and facilitators of diabetes health screen</i>	In house	The questionnaire includes questions on diabetes health screening frequency, factors that facilitate attendance to health screens and barriers to regular health screening. It also includes items to measure the motivators to facilitate regular health screening. Responses

				include “strongly agree, agree neutral, disagree and strongly disagree”
13	<i>Disability</i>	<i>Disability screening questionnaire</i>	CDC, 2016	This questionnaire is meant to understand the health problems or impairment due to physical, mental or emotional health conditions. Responses include “not really a barrier, somewhat of a barrier, very much a barrier”.
14	<i>Barriers to physical activity</i>	<i>Barrier to physical activity questionnaire</i>	In house	This question lists down common factors that could potentially act as barriers to become physically active in the local context. It includes 12 items that are relevant locally captures under the response options “not really a barrier, somewhat of a barrier, very much a barrier”
15	<i>Awareness towards ongoing anti-diabetes campaigns</i>	<i>Awareness towards diabetes programme</i>	In house	This section includes questions to understand the public’s awareness towards the ongoing anti-diabetes campaigns. It also captures their perceived effectiveness of these campaigns and feedback for improvements.
16	<i>Lifestyle</i>	<i>Lifestyle questionnaire</i>	In house	The questionnaire carries various domains to measure the current lifestyle of the respondent, reasons for adopting healthy lifestyle (25 items), factors that can promote healthy lifestyle (25 items) and guidelines/regulation that could help people to achieve healthy lifestyle (8 items). The response options include “strongly agree, agree neutral, disagree and strongly disagree”.
17	<i>Acceptability and readiness towards E-health</i>	<i>E-Health</i>	Wootton et al., 2011 Klein et al., 2010 (questions were modified and adapted)	The questionnaire measures readiness for e-health, acceptability, perceived advantages and disadvantages of e-health services for diabetes care.
18	<i>Diabetes disease severity</i>	<i>The Diabetes Mellitus Disease Severity Index (DCSI)</i>	Glasheen et al., 2017 (adapted)	This scale is a refined and validated version of the DCSI according to ICD-10 criteria. Based on 7 dimensions and scores 0-2, described by Glasheen et al (2017) a specific grading criteria for individual dimensions to match the local clinical cases was developed by the diabetologists in the study team. The data will be extracted by clinicians and research officers trained and supervised by the clinicians. Associations of these categories with both socio-demographic characteristics as well as KAP will be examined. Scores are given from 0-2 for 7 severity dimensions (retinopathy,

				nephropathy, neuropathy, cerebrovascular, cardiovascular, peripheral vascular disease, and metabolic)
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# BMJ Open

## Study protocol for a nationwide Knowledge, Attitudes and Practice (KAP) Survey on Diabetes in Singapore's General Population

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3 **Study protocol for a nationwide Knowledge, Attitudes and Practice (KAP) Survey on**  
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5 **Diabetes in Singapore's General Population**  
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## Abstract

## Introduction

This study aims to establish the knowledge, attitude, and practices (KAP) of the general population (people with and without diabetes) towards diabetes. The study will examine (a) recognition and understanding of causes, prevention and treatment strategies of diabetes (b) identify the knowledge gaps and behavioural patterns that may hamper diabetes prevention and control (c) stigma towards and stigma perceived by people with diabetes and (d) awareness of anti-diabetes campaigns.

## Methods and Analysis

The study is a nationwide cross-sectional study of Singapore's general population aged 18 years and above (n=3000), comprising Chinese, Malay, Indian, and other ethnic groups, who can understand English, Chinese, Malay or Tamil language. The sample was derived using a disproportionate stratified sampling using age and ethnicity. The proportion of respondents in each ethnic group (Chinese, Malay, and Indian) was set to approximately 30%, while the proportion of respondents in each age group was set around 20% in order to ensure a sufficient sample size. The respondents will be administered questionnaires on diabetes KAP, stigma towards diabetes, lifestyle, diet, and awareness of local anti-diabetes campaigns. The analysis will include descriptive statistics and multiple logistic and linear regression analyses to determine the socio-demographic correlates of correct recognition of diabetes, help-seeking preferences, as well as overall knowledge and attitudes among those with and without diabetes. We will consider a p-value  $\leq 0.05$  as significant.

## Ethics and Dissemination

This study protocol has been reviewed by the Institutional Research Review Committee (IRRC) and the National Healthcare Group Domain Specific Review Board (NHG DSRB Ref

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3 2018/00430). The results of the study will be shared with policymakers and other stakeholders.  
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6 There will be a local mass media briefing to disseminate the findings online, in print, and on  
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8 television and radio. The results will be published in peer-reviewed journals and presented in  
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10 scientific meetings.  
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### 13 **Strengths and Limitations of the study**

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- 15
- 16 • This is the largest nationwide survey conducted to date to track the KAP pertaining to  
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18 diabetes  
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- 20 • The protocol includes strict quality controls to ensure the accuracy and integrity of the  
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22 data  
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- 24 • Multiple methodological considerations such as disproportionate sampling, cognitive  
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26 testing of survey questionnaire and recruitment of supplementary groups have been  
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28 adopted to improve the quality of the study.  
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- 30 • The limitation of this household survey is that it excludes people who are  
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32 institutionalised (hospitalised, long term care, imprisoned, etc.) during the entire field  
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34 period of the survey.  
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40 **Keywords:** diabetes, knowledge, attitudes, lifestyle, diet, diabetics, KAP survey  
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## BACKGROUND

Diabetes Mellitus (DM) is one of the most prevalent metabolic diseases in the world. The prevalence of diabetes worldwide among adults over 18 years has doubled from 4.7% (equivalent to 108 million) in 1980 to 8.5% (equivalent to 422 million) in 2014 [1] and is projected to increase to 693 million in 2045. [2] The social and financial implications due to this disease are complex and include higher rates of mortality, morbidity, and economic costs. In 2017, 5 million deaths worldwide were attributable to diabetes or diabetes-related complications among people aged 20 to 99 years. [2] Significant complications of diabetes include microvascular (neuropathy, nephropathy, retinopathy), macrovascular (cardiovascular, cerebrovascular, peripheral vascular diseases), and miscellaneous complications (cardiomyopathy, metabolic crisis, etc). [3] Diabetes and the complications arising from it not only affect the individuals and their family but also impact the healthcare system and the national economy, due to the higher medical costs and loss of productivity resulting from the condition. The cost of diabetes treatment was estimated to be USD 727 billion for people aged 20 to 79 years old in 2017 and is predicted to increase to USD 776 billion in 2045 globally. [2] Singapore is a highly developed country in South-east Asia, with a competitive economy ranked number one in the world. [4] It has a multi-ethnic population comprising mainly Chinese, Malays, and Indians. Despite its efficient healthcare system, [5] it has a higher prevalence of diabetes compared to the global prevalence rate, with 1 in 9 Singaporeans (11.3%) suffering from the disease. [6] Diabetes was the seventh leading cause of disability-adjusted life years in Singapore in 2017.[7] In 2010, the total economic costs of diabetes per working-age patient in Singapore was estimated to be US\$5,646, of which 42 % were excess direct medical costs and 58 % were indirect productivity-related losses. [8] Thus, diabetes is a significant public health concern in Singapore. The Ministry of Health, Singapore declared a 'War on Diabetes' campaign in 2016 to mobilise citizens to promote 1) healthy lifestyles to

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3 prevent diabetes, 2) early detection and intervention to reduce the complications associated  
4 with diabetes and 3) effective management of diabetes. The Ministry of Health, Singapore  
5 recruited a citizen's jury of 76 volunteers belonging to diverse backgrounds, comprising those  
6 living with/without diabetes, caregivers and healthcare providers who came up with the  
7 following recommendations to a) improve awareness of diabetes through education, b) promote  
8 healthy living through exercise, healthy diet habits, etc., c) strengthen peer /community  
9 support initiatives d) enhance the skills of healthcare providers and e) improve funding for  
10 medical costs. The 'War on Diabetes' was further strengthened recently with recommendations  
11 to ban advertisements for drinks with very high sugar content along with recommendations to  
12 colour code the beverages to indicate the sugar content. [9]

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KAP studies collect information on what is known, believed, and done in relation to a particular topic in a specific community. Understanding the levels of knowledge, personal attitudes, and practices can enable a more efficient process of awareness creation by identifying specific gaps, which allows tailoring of programmes to the needs of the community. [10] KAP surveys thus reveal misconceptions among the population and diabetics that may pose obstacles to the activities that agencies would like to implement, as well as potential barriers to behaviour change. Previous studies have shown the utility of such KAP surveys in determining the need for tailored preventive and educational initiatives. [11,12]

There are three main types of diabetes (type 1 (T1DM), type 2 (T2DM), and gestational diabetes), however T1DM forms a very small proportion (5-10%) of the total diabetes cases and gestational diabetes occurs transiently. Moreover, T2DM is more amenable to prevention through lifestyle and dietary changes, therefore, the current study mainly targets T2DM in Singapore. For the purposes of this study, diabetes thus refers to T2DM.

*The current study aims to:*

- (i) Conduct a nationwide survey to examine the KAP pertaining to the prevention and early detection of diabetes among Singapore's general population,
- (ii) Examine the differences in lifestyle and preventive health behaviours of Singapore residents (Singapore citizens and Permanent Residents (PR)) with and without diabetes as well as to explore specific treatment-related behaviours of those diagnosed with diabetes.
- (iii) Identify the knowledge gaps and behavioural patterns that may hamper diabetes prevention, and control in Singapore's resident population
- (iv) Identify socio-demographic correlates of diabetes KAP.
- (v) Examine diabetes-related stigma from the perspective of those with diabetes (self-stigma) and those without diabetes (public stigma).
- (vi) Explore lifestyle factors and elucidate facilitators and barriers to the adoption of a healthy lifestyle in the population.
- (viii) Understand the awareness of the population towards anti-diabetes campaigns.

## **METHODS**

This cross-sectional study will be conducted among 3000 respondents who will be randomly selected across the country. A flow chart of the study processes is presented in Figure 1. The study is currently in the data collection phase with fieldwork actively on-going. All the study related activities were initiated after obtaining the relevant approval from the Institute of Mental Health's Institutional Research Review Committee (IMH, IRRC) as well as the Ethics Committee (National Healthcare Group Domain Specific Review Board (NHG DSRB Ref 2018/00430). Only persons capable of providing written informed consent will be included in the study. Parental consent will be sought for those who are 18-21 years of age as the official age of adulthood in Singapore is 21 years and above. As this survey assesses the knowledge,



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3 including the subject's ability to recognise the symptoms of diabetes, the study will not be  
4 introduced as a KAP study of diabetes in the consent form or in any other information material  
5 given to the respondent before answering the specific knowledge related questions. Instead, the  
6 term 'chronic physical condition' will be used. The actual disease of interest will be revealed  
7 after the diabetes recognition questionnaire is administered to them. The purpose of this  
8 "blinding" will be explained to the subjects during the consent phase with the assurance to  
9 unblind them later during the study. The survey (data collection) was launched in February  
10 2019 and is expected to conclude by December 2020.

### [Figure 1]

#### ***Patient and public involvement***

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28 Patients and members of the public were involved in the development of the research questions  
29 and outcome measures. Prior to the commencement of the survey, the questionnaires were  
30 cognitively tested among members of the general public and diabetes patients to improve the  
31 quality of the questionnaire and to adapt it to the local population. This step helped to identify  
32 questions, words, or phrases that were difficult to understand or unacceptable to them.  
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Participants were asked to provide feedback on the mode of administration of the  
questionnaires and suggest domains/questions that may be important to assess the KAP but had  
been missed out by the researchers. Patients with diabetes were explicitly asked about the  
acceptability and relevance of the stigma related questions and social constraints scale. There  
was no patient/public involvement in the recruitment and conduct of the study. The results of  
the study will be shared with the public through media releases, public sharing sessions, and  
open access publications.

#### ***Study design***

This nationwide cross-sectional study includes Singapore Citizens and PRs aged 18 years and above, comprising Chinese, Malay, Indian and Other ethnic groups, who can understand English, Chinese, Malay, or Tamil. The inclusion and exclusion criteria are included in table 1.

**Table 1:** Inclusion and Exclusion criteria

Inclusion criteria	Exclusion criteria
Singapore citizens and PRs residing in Singapore	Non-Singapore citizens and non-PRs
Age $\geq 18$ years	
Ethnicity: Chinese, Malay, Indian, and Other ethnic groups	Incapable of doing the interview
Can speak English, Mandarin, Malay, or Tamil	Living out of the country throughout the field period.
	Long-term hospitalisation or institutionalization throughout the field period

### ***Study population, recruitment strategy, and training of interviewers***

#### *Sample size calculations, sampling and sample release*

The sample size estimates for the general population sample were produced by running statistical power calculations for binary proportions to determine what sample sizes are necessary overall, as well as for sub-groups, to produce a precise estimate with a margin of error less than or equal to 0.05. It was assumed that a statistical power of 0.80 was required, while the Type 1 error rate is controlled at  $\alpha = 0.05$ , as is standard. Power calculations were generated based on prevalence rates of general knowledge on diabetes and its risk factors. Data from the study by Wee *et al.*, [13] revealed that, on average, about 60% of respondents interviewed had correct responses to the questions related to the general knowledge on diabetes

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3 and its risk factors. The sample size was adjusted to account for deviations from simple random  
4 sampling. These deviations are known as the design effect (DEFF). The estimated DEFF after  
5 over-sampling on age and race was 2.029. In this study, the sample was derived using a  
6 disproportionate stratified sampling design. Sampling was done based on a total of twelve  
7 strata: a combination of 3 strata for ethnicities (Chinese, Malay, and Indian) and 4 strata for  
8 age (18-34 yrs, 35-49 yrs, 50-64 yrs, and 65 yrs and above) were employed. The proportion of  
9 respondents in each ethnic group (Chinese, Malay, and Indian) was set to approximately 30%  
10 while the proportion of respondents in each age group was set around 20% in order to ensure  
11 that sufficient sample size for these population subgroups could be achieved to improve the  
12 reliability of our estimates. We have incorporated all DEFF values in the calculation. In our  
13 calculation, realistic sample sizes were assumed (e.g., n=2,500 and 3,000) and then the margin  
14 of error was computed. A target sample size of 3,000 was estimated to be adequate to  
15 determine the general knowledge of diabetes in the population. The margin of error for the  
16 overall prevalence estimate was 2.5%, while the margin of error for the sub-groups defined by  
17 age and ethnic groups was between 4.5% and 5%. Note that as the margin of error (or  
18 precision) of a binary proportion depends on the estimate, we also computed the relative  
19 standard error (RSE), which is acceptable if  $< 30\%$ . It was noted that RSE was excellent for  
20 an overall estimate (2.1%) and for sub-groups (age and ethnicity group) estimates which ranged  
21 between 3.9% and 4.21%.

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The sample was drawn from a national administrative database of all residents in Singapore  
which served as a sampling frame. A total sample of 10,000 individuals was drawn, which will  
be released during the active survey period (1-1.5 years) in 5-10 replicates while closely  
monitoring the recruitment to ensure a good response rate and inclusion of hard-to-reach  
population. We intend to achieve a response rate of 65-70% and a final recruitment target of  
3000 respondents. The size and number of the replicates will be estimated based on the

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3 finalisation and response rates of the previous releases. Finalisation rates will be calculated  
4 based on the ineligible cases and refusals. We foresee approximately 15-20% ineligible cases  
5 and 10-15% refusals, based on our previous national surveys. [14-15] An overview of the  
6 sampling strategy and processes are shown in Figure 2.  
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13 **[Figure 2]**  
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16 *Recruitment strategy and interviewer training*  
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19 The fieldwork for the survey will be conducted by a survey firm that was selected following  
20 the institutional guidelines. All the interviewers (30-40 interviewers) involved in the fieldwork  
21 are aged more than 21 years and experienced in door-to-door surveys. All field interviewers  
22 undergo training over two weeks on the study methodology and fieldwork which included  
23 lectures and hands-on sessions on ethics, techniques on approaching a household, initial self-  
24 introduction/communication with the respondent, consent taking, questionnaire administration,  
25 maintaining visitation records, and other administrative tasks. All the interviewers underwent  
26 an evaluation and those who did not pass the requirements set by the study team were not  
27 allowed to conduct the survey. The training was conducted in English followed by language-  
28 specific training for interviewers who are conversant in one of the three local languages –  
29 Chinese, Malay and Tamil. The field supervisors and/or members from the research team will  
30 accompany the interviewers during the initial weeks to identify and resolve any problems  
31 during the survey. The interviews will be administered via a computer-assisted personal  
32 interview (CAPI) which allows real-time data collection. This method is an effective method  
33 for data collection and has been used in our previous national surveys. [14] This innovative  
34 application is available in dual language-English, together with Chinese, Malay, or Tamil. The  
35 dual-language interface aids standardisation across languages and allows interviewers to  
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3 rephrase hard to understand questions easily. The real-time data capture protects confidential  
4 content against loss and theft, and data are available for analysis instantaneously.  
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8 The selected respondents will receive an invitation letter one to two weeks before the actual  
9 household visit by trained interviewers. The invitation letters include the details of the study,  
10 contact numbers they could use to get more information about the survey, provide feedback,  
11 or register their refusal for the survey. A maximum of 10 visits will be made per household at  
12 different days and times before finalising the case. For cases where the respondent is not at  
13 home during the visit, “*while you were out*” cards will be dropped in the letterbox or at their  
14 doorstep to allow the respondent to contact the survey firm. Upon completion of the survey,  
15 the participants will be given a \$40 inconvenience fee in cash.  
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### 26 27 *Quality Assurance* 28

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30 Quality control is ensured at different phases of the study starting from the interviewer selection  
31 and training, where interviewers are selected only if they have at least secondary level  
32 education, are proficient in one of the main local languages, have basic computer skills, and  
33 prior experience in door-to-door surveys. The training for the interviewers is intense and the  
34 evaluation involves a simulation of the entire survey setting using a lay respondent, starting  
35 from the first contact with the respondent till the final administration procedures after payment  
36 of the inconvenience fee. Only those interviewers who pass this evaluation will be allowed to  
37 conduct the survey. The initial visits and interviews will be done in the presence of the trained  
38 team member or field supervisors. The details of the quality assurance procedures that are  
39 followed in all our surveys are reported elsewhere. [15]  
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54 A trained team will constantly monitor the progress of replicates, aging cases, and visitation  
55 records to monitor the trends and highlight the discrepancies to the team for clarification and  
56 resolution. Around 10% of the interviews per interviewer will be selected for routine quality  
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3 checks (QC) which involve verification of the survey and responses for the selected questions  
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5 over the phone, on-site during the interview, or by visiting the respondent's house. Apart from  
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7 the QC, regular monitoring will be conducted to verify that the consent process, visitation  
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9 records and payment of inconvenience fees follow approved procedures. Quality will be  
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11 assured at the data processing stages through logic checks that are in place for data verification.  
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13 Trained staff will closely monitor the data influx to identify and highlight any errors occurring  
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15 in this phase.  
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### 20 *Supplementing the general population sample with patients with diabetes*

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22 Although previous studies have shown that the prevalence of diabetes in Singapore is 11%,  
23  
24 many were not diagnosed. [6] It is therefore expected that only a limited number of respondents  
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26 (approximately n=165) diagnosed with diabetes will be recruited from the general population,  
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28 which would, therefore, reduce the power to detect differences between those with and without  
29  
30 diabetes in the general population. Hence, we will be supplementing this group with patients  
31  
32 already diagnosed with diabetes who are seeking care from either primary care or specialist  
33  
34 care settings with 1:2 allocation ratios. We will recruit approximately 330 ( $330=2 \times 165$ )  
35  
36 additional patients already diagnosed with diabetes, who will be matched to those with diabetes  
37  
38 in the general population by age group, gender, and ethnicity. Both the populations i.e. those  
39  
40 with and without diabetes will be administered a similar set of questionnaires with some key  
41  
42 differences. The subjects in the general population who indicate that they are not seeking  
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44 treatment for their diabetes will not be included in the diabetes group. Depending upon the  
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46 numbers, we will consider a separate analysis for this group.  
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53 The study population is represented in Figure 3.

### 54 *Screening for diabetes in the general public*

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3 Since a significant proportion of the population is likely to be unaware of their diabetes status,  
4 [6] those without a history of diabetes will be offered a blood test to measure their fasting blood  
5 glucose glycosylated hemoglobin (HbA1c). Among those who provide consent for the blood  
6 test, a maximum of 300 respondents will be randomly chosen to undergo the test. The selection  
7 of the respondents is indicated in Figure 3. The results will provide information on the extent  
8 of 'undiagnosed' diabetes in the population. This group considered as 'undiagnosed diabetes'  
9 will be compared against those with and without diabetes.  
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20 **[Figure 3]**

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23 ***Questionnaires***

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26 The following questionnaires are included in the survey. The details of the questionnaire are  
27 included in the supplementary section.  
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- 30  
31 i) *Socio-demographic information*  
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33 ii) *Diabetes recognition and knowledge using vignettes*  
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35 iii) *Diabetes KAP questionnaire*  
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37 iv) *Diabetes Stigma Questionnaire:*  
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39 v) *Chronic conditions checklist:*  
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41 vi) *Health related quality of life*  
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43 vii) *Global Physical Activity Questionnaire*  
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45 viii) *Brief Health Literacy Screen*  
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47 ix) *Marlowe-Crowne Social Desirability Scale*  
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49 x) *Lepore's Social Constraints scale*  
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51 xi) *Diet screener*  
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53 xii) *Barriers and facilitators of diabetes health screen*  
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55 xiii) *Disability screening questionnaire*  
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xiv) *Barrier to physical activity questionnaire*

xv) *Awareness towards diabetes programme*

xvi) *Lifestyle questionnaire*

xvii) *E-Health*

xviii) *The Diabetes Mellitus Disease Severity Index (DCSI)*

#### ***Additional Data collected among patients with diabetes***

The flow of the questionnaires between those with and without diabetes is represented in Figure 4. Those with diabetes will be asked additional questions on diabetes knowledge (care and management), self-stigma, and social constraints. The DCSI data are captured for diabetes patients by the attending clinician or a researcher supervised by the clinician.

**[Figure 4]**

#### ***Translation and cognitive interviews (CIs)***

All survey measures were available or translated into the three local languages – Chinese, Malay, and Tamil using a professional translating firm. The translation procedure undertaken was aimed at achieving conceptual equivalence using a four-step process that was adapted from the World Health Organisation method: 1) forward translation, 2) expert panel review, 3) pre-testing and cognitive interviewing and 4) development of a final version. 1) Forward translation, the initial translation of the original English version into the three main local languages spoken in Singapore (Chinese, Malay, and Tamil) was done by professional translators. 2) An expert panel review, in which members who acted as expert consultants in various fields pertinent to the study, as well as a layperson, offered advice and possible solutions to problems identified in the first draft of the translation. Issues were resolved by critical evaluation of the considerations and recommendations by each expert in their respective fields. 3) Pre-testing and CIs were undertaken to assess how well the measures were likely to be received by the lay



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3 members of the public, the target audience for the survey, in each of the specified languages.  
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5 Around 25 CIs were conducted to ensure that the vignette and questionnaires would be well  
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7 understood by lay respondents for comprehension, retrieval, decision-making and response  
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9 processes. The questionnaire was modified based on the CI, by incorporating the respondents'  
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11 feedback and suggestions.  
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### 14 15 ***Data Analysis Plan*** 16

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18 Descriptive statistics will be used to describe the socio-demographic characteristics of the  
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20 sample. Since the majority of the questionnaires are being used for the first time in the local  
21  
22 population, they will be validated. To evaluate reliability, Cronbach's alpha for each of the  
23  
24 questionnaires will be calculated. Internal consistency of the knowledge questionnaire,  
25  
26 including items related to diabetes care principles, will be measured. Similarly, the reliability  
27  
28 of other questionnaires for attitude, diet, and physical activity behaviour and stigma will be  
29  
30 calculated. The construct validity of the KAP questionnaire will be assessed with exploratory  
31  
32 factor analysis.  
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37 Cross tabulation will be used to determine the findings relating to recognition, and KAP across  
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39 the two groups. Significant differences in the proportions of people endorsing various KAPs  
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41 will be determined using a Chi-Square test. Beliefs about the causes and treatment options for  
42  
43 diabetes as well as the expected outcomes for someone with diabetes will also be similarly  
44  
45 described. We will use listwise deletion to deal with missing data when analysing the dataset.  
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47 However, if the proportion of missing data is significantly high, we will examine the missing  
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49 data pattern to determine if it is missing at random (MAR), missing completely at random  
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51 (MCAR), or missing not at random (MNAR) before performing imputations on the dataset.  
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3 Multiple logistic and linear regression analyses will be carried out to determine the socio-  
4 demographic correlates of correctly recognizing diabetes, help-seeking preferences, as well as  
5 overall knowledge and attitudes among those with and without diabetes. Practices and attitudes  
6 regarding treatment and stigma will be investigated among important subgroups. In order to  
7 ensure that the findings from the household survey represent the Singapore adult population,  
8 all estimates will be analysed using survey weights to adjust for oversampling, non-response,  
9 and post-stratification according to age and ethnicity of the Singapore population. Sampling  
10 errors will be assessed by an estimated 95% confidence intervals around the estimates and  
11 performing relevant sensitivity analyses. We will consider a p-value of  $\leq 0.05$  as significant.  
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## 24 **Discussion**

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27 This is one of the first population-wide studies that aims to explore diabetes KAP among the  
28 resident population in Singapore. , The majority of the studies conducted in Asia and southeast  
29 Southeast Asia, have focused on either patients with a known diagnosis of diabetes or the  
30 general public who are not representative of the overall population of the country. [17-21] The  
31 methodology, which includes the use of a vignette-based approach, has been used previously  
32 in Singapore to capture recognition, knowledge, and attitudes towards people with mental  
33 illness in a recently completed national mental health literacy study. [22-23] The current study  
34 will serve as a baseline measure of diabetes knowledge for Singapore's general population and  
35 will be used to inform future health policies and as part of on-going efforts in the 'War on  
36 Diabetes'. More specifically, it will identify whether people are able to recognise the signs and  
37 symptoms of diabetes and whether they know where to seek help or treatment for diabetes. It  
38 will also identify subgroups of the population who may have poor recognition or knowledge  
39 of diabetes, which will then allow for targeted efforts to improve their knowledge.  
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3 While the concept of stigma has been largely examined in association with mental illness, there  
4 are very few studies done elsewhere that have examined stigma among those with diabetes. An  
5 online survey of over 5000 people with diabetes in the USA found that 61% of people with  
6 type 2 diabetes on intensive insulin therapies and 51% of people taking pills reported feeling  
7 stigmatised [24]. This could be due in part to the therapy's visibility such as finger pricks and  
8 shots, as people without diabetes may not fully understand it leading to awkwardness or  
9 questions which may lead to self-stigma. Schabert *et al.* [25] highlighted the adverse  
10 consequences of the stigma e.g., distress, poorer psychological well-being, and sub-optimal  
11 self-care, and they emphasised the need for strategies to reduce diabetes-related stigma. This  
12 study is the first in Singapore to explore the components and associations of stigma with KAP  
13 among those with diabetes. This hitherto neglected area would have important implications in  
14 the management of diabetes.

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31 The study will also capture and compare the dietary and lifestyle practices of the respondents  
32 with and without diabetes. Several studies have shown that a large proportion of cases of type  
33 2 diabetes can be prevented. The results of a meta-analysis of the evidence from cohort studies  
34 suggest that high glycaemic index diets may increase the risk of diabetes [26-27] while a diet  
35 rich in dietary fiber may reduce the risk. [28] Pan *et al.* [29] conducted a cluster randomised  
36 trial that showed a healthy diet, exercise, and a combination of diet and exercise can all  
37 substantially reduce the risk of diabetes. A 20-year follow-up study combining the three  
38 lifestyle intervention groups showed a 43% lower diabetes risk compared with the control  
39 group. [30] Similarly, multiple studies conducted in Japan, Finland, and the Middle East have  
40 shown a decrease in diabetes incidence through active intervention. [31-34] The information  
41 gathered in our study will help us to understand the current lifestyle, factors contributing to  
42 unhealthy lifestyle, reasons for the choice of lifestyle practices, current physical activity, and  
43 barriers and facilitators of physical activity of the general population with and without diabetes.

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3 This knowledge is helpful to estimate the effectiveness of on-going public lifestyle campaigns  
4 and to identify areas of improvement.  
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8 We acknowledge several challenges with our study design. As the survey pertains to lifestyle  
9 and health practices the respondents may provide socially desirable answers leading to social  
10 desirability bias, this will, however, be controlled through the scores on the Marlowe-Crowne  
11 social desirability questionnaire that has been embedded in the survey. This being a cross-  
12 sectional study we will not be able to rule out the intrinsic risk of reverse causation.  
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16 In summary, this study will form the first nationwide survey representative of the entire  
17 Singapore population, conducted in the last 10-year period to understand the Singapore  
18 residents' KAP towards diabetes. This study will further our understanding of the current  
19 lifestyle of Singapore residents, as well as preventive and management strategies adopted by  
20 the residents towards diabetes. The study will also shed light on the awareness of the public  
21 towards on-going "War on Diabetes" and other government initiatives to tackle diabetes and  
22 thus help the policymakers to design meaningful and suitable programmes that have better  
23 penetration and are aligned with the expectations of the public.  
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### 40 **Ethics and Dissemination**

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42 This study protocol has been reviewed by the Institutional Research Review Committee  
43 (IRRC) and the National Healthcare Group Domain Specific Review Board (NHG DSRB Ref  
44 2018/00430). Following the analysis, the study findings will be disseminated to the relevant  
45 stakeholders. This will include a press briefing informing the local mass media of the study  
46 findings and using this platform to disseminate the findings to the general population, via  
47 online, television, print and radio. A structured dissemination plan has been developed and will  
48 encompass various forms and will occur via multiple platforms including publishing in  
49 academic journals, presentations at scientific meetings and conferences, presentation of the key  
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3 findings to key stakeholders e.g. Ministry of Health, Health Promotion Board, Diabetes Society  
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5 of Singapore, general practitioners and other health care providers involved in the care of  
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7 people with diabetes.  
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## 10 **Acknowledgements**

11  
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13 We thank the participants from the general public and diabetes clinics who gave us valuable  
14  
15 inputs in the questionnaire development phase that helped us to improve the questionnaire and  
16  
17 adapt it for local population  
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19

## 20 **Author contributions**

21  
22  
23 MS, CSA, RMVD, LES and SCF were involved in the conceptualization of the study. PVA  
24  
25 wrote and revised the manuscript. JV, PKR, PVA, FDSK, AJ, MS, CSA, RMVD, LES, SCF  
26  
27 and SS were involved in the questionnaire design. MS, PVA, FDSK and PKR conducted  
28  
29 cognitive testing of the survey questionnaire. EA provided the statistical design and sampling  
30  
31 strategy. CBY designed and supports the database. All the authors reviewed and approved the  
32  
33 manuscript. MS and CSA take full responsibility of the protocol design.  
34  
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39  
40  
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42  
43 NMRC/HSRG/0085/2018).  
44  
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## 46 **Conflict of Interest**

47  
48  
49 The authors declare no conflict of interest.  
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## 52 **Patient Consent**

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54  
55 Not Required  
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## 58 **Ethics approval**

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2  
3 This study protocol has been reviewed and approved by the Institutional Research Review  
4  
5 Committee (IRRC) and the National Healthcare Group Domain Specific Review Board (NHG  
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7 DSRB Ref 2018/00430).  
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## 10 **Footnotes**

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12 The article includes online supplementary materials.  
13  
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## 15 **Figure Legends**

16  
17 **Figure 1:** Flow chart of the KAP study  
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22 **Figure 2: Sampling and procedure:** The sample was drawn from a national administrative  
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24 database of all residents in Singapore which served as a sampling frame. Household surveys is  
25  
26 being conducted among those who provide written informed consent.  
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30 **Figure 3: Study sample and Recruitment plan:** The study population involved in this  
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32 national survey includes general public who do not have diabetes and those who self-report a  
33  
34 diagnosis of diabetes. The diabetes population will be supplemented with age, gender and  
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36 ethnicity matched treatment seekers (n=330) for a robust analysis.  
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40 **Figure 4:** Flow chart of the questionnaires  
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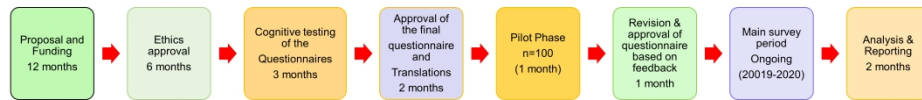


Figure 1: Flow chart of the KAP study

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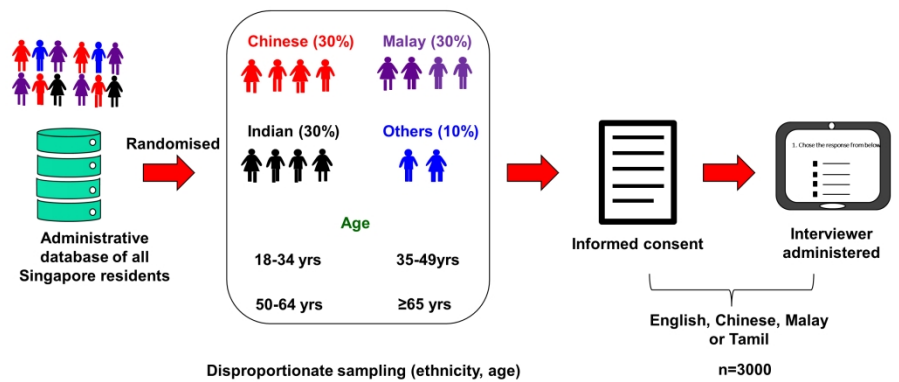


Figure 2: Sampling and procedure: The sample was drawn from a national administrative database of all residents in Singapore which served as a sampling frame. Household survey is being conducted among those who provide written informed consent.

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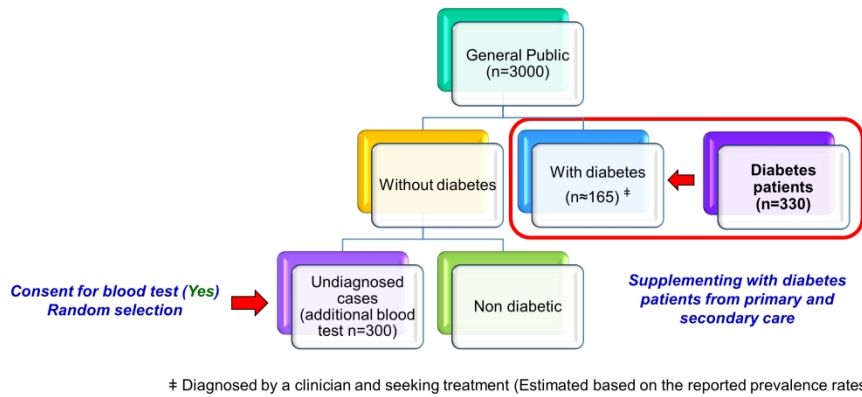


Figure 3: Study sample and Recruitment plan: The study population involved in this national survey includes the general public who do not have diabetes and those who self-report a diagnosis of diabetes. The diabetes population will be supplemented with age, gender and ethnicity matched treatment seekers (n=330) for a robust analysis.

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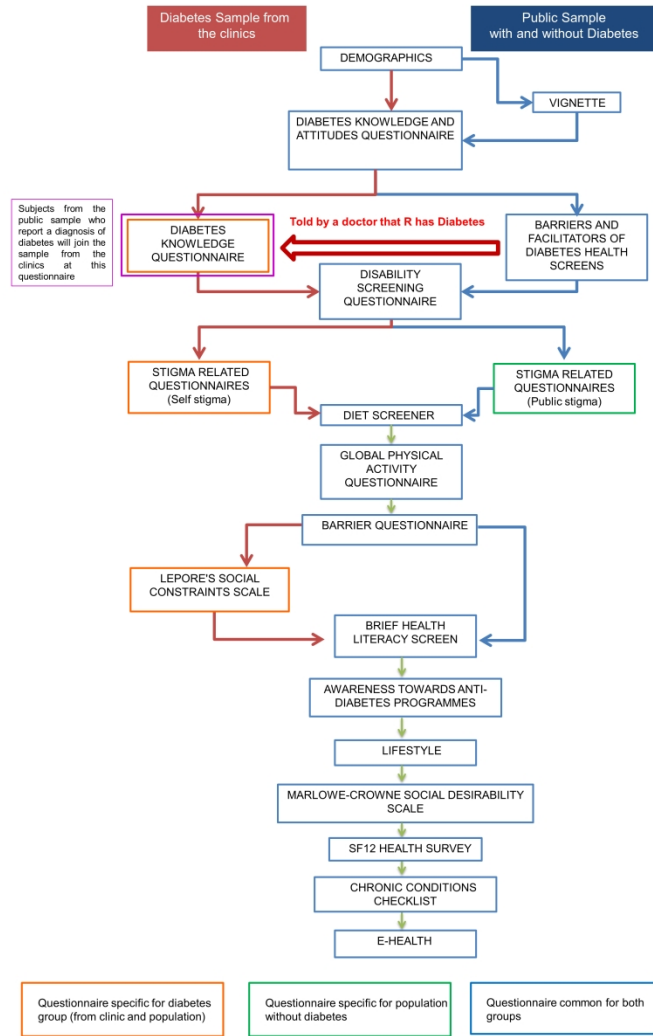


Figure 4: Flow chart of the questionnaires

250x450mm (300 x 300 DPI)

## Supplementary file: Questionnaire used in the KAP study

No	Outcome	Questionnaire	Reference	Description
1	<i>Socio-demographics</i>	<i>Socio-demographic information</i>	Developed in house	This section includes questions to collect information on age, gender, ethnicity, religion, marital status, education level and employment status, occupation, family composition, personal and household income, housing type and area of residence. The study will obtain self-reported information on height and weight.
2	<i>Diabetes recognition &amp; knowledge</i>	<i>Diabetes recognition and knowledge using vignettes</i>	Developed in house	<p>This section includes questions regarding diabetes recognition and knowledge. Diabetes knowledge will be assessed via two methods: the use of a vignette describing someone with diabetes and KAP questionnaires. Vignettes are “short stories about hypothetical characters in specified circumstances, to whose situation the interviewee is invited to respond”. Vignettes can be generated from a range of sources including previous research, consultation with experts in the fields and real-life case histories. The vignette will then be used to elicit perceptions, opinions, beliefs and attitudes about diabetes. To ensure the respondent can best relate to this person in the vignette, we will match the gender and ethnicity of the person described in the vignette with that of the respondent and will use a local name to describe the person in the vignette.</p> <p>An example of the vignette is:</p> <p><i>“Mr. Tan is a 68-year old male who has found activities like oil painting to fill his days since retiring from his job three years ago. Mr. Tan keeps himself busy in the mornings by looking after his plants looking after his plants in the corridor of his HDB apartment. He notices that he seems to be going to the bathroom (urinating) quite often. After eating lunch with his wife, Mr. Tan takes a walk around the block. He feels extremely tired and very thirsty upon returning home. He also notices that the wound on his foot is taking a long time to heal. He does not work on his painting sometimes because his vision is blurry.”</i></p> <p><i>(The name of the character will change according to the ethnicity and gender of the respondent)</i></p>

3	<i>Knowledge, attitudes and practices towards diabetes</i>	<i>Diabetes KAP questionnaire</i>	Eigenmann <i>et al.</i> , 2011 Tanamas <i>et al.</i> , 2013 (questionnaire were adapted for local context)	Overall, these questions will focus on all three levels of diabetes prevention: 1) Primary prevention: Are healthy lifestyles adopted to prevent diabetes? 2) Secondary prevention: Are people motivated to attend screening for diabetes and are they motivated to change their lifestyle / take part in a lifestyle program if they have pre-diabetes or seek adequate treatment if they have undiagnosed diabetes? 3) Tertiary prevention: Adherence to doctor's visits and treatments after people have been diagnosed with diabetes to prevent complications.
4	<i>Stigma (self, public)</i>	<i>Diabetes Stigma Questionnaire:</i>	In house	These questions will assess stigma related to diabetes. Those with diagnosed diabetes will be asked questions on perceived/ self-stigma i.e. whether they feel stigmatised by others or whether they are embarrassed by their condition. Those without diabetes will be asked both about their stigmatising attitudes towards those with diabetes (public stigma) as well as the concerns they may have about being diagnosed with diabetes. Response options range from 1 to 4, from “definitely willing, probably willing, probably unwilling, and definitely unwilling.
5	<i>History of Chronic medical conditions</i>	<i>Chronic conditions checklist:</i>	Subramaniam <i>et al.</i> , 2019	This item will assess chronic medical conditions among the respondents. A brief medical history will be obtained using a self-report chronic conditions checklist where respondents will be asked to report being diagnosed with any of the listed 18 physical conditions in their lifetime. For those conditions which the respondents indicate they have a lifetime diagnosis, they will then be asked about the age of diagnosis and whether they received treatment for those specific conditions in the past 12 months. Responses are captured as Yes or No.
6	<i>Quality of Life</i>	<i>Health related quality of life (HRQoL)</i>	Ware <i>et al.</i> , 1996	These questions will assess the Quality of Life using Short Form (SF)-12 questionnaire which is a multi-purpose, generic, short-form



				health survey with 12 items. It yields physical and mental health summary measures and a preference-based health utility index.
7	<i>Physical activity</i>	<i>Global Physical Activity Questionnaire (GPAQ)</i>	Chua <i>et al.</i> , 2015 Bull <i>et al.</i> , 2009	These questions will capture the information on physical activity. The GPAQ consists of 16 questions designed to estimate an individual's level of physical activity in three domains (work, transport and leisure time) and time spent engaging in sedentary behaviour. This questionnaire has been validated in Singapore. Responses are captured as yes or no.
8	<i>Health literacy</i>	<i>Brief Health Literacy Screen (BHLS)</i>	Chew <i>et al.</i> , 2004, Peterson <i>et al.</i> , 2011	These questions are used widely to measure health literacy in diverse populations. This instrument is short, comprising three items and can be administered by the interviewer with minimal training. Responses include "all of the time, most of the time some of the time, a little of the time, none of the time".
9	<i>Social desirability</i>	<i>Marlowe-Crowne Social Desirability Scale (MC-SDS)</i>	(Crowne <i>et al.</i> , 1960).	This questionnaire measures and controls for social desirability. The scale represents culturally acceptable items that are unlikely to happen. The scale comprises 33 statements to which respondents are asked to answer "true" or "false" with true answers given a score of 1 and false scored 0. Higher scores indicate more social desirability. This scale is useful in surveys to assess the degree of bias in the responses, in a socially desirable direction than actual behaviour.
10	<i>Social constraints</i>	<i>Lepore's Social Constraints scale</i>	Lepore <i>et al.</i> , 1996, Braitman <i>et al.</i> , 2008	These questions measure the cognitive processing of those with diabetes when sharing the diabetes-related experiences with others. Talking about the disease to someone who is supportive is believed to aid in coping, to promote self-care and to desensitise people from disease-related thoughts. A higher score indicates higher social constraints. The scale consists of 15 items with response options that range from "never", "rarely", "sometimes" and "often".
11	<i>Dietary habits</i>	<i>Diet screener</i>	Whitton <i>et al.</i> , 2017, 2018	These questions include a list of 37 items developed to meet the dietary style of the local population with a 10-point frequency scale. The scale was developed and validated locally and includes healthy

				food items recognised internationally and locally. Frequencies of “never or rarely, once a month, 2-3 times a month, once a week, 2-3 a week, 4-6 a week, once a day, 2-3 a day, 4-5 a day, 6+ a day are captured for each item.
12	<i>Barriers and enablers of diabetic screen</i>	<i>Barriers and facilitators of diabetes health screen</i>	In house	These questions include questions on diabetes health screening frequency, factors that facilitate attendance to health screens and barriers to regular health screening. It also includes items to measure the motivators to facilitate regular health screening. Responses include “strongly agree, agree neutral, disagree and strongly disagree”.
13	<i>Disability</i>	<i>Disability screening questionnaire</i>	CDC, 2016	These questions are meant to understand the health problems or impairment due to physical, mental or emotional health conditions. Responses include “not really a barrier, somewhat of a barrier, and very much a barrier”.
14	<i>Barriers to physical activity</i>	<i>Barrier to physical activity questionnaire</i>	In house	These questions list down common factors that could potentially act as barriers to being physically active in the local context. It includes 12 items that are relevant locally captures under the response options “not really a barrier, somewhat of a barrier, very much a barrier”.
15	<i>Awareness towards on-going anti-diabetes campaigns</i>	<i>Awareness towards diabetes programme</i>	In house	These questions will help to understand the public’s awareness towards the ongoing anti-diabetes campaigns. It also captures their perceived effectiveness of these campaigns and feedback for improvements.
16	<i>Lifestyle</i>	<i>Lifestyle questionnaire</i>	In house	This item will assess the current lifestyle of the respondent, reasons for adopting healthy lifestyle (25 items), factors that can promote healthy lifestyle (25 items) and guidelines/regulation that could help people to achieve healthy lifestyle (8 items). The response options include “strongly agree, agree neutral, disagree and strongly disagree”.

17	<i>Acceptability and readiness towards E-health</i>	<i>E-Health</i>	Wootton et al., 2011 Klein et al., 2010 (questions were modified and adapted)	These questions will assess readiness for e-health, acceptability, perceived advantages and disadvantages of e-health services for diabetes care.
18	<i>Diabetes disease severity</i>	<i>The Diabetes Mellitus Disease Severity Index (DCSI)</i>	Glasheen et al., 2017 (adapted)	This scale is a refined and validated version of the DCSI according to ICD-10 criteria. Based on 7 dimensions and scores 0-2, described by Glasheen <i>et al</i> (2017) a specific grading criteria for individual dimensions to match the local clinical cases was developed by the diabetologists in the study team. The data will be extracted by clinicians and research officers trained and supervised by the clinicians. Associations of these categories with both socio-demographic characteristics as well as KAP will be examined. Scores are given from 0-2 for 7 severity dimensions (retinopathy, nephropathy, neuropathy, cerebrovascular, cardiovascular, peripheral vascular disease, and metabolic).

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