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Prevalence of Undiagnosed Type 2 Diabetes Mellitus and Its Associated Factors Among the Malaysian Population: The 2015 National Health and Morbidity Survey, Malaysia

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Abstract

Background: The prevalence of diabetes has increased dramatically in the last decade. Compounding the problem are undiagnosed cases of type 2 diabetes mellitus. These respondents are those who do not know that they have the disease. Undiagnosed cases have substantial implications as they are at more risk to develope fatal complications. This study aims to determine the prevalence of undiagnosed T2DM and to identify its associated factors in Malaysia.

Methods: A nationwide cross-sectional study was conducted involving 19,935 respondents. Two-stage stratified sampling design was used to select a representative sample of the Malaysian adult population. Face-to-face interviews using structured, validated questionnaires were used to obtain data from the respondents. Respondents who claimed that they were not diagnosed with diabetes before were asked to undergo a finger-prick test.

Results: The overall prevalence of T2DM was 17.5% while the prevalence of undiagnosed T2DM was 9.2% (n=2103). Respondents aged 60 years old & above had the highest percentage of undiagnosed T2DM at about 13.6 %, followed by those with no formal educational at 12.9%, among Indians were 11.9%, among female at 9.2%, among non-working citizen at 9.8%, widowed/divorced (12.0%), smokers (9.5%), obesity (13.6%) and hypertensive (12.8%). Multivariable analyses revealed that age group, ethnicity, education level, marital status, obesity and hypertensive were more likely to have undiagnosed T2DM.

Conclusion: This study showed a high prevalence of undiagnosed T2DM in Malaysia. Factors associated with undiagnosed diabetes mellitus were obesity, age, ethnicity, educational level and hypertension. Screening is essential among adults aged 30 to 60 year old to enable early intervention and prevent development of serious complications of this disease.

Keywords: prevalence of diabetes, undiagnosed, type 2 DM, risks factor, Malaysia

Abbreviations

T2DM: Type 2 diabetes mellitus; IDFA: International Diabetes Federation Atlas; LQ: Living quarters; EB: Enumeration blocks; BMI: Body Mass Index; IPAQ: International Physical Activity Questionnaire; MET: Metabolic equivalent of task; CI: Confidence interval; SD: Standard deviation.

1. Background

Type 2 diabetes mellitus (T2DM) has become a major public health problem both locally and globally. A report in 2006 described diabetes as an epidemic based on the dramatic increase in prevalence in the past 10 years (Steinbrook, 2006). Diabetes is increasingly diagnosed among adolescents and younger adults (Dabelea et al., 2009). Increase in obesity is one of the main factors thought to be driving the diabetes (Mainous, Diaz, & Everett, 2007). As the prevalence of diabetes rises, there will be more young adults and adolescents with diabetes. Thus, it is crucial from a clinical and public health perspective to identify these high-risk populations (Mainous et al., 2007). In Malaysia, the National Health and Morbidity Survey (NHMS) in 2006 (Institute for Public Health, 2006) showed that the prevalence of T2DM was 11.6%. This figure increased to 15.2% and 17.5% in NHMS

2011(Institute for Public Health (IPH), 2011) and NHMS 2015 (Institute for Public Health, 2015) respectively.

The International Diabetes Federation Atlas (IDFA) in 2015 estimated 415 million people suffer from DM globally and the number is expected to increase to 642 million, with 45% of them remaining undiagnosed and thus unaware of their condition (IDFA, 2015). Whereas in Malaysia, the NHMS shows that undiagnosed diabetes among Malaysian population aged ≥30 years was 1.8% in 1996 to 5.4% in 2006 (Institute for Public Health, 2006), an alarming 200% increase in a decade. Undiagnosed diabetes has substantial public health implications because as these individuals remain untreated they are at risk of serious complications (Franse et al., 2001). Microvascular and macrovascular complications of untreated diabetes could cause morbidity and even mortality (Thévenod, 2008). The pathophysiology of T2DM are complex and interwoven and hence it is important to identify its risk factors. Socio-demographic factors were also found to be associated with prevalence of T2DM such as age (Wondemagegn et al., 2017), gender (Goto et al., 2015), higher BMI (Goto et al., 2015) and co-morbidities such as hypertension (Wondemagegn et al., 2017). This study aims to determine the prevalence of undiagnosed T2DM and to identify its associated factors in Malaysia.

2. Methods

This study used data from the National Health and Morbidity Survey (NHMS) 2015, a survey conducted by the Institute for Public Health, Ministry of Health Malaysia. NHMS 2015 employed a multi-stage stratified sampling design proportionate to the population size throughout all state in Malaysia, covering both urban and rural areas. The target population was residents of all non-institutional living quarters (LQ) in Malaysia for at least 2 weeks prior to data collection. Institutionalized populations such as those staying in hotel, hostels, hospitals etc. were excluded from the survey. Two-stage stratified sampling design was used to ensure national representativeness.

Geographical areas in Malaysia were divided into 75,000 Enumeration Blocks (EB). On average, each EB contains between 80 to 120 Living Quarters (LQs) with an average population of 500 to 600 people. The sampling frame was provided by Department of Statistic Malaysia. A total of 869 Enumeration Blocks (EB) were selected from the total EBs, of which 536 and 333 EBs were randomly selected from urban and rural areas respectively. Twelve LQs were randomly selected from each selected EB and all households within the selected LQs and all members in the households were surveyed (Institute for Public Health, 2015).

This study used structured questionnaires administered by trained interviewers. The data collection team conducted face-to-face interview using mobile devices with a system developed specially for the data collection. Completed questionnaires were sent to the data management team through the NHMS server in Institute of Public Health, whenever there was an internet connection. Quality control checks were performed (especially on the respondent ID, outliers or incorrect data). Modules in the structured questionnaires of the survey includes general household, socio-demographic, and specific health problems. Blood glucose level and blood pressure were also measured. The clinical anthropometric measurements we done by trained research assistants while the finger prick biochemistry tests were taken by qualified nurse. All measurements were taken by a member of the data collection team. A total of 10,428 LQs were sampled and all individuals aged 18 years and above were within the selected LQ were eligible to answer the diabetes module questionnaire. Informed consent was obtained from all the available and eligible respondents before the questionnaire was administered.

Measurement of fasting blood glucose was performed on finger-prick blood samples using the CardioChek portable blood test system, only on respondents who claimed to be not diabetic. Definition of "undiagnosed diabetes" for the purpose of this study is when the respondent was not diagnosed to have T2DM previously but had a fasting capillary blood glucose (FBG) of ≥ 6.1mmol/L (World Health Organization. Dept. of Noncommunicable Disease Surveillance., 1999).

Respondents' systolic and diastolic blood pressure were measured using Omron digital automatic blood pressure monitors Model HEM-907 which had been validated and calibrated before being used in this study. Three readings were taken for both systolic and diastolic blood pressure, with a gap of 15 minutes between each reading and the average value of the second and third reading was recorded. Respondents were considered hypertensive if their average systolic blood pressure was ≥140 mmHg and /or diastolic blood pressure ≥90 mmHg or were self-reported hypertensives.

Weight of respondents were measured in kilograms using a digital weighing machine (TANITA HD-319) and height was measured in centimeters using Seca 206 Body meter. Body Mass Index (BMI) was calculated as weight divided by height squared. Respondents with BMI of 30.0 kg/m2 or more were classified as obese ("WHO | Obesity: preventing and managing the global epidemic," 2015).

The respondents' physical activity level was assessed using the International Physical Activity Questionnaire

(IPAQ) - short form. Respondents were classified as physically active if they achieved a minimum combination of vigorous-intensity, moderate-intensity and walking activities of 600 metabolic equivalent of task (MET)-minute/week (Institute for Public Health, 2015).

Smoking status of respondents who reported to have never smoked were reported as "non-smoker" and respondents who reported as still smoking during the interview were classified as "smoker".

3. Statistical Analysis

SPSS Version 20 were used to analyse the data. Categorical variables were presented as frequencies and percentages. Meanwhile, continuous variables were presented as means with 95% confidence interval (CI) and standard deviations (SD). Pearson's chi-square test was used in order to determine association between categorical variables.

Finally, multiple logistic regression analysis using a backward step wise method as performed to determine variable associated with undiagnosed diabetes when the effects of possible confounders were controlled. The selection of variable was based on the significant changes in the -2 log likelihood. The response variable was undiagnosed and the predictor variables included the analysis were age group, ethnic group, education level, marital status, occupational status physical activity level, obesity and blood pressure status. Adjusted odds ratios (AORs) and 95% confidence intervals (CIs) were estimated. Statistical significance was set at P value <0.05.

4. Results

4.1 Socio-Demographics

The total number of respondents for the diabetes questionnaire was 19,935 with the response rate of 91.1%. Distribution of male and female respondents was nearly equal with slightly more females (52.4%). By age, respondents aged 18 - 39 year old comprised 44.7% and urban residents 57.7% of the respondents. Malay respondents constituted the majority with 61.9%, followed by Chinese (16.0%) and Indian (7.1%). More than 60.0% of respondents had up to either primary or secondary school education. About 70.0% respondents were married, while more than 60.0% were employed (Table 1).

Table 1. Socio-demographic characteristics of the respondents

Socio-demographic characteristic	**N**	**%**
Gender		
Male	9482	47.6
Female	10453	52.4
Age group(mean, sd) : 42.1, 15.99		
18 – 39	8906	44.7
40 – 59	1924	36.3
60 & above	2174	19.0
Residence		
Urban	11504	57.7
Rural	8431	42.3
Ethnic group		
Malay	12345	61.9
Chinese	3193	16.0
Indian	1410	7.1
Other indigenous	1750	8.8
Others	1237	6.2

Education level		
No formal education	1370	7.0
Primary school education	4781	24.3
Secondary school education	9147	46.4
Tertiary education	4397	22.3
Unclassified	216	1.1
Marital status		
Single	4191	21.0
Married	13805	69.3
Widow/widower/divorcee	1939	9.7
Occupation status		
Working	12139	60.9
Not working	7794	39.1

4.2 Prevalence of Undiagnosed Diabetes Mellitus

The prevalence of undiagnosed diabetes mellitus in this study was 9.2% (95% CI: 8.5, 9.9). There were significant differences by age group ($p<0.001$), ethnic group ($p=0.014$), educational level ($p<0.001$), marital status ($p<0.001$), occupation status ($p=0.048$), physical activity level ($p=0.036$), obesity status ($p<0.001$) and hypertensive status ($p<0.001$). However, gender, residence, occupational status and smoking were not statistically significant factors in this study.

Table 2. Prevalence of undiagnosed diabetes mellitus by socio-demographic characteristics

Socio-demographic characteristic	Prevalence of undiagnosed diabetes mellitus % (95% CI)	p-value
National	9.2 (8.5, 9.9)	
Gender		0.813
Male	9.1 (8.3, 10.0)	
Female	9.2 (8.4, 10.2)	
Age group		<0.001
18 – 39 years	7.0 (6.3, 7.9)	
40 – 59 years	11.7 (10.5, 12.9)	
60 years old and above	12.3 (11.0, 13.9)	
Residence		0.567
Urban	9.1 (8.2, 10.0)	
Rural	9.5 (8.5,10.6)	
Ethnic group		0.014
Malays	9.8 (9.0,10.6)	
Chinese	7.7 (6.4,9.4)	
Indians	11.9 (9.5,15.0)	
Other Bumiputra	8.1 (6.6,9.8)	
Others	8.6 (6.7,11.1)	

Education level		<0.001
No formal education	12.9 (10.5,15.7)	
Primary school education	11.1 (9.8,12.6)	
Secondary school education	9.0 (8.1,10.0)	
Tertiary education	7.1 (6.1,8.3)	
Marital status		<0.001
Single	6.4 (5.5,7.6)	
Married	10.0 (9.2,10.9)	
Widow/widower/divorcee	12.0 (10.1,14.2)	
Occupation status		0.048
Working	8.8 (8.1,9.6)	
Not working	9.8 (8.9,10.8)	
Smoking status		0.496
Smoker	9.5 (8.3,10.8)	
Non-smoker	9.1 (8.3,9.8)	
Physical activity		0.036
Active	9.6 (8.8,10.5)	
Inactive	8.4 (7.6,9.3)	
Obesity		<0.001
Obese	13.6 (12.2,15.2)	
Non-obese	8.8 (8.1,9.6)	
Blood pressure status		<0.001
Hypertensive	7.6 (6.9,8.3)	
Normotensive	12.8 (11.8,14.0)	

4.3 Factors Associated With Undiagnosed Diabetes Mellitus

Multivariable analysis (multiple logistic regression) was performed for variables found significant in the univariate analysis (Table 3). Table 3 showed the adjusted odds ratios (aOR) of the factors, for undiagnosed diabetes mellitus. Significant associations were found for age group (40-59 years aOR 1.33 (95% CI: 1.12,1.59) 60 year old and above aOR1.28 (95% CI: 1.01,1.63), ethnic group (Malays aOR1.25 (95% CI: 0.99,1.57) Indians aOR 1.47 (95% 1.07, 2.01), Educational level (No formal education aOR 1.68 (95% CI: 1.23, 2.27), Primary education aOR1.30 (95 CI: 1.05,1.62), Obese aOR1.42 (95% CI: 1.22,1.64) and hypertensive status (aOR 1.33 (95% CI: 1.15,1.53). No significant associations were found for occupational status, marital status and physical activity.

Table 3. Factors associations with undiagnosed diabetes mellitus (using multiple logistic regression)

	OR (95% CI)	p-value	aOR (95% CI)	p-value
Age group				
18 – 39	1.00	-	1.00	-
40 – 59	1.75 (1.51, 2.03)	<0.001	1.33 (1.12, 1.59)	0.001
60 years old and above	1.86 (1.57, 2.22)	<0.001	1.28 (1.01, 1.63)	<0.040
Ethnic group				
Chinese	1.00	-	1.00	-
Malays	1.30 (1.04,1.62)	0.021	1.25 (0.99,1.57)	0.057
Indians	1.62 (1.19,2.20)	0.002	1.47 (1.07,2.01)	0.017
Other Bumiputra	1.04 (0.77,1.41)	0.780	0.90 (0.66,1.23)	0.521
Others	1.12 (0.80,1.57)	0.503	1.06 (0.75,1.50)	0.758
Education level				
No formal education	1.92 (1.45, 2.55)	<0.001	1.68 (1.23, 2.29)	0.001
Primary education	1.63 (1.33,1.99)	<0.001	1.30 (1.05,1.62)	0.016
Secondary education	1.29 (1.08,1.54)	<0.001	1.15 (0.96,1.38)	0.136
Tertiary education	1.00	-	1.00	-
Marital status				
Single	1.00	-	1.00	-
Married	1.62 (1.34,1.95)	<0.001	1.21 (0.96,1.51)	0.099
Widow/widower/divorced	1.98 (1.54,2.55)	<0.001	1.23 (0.91,1.67)	0.172
Occupation status				
Working	1.00	-	1.00	-
Not working	1.13 (1.001,1.27)	<0.001	0.97(0.85, 1.12)	0.705
Physical activity level				
Active	1.00	-	1.00	-
Inactive	0.86 (0.756,0.99)	0.036	0.87 (0.76,1.01)	0.070
Obesity				
Obese	1.63 (1.42,1.88)	<0.001	1.42 (1.22,1.64)	<0.001
Non-obese	1.00		1.00	
Blood pressure status				
Hypertensive	1.80 (1.60,2.03)	<0.001	1.33 (1.15,1.53)	<0.001
Normotensive	1.00		1.00	

Notes. *p <0.05 was considered statistical significant.

5. Discussion

Our study shows that nearly 1 in 10 Malaysians have undiagnosed DM. Although the prevalence of 9.2% is lower compared to some Southeast Asian countries; 11.1% in Tamil Nadu (Subramani, Devi, & Shankar, 2014) and 11.1% in Singapore (Huang et al., 2015) but it is nonetheless significantly higher compared to other countries like Canada (2.2%) (Flores-Le Roux et al., 2011) and the United Kingdom (2.0%) (Moody, Cowley, Ng Fat, & Mindell, 2016). These undiagnosed DM in Malaysia could be due to lack of awareness of the necessity of health screening at an earlier age and of early diabetes symptoms. Furthermore, patient overload in public primary health care centers

pose difficulties and hinder Malaysians from seeking diabetes screening (Letchuman et al., 2006). Factors such as population growth, population aging, increasing urbanization and increasing prevalence of obesity and physical inactivity could also play a role, especially in developing and developed countries. For example, in the United States of America, the Diabetes Statistics Report of 2014 stated that a total of 29.1 million (9.3%) of its population had diabetes but 8.1 million (27.8%) of them were undiagnosed (Centers for Disease Control and Prevention, 2014).

Based on Table 2, the prevalence of undiagnosed DM increases with age as it was higher among those aged 60 years and above (12.3%). This is probably due to increasing tendency to exercise less or being physical inactive, loss of muscle mass and gaining weight with age. It has been established that the more abundant the fatty tissue in the body, the more resistant are the cells to insulin (Wondemagegn et al., 2017). This finding is similar to findings from Azimi-Nezhad et al. in Iran (R & M J, 2008) which showed that further age-related glucose intolerance is related to decreased insulin sensitivity and decreased β- cell function(Shih, Tseng, & Article, 2009).

There seems to be an association between undiagnosed DM and ethnicity in Malaysia. This study shows a high prevalence of undiagnosed DM among Malaysian Indians compared to Malays and Malaysian Chinese. Respondents of Indian descent had the highest prevalence of undiagnosed DM not only in the recent NHMS 2015 but also in NHMS 2011 and 2006. Our study shows that Indians were 1.47 times more likely to have undiagnosed DM compared to the others ethnic group. In the Malaysian context, this may be attributed to differences in the food consumption pattern, dietary behavior, lifestyle and genetic susceptibility between the three major races in Malaysia. This study also found lower prevalence of undiagnosed DM among Malaysians of Chinese descent. This situation is probably due to many Chinese living in urban areas that have adequate health facilities and amenities as well as transportation system that can facilitate in early detection of diabetes mellitus among them.

The results in table 2 show that the prevalence of undiagnosed DM among widow/widower/ divorced and married individuals are significantly higher compared to those who are unmarried. This finding is consistent with the NHMS 2015 survey. Married individuals are 1.21 times more likely to have undiagnosed DM compared to single individuals. Some finding suggest that time constrain when managing careers and family life among married couples may cause lack of opportunity and awareness for prevention practices (Golden et al., 2012). However, other study have suggested that single, divorced and widowed statuses increase the risk of developing DM (Poljičanin, T., Šekerija, M., Boras, Kolarić, Vuletić, & Metelko, 2012).

In terms of education status, higher prevalence was observed in those without formal education, followed by those with primary education. There was a statistical significant association between education status and undiagnosed DM. Low education status may be associated with less awareness and less opportunity for prevention/control, and vice versa, for those with higher education status. However, the present study differs from other studies which found a lack of association, for example Muyer et al., 2012 and Signorello et al., 2007 in USA. Further study is needed to confirm the association between education and DM.

The results showed higher prevalence of undiagnosed DM among obese individuals. This study revealed that obese people were 1.42 times more likely to have undiagnosed DM. Studies by NHMS 2011(Institute for Public Health, 2015), and Nyamdorj et al., 2010 in Finland also reported a significant positive association between obesity or high BMI status with undiagnosed DM. It has been postulated that large abdominal fat stores affect insulin metabolism by releasing free fatty acids (Bennett, Guo, & Dharmage, 2007). In addition, fat cells secrete signaling factors Interlukein-6 (IL-6) and tumor necrosis factor- α (TNF- α) which is involved in the development of insulin resistance(Bennett et al., 2007).

This study revealed that respondents who had hypertension are 1.33 times more likely to have undiagnosed DM. Similar findings were reported in a Kenyan study by Meme, Amwayi, Nganga, & Buregyeya, 2015 and in Ethiopia study by Amsalu T W, Habtamu M B et al 2017. This association could be partially due to physiological traits: this mean that the effects of one disease increases the likelihood for developing the other disease. In addition, the two are more likely to occur together simply because they have important shared risk factors. Screening for DM should also be targeted at hypertensive patients in Malaysia as study had shown that lowering blood pressure can reduce the incidence of clinically-detected diabetes ("Screening for Type 2 Diabetes Mellitus in Adults: U.S. Preventive Services Task Force Recommendation Statement," 2008).

This study has some limitations. Although the NHMS 2015 was a national study that provided representative data, there were only a limited number of variables on the possible risk factors for undiagnosed DM that could be included in the analysis. Also, because there were few studies pertaining to undiagnosed DM, there were difficulties when it comes comparing results.

5. Conclusion

Undiagnosed T2DM among Malaysians were significant in 2015. Results from this study show that significant associated factors of undiagnosed T2DM are age, ethnic group, education level, marital status, physical activity level, obesity and blood pressure status. It is alarming to know that a large proportion of the community have diabetes mellitus but were unaware of it. Therefore, increasing public awareness of the importance of early diabetic screening is crucial especially among adults aged 30 years and above, and among high risk groups to prevent more serious complications and reduce the burden of this disease.

Declarations

Ethics Approval and Consent to Participate

Ethical approval was obtained from the Medical Research and Ethics Committee of the Ministry of Health Malaysia.

Consent for Publication

Not applicable.

Availability of Data and Materials

Funding

Not applicable.

Authors' Contributions

HI, MAO and TAS contributed to management and acquisition of the data, conducted the analysis and interpretation of data and drafted the manuscript. MFM, NAMZ, LKK and TA contributed drafted the manuscript and critically reviewing the content. All authors revised and approved the final manuscript.

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Competing Interests Statement

The authors declare that they have no competing interests.

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