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ANALYSIS OF RISK FACTORS ON UNDIAGNOSED DIABETES MELLITUS AMONG INDIVIDUALS: EVIDENCE FROM MALAYSIA

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ABSTRACT
This paper examines risk factors which include modifiable and non-modifiable risk factors in the prediction of undiagnosed Diabetes Mellitus among Malaysians by using binary logistic regression approach with the estimation of odds ratio with 95% confidence interval. This study uses secondary data from the cross-sectional population-based survey : The Fourth National Health and Morbidity Survey (2011) which was conducted by the Ministry of Health in 2011. The sample consists of 17602 participants. The results demonstrate obese, overweight, physically inactive respondents and current drinkers are statistically significant predictors for undiagnosed Diabetes Mellitus. Specifically, younger aged, widow/widower/divorced, female, other Bumiputra, Indians, Chinese, private employees, retirees and lower educated respondents are found statistically significant in affecting the likelihood of having undiagnosed Diabetes Mellitus in Malaysia. Thus, through the findings of this study, promotion of healthy lifestyle and intervention programs by the government especially in younger aged group is an urgent need to monitor and control the prevalence of undiagnosed Diabetes Mellitus among Malaysians.

Keywords: *Undiagnosed Diabetes Mellitus, modifiable risk factors, non-modifiable risk factors*

1. Introduction

In Malaysia, NCDs such as cardiovascular diseases, Diabetes Mellitus (DM), Hypertension (HP) and Hypercholesterolemia (HC) are the major health burden of the country. For instance, the Malaysian Burden of Disease and Injury Study estimated that there were 2,261 deaths attributed to Diabetes Mellitus (DM) (857 men and 1404 women) in 2002 (Yusoff et al. 2005).

The impact of Diabetes Mellitus (DM) in society was substantial because it exerted a giant societal burden by reducing the quality of life and life expectancy which lead to the economic loss among individuals and nations (Thomas et al. 2013). Even if Malaysia has a parallel public and private system, the majority of treatment for chronic diseases is provided by the public health system which is heavily subsidized by the government. For instance, the cost of Diabetes Mellitus to the nation was significant and based on a macro-economic study in 2011, it showed that the cost was approximately RM2 billion and was potentially representing 13% of the healthcare budget for the year of 2011 and the treatment cost and its complications were included for Diabetes Mellitus.

Many of these modifiable risk factors which include physical inactivity, Body Mass Index (BMI):

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overweight/obesity, inadequate fruit and vegetables consumption, excess alcohol consumption/drinking and smoking are related to heart disease and diabetes mellitus. As a result, lifestyle changes is necessary which involve in alterations of all the above mentioned personal habits (Scheffler and Paringer 1980).

Besides, Malaysia is a multi-racial country which is full of various culture and lifestyles among the ethnics. The ethnic groups in Malaysia have diverse cultures, religious and background characteristics (Johnson and DaVanzo 1998). The comparison among these ethnic groups may reveal differences in the diabetes mellitus prevalence and patterns. For example, Indian males had the highest prevalence of life threatening diabetes and also experience the lowest life expectancy (Teh, Tey, and Ng 2014). Although these non-modifiable risk factors cannot be the primary targets of interventions, it is important to consider as they influence the overall burden of Diabetes Mellitus. Therefore, it is essential to look into the socio-demographic and socio-economic factors which are recognized as non-modifiable risk factors among the individuals in order to tackle the Diabetes Mellitus prevalence issues by addressing different ethnic groups for policy implementation in Malaysia.

Lastly, Diabetes Mellitus consists of various stages and different level of outcomes. Furthermore the prevalence of known Diabetes Mellitus is resulted from the progression of undiagnosed Diabetes Mellitus. For instance: undiagnosed Diabetes Mellitus (DM) will subsequently develop Known Diabetes Mellitus (DM) (Nathan et al. 2007; Shaw et al. 1999; Tuomilehto et al. 2001). Hence, for interventions that require less spending but have been proven to be cost effective must be sought and employed in order to decrease the burden of these diseases, improve the quality of life in the country and also to promote sustainable development. Therefore, the controlling of the rate on undiagnosed Diabetes Mellitus for individuals is the main challenge in monitoring the prevalence of Diabetes Mellitus. As a result, this study is aimed at calling for an estimation of odds ratio on modifiable and non-modifiable risk factors on the prediction of undiagnosed Diabetes Mellitus in Malaysia.

2. Methods

2.1 Sample

This research involves 17,602 eligible respondents. Findings of the Fourth National Health and Morbidity Survey (NHMS IV) and was analysed by using binary logistic regression. Both urban and rural areas of every state were included in this survey. Institutional population such as those staying in hotel, hostels, hospitals etc. were not included. Hence, the target population included all non-institutionalized individuals residing in Malaysia for at least 2 weeks prior to data collection (Health 2011).

A two-stage stratified sampling design was used to ensure national representativeness of this study. The Department of Statistics Malaysia provides the sampling frame of the Fourth National Health and Morbidity Survey. From the sampling frame of this survey, Malaysia was divided into Enumeration Blocks (EB) which was geographically continuous areas with identified boundaries. A total of 794 EBs were selected from the total EBs in Malaysia, where 484 and 310 EBs were randomly selected from urban and rural area respectively (NHMS, 2011). In the year 2010, there were about 75,000 EBs were in Malaysia. Each EB has between 80 to 120 Living Quarters with an average population of 500 to 600 people. Additionally, the EB in the sampling frame has been classified into rural and urban areas by the Department of Statistics according to the population size of gazetted and built-up areas. Further, structured questionnaires with face-to-face interviews as well as administered methods were used to collect data by the Ministry of Health, Malaysia. This study was registered under the National Medical Research Registry (NMRR-12-324-11225).

2.2 Variables

The analysis had been performed through binary logistic regression to identify factors which influence the likelihood to have undiagnosed diabetes mellitus. The binary logit model was used to estimate the odd

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ratios (95% CI). Under this modeling approach, the dependent variables were generated into two categories : 0 = “No undiagnosed diabetes mellitus” and 1 = “undiagnosed diabetes mellitus”. The dependent variable is undiagnosed diabetes mellitus which is in this equation is the logarithm of the odds that a risk factor has been predicted. Undiagnosed diabetes mellitus has been defined as not known to have diabetes and has a fasting capillary blood glucose(FBG) equal to or more than 6.1mmol/L (non-fasting blood glucose or more than 11.1 mmol/L) in the The Fourth National Health and Morbidity Survey (NHMS) 2011 survey report (Health 2011).

Meanwhile, the modifiable risk factors as shown in Table 1 consist of physical inactivity (inactive and active), drinking status (unclassified, current drinker, ex-drinker and non-drinker), smoking status (current smoker, ex-smoker and non-smoker), Body Mass Index (BMI) which includes of Body Mass Index (BMI) : overweight (BMI > 18.5 kg/m^2), obesity (BMI ≥ 30.00 kg/m^2) and underweight (BMI < 18.5 kg/m^2). For those individuals with normal BMI (18.5 -24.99 kg/m^2) will be identified as the reference category. Furthermore, fruit and vegetables consumption (inadequate and adequate) is included in the regression model.

Table 1 : Categorical Variable Coding for Modifiable Risk Factors

Modifiable Risk Factor(s)	Variable Coding(s)	Definition
Physical Activity	1=Inactive	There is no activity is reported or some activity is reported but not enough to meet moderate or high categories.
	2=Active (Reference)	If his/ her combination of vigorous-intensity, moderate-intensity and walking activities achieved a minimum 0f 600 MET-minutes per week.
Drinking Status (define and analysis based on respondent's answer)	0=Unclassified	Declared as current drinker in question B9100 but did not answered module L.
	1=Current drinker	Respondent who is still consuming alcoholic beverages for the past 12 months.
	2=Ex-drinker	The respondent was previously a drinker.
	3=Non-Drinker (Reference)	The respondent is a non-drinker.
Smoking Status	0=Current Smoker	The respondent is a current smoker.
	1=Ex-Smoker	The respondent was previously a smoker.
	2=Non-Smoker (Reference)	The respondent is a non-smoker
Fruit and Vegetables Consumption (based on STEPS WHO criteria)	1=Inadequate	< 5 servings per day.
	0=Adequate (Reference)	≥ 5 servings per day.
	0=Obese	≥30.0 kg/m^2

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Body Mass Index (BMI) Status (WHO1998)	1=Overweight	25.0–29.99 kg/m^2
	2=Underweight	<18.5 kg/m^2
	3=Normal weight (Reference)	18.5–24.99 kg/m^2

Next, the independent variables which include non-modifiable risk factors consist of age (above 65 years old, 55-64 years old, 45-54 years old, 35-44 years old, 25-34 years old, 15-24 years old and below 15 years old), gender (female and male), race (others, other Bumiputra, Indian, Chinese and Malays), education levels (unclassified, no formal, primary, secondary and tertiary), marital status (widow/widower/divorced, married and single), occupation (retire, home maker, self-employed, private and Government/semi government) household income (above RM7,000, RM5,001-RM7,000, RM3,001-RM5,000, RM1,501-RM3,000, RM0-RM1,500) and residential area (urban and rural), were entered in the regression equation and the results were obtained after compared with the reference category.

The data has been coded, and analyzed using IBM Statistical Package for the Social Sciences (SPSS) software 23. The independent variables are selected through the significant test of the overall model, goodness-of-fit measures and validation of predicted probabilities using odds ratio. The checking of multicollinearity has been conducted by using Variance Inflation Factor (VIF). It shows that there is no collinearity existed among the independent variables in the model since the Variance Inflation Factor is less than 10 (VIF values <10). Descriptive statistics has been performed and data are presented as frequency and percentage. Chi-square is employed to assess the independent variables.

2.3 Binary Logistic Regression Model

The dependent variable, undiagnosed diabetes mellitus has been assessed using the binary logit model (BLM) and the outcome variables consists of two categories. The outcome variable has been coded as 1 to be the *EVENT* (suffer from undiagnosed diabetes mellitus) and the dependent variable was coded as 0 to be *[1-EVENT]* as no undiagnosed diabetes mellitus. The logistic regression function can be written as follows:

Prob [*Event*] = $\frac{1}{1+e^{-Z}}$ (1)

where Z = $\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_2 X_2 + \varepsilon$

The Z function is transformed to obtain either probability of the *EVENT* occurring or [1-*EVENT*] if not occurring. The probability of an event which is not happening is estimated as the following:

Prob [No event] = 1-Prob [Event]
(2)

For a binary response variable *Y* which consists of two outcome variables and takes value of 1 as 'success' outcome (π) and 0 as 'failure' outcome (1-π). In the context of this study, Y_i equals to 1 if respondents had undiagnosed diabetes mellitus and 0 if not.

$$P(Y_i) = \pi_i = \frac{\exp(\beta' X_i)}{1+\exp(\beta' X_i)}$$

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(3)

with $\beta' X_i = \beta_0 - \beta_1 X_{i1} + \beta_{i-1} X_{i,i-1} \cdot \beta_k$ is the parameter of the model. When Y is the outcome variable and X_i is the value of independent variable *i*. The logistic regression model predicts the logit of *Y* from *X* and the logit is the natural logarithm (ln) of odds of *Y*. Through the transformation, the multiple binary logistic model is given as follows :

$\pi' = \ln\left[\frac{\pi}{1-\pi}\right]$ = ln(odds)

(4)

The model tangible to a linear model that creates logit response function is :

$\pi' = \beta' X = \beta_0 + \beta_1 X_{i1} + \beta_{i-1} X_{i,i-1}$

(5)

3. Empirical Results

3.1 Respondents Profile

The Descriptive information of the independent variables is obtained from the frequency runs as presented in Table 2. A total of 17,602 of respondents from the Fourth National Health and Morbidity Survey (NHMS IV) are used in this study. Sample demographic factors consist of gender, age, race, education level, occupation, household income, residential area, and marital status. There are more females than males which comprises of 47.3% of males respondents and 52.7% are females respondents. Majority of the respondents have secondary education (42.6%) but only 4.0% of the respondents have no unclassified education. About 36.2% which most of the respondents worked in private sector. However, more than 30% of the respondents have low income which are in the range from RM0 to RM1,500 whereas only 9.1% of the respondents earned from RM5,001 to RM7,000. Overall, majority of the sample were Malays (57.1%), followed by Chinese (19.1%), other Bumiputra (10.3%), Indians (7.3%) and 6.2% for other races. Most of the respondents are in their age between 25 and 34 years old (21.0%), married (59.1%) and urban residents (57.9%).

Table 2: Descriptive Analyses of Demographic and Socioeconomic Characteristics of Respondents

Variable(s)	Level(s)	Frequency (n)	Percent (%)
Gender	Male	8329	47.3
	Female	9273	52.7
Education level	Unclassified	709	4.0
	No formal education	1201	6.8
	Primary education	4719	26.8
	Secondary education	7501	42.6
	Tertiary education	3472	19.7
Occupation	Retire	1695	9.6
	Home maker	3490	19.8

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	Self employed	3758	21.3
	Private	6371	36.2
	Government/Semi Government	2288	13.0
Household income	Above RM7,000	1936	11.0
	RM5,001-7,000	1599	9.1
	RM3,001-5,000	3609	20.5
	RM1,501-3,000	4840	27.5
	RM0-1,500	5618	31.9
Residential area	Urban	10194	57.9
	Rural	7408	42.1
Race	Others	1100	6.2
	Other Bumiputra	1813	10.3
	Indian	1279	7.3
	Chinese	3362	19.1
	Malays	10048	57.1
Marital Status	Widow/widower or Divorced	1128	6.4
	Married	10394	59.1
	Single	6057	34.5

Table 2, continued.

Variable(s)	Level(s)	Frequency (n)	Percent (%)
Age	>65 years old	1276	7.2
	55-64 years old	1797	10.2
	45-54 years old	2784	15.8
	35-44 years old	3194	18.1
	25-34 years old	3700	21.0
	15-24 years old	3230	18.4

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<15 years old	1621	9.2

3.2 Descriptive Statistics for Diabetes Mellitus Status

Table 3 shows overall 17602 respondents in the study has diabetes with 3915 (22.2%) "undiagnosed" Diabetes Mellitus cases. 77.8% (13687 out of 17,602) are identified as have no undiagnosed Diabetes Mellitus.

Table 3: Descriptive Statistics of Diabetes Mellitus Status

Diabetes Mellitus Status	Frequency	Percent (%)
No Undiagnosed Diabetes Mellitus	13687	77.8
Undiagnosed DM	3915	22.2
Total	17602	100.0

3.3 Diagnostic Tests for Binary Logistic Regression Model

Diagnostic tests have been conducted to the binary logistic regression model in order to identify how do the variables best fit under the prediction of the dependent variables. For Hosmer and Lemeshow goodness of fit test demonstrates this model is considered poor because the significance value is less than 0.05 (Table 4).

Table 4 : Hosmer and Lemeshow Test

Chi-square	df	Sig.
42.880	8	<0.001

The values of Pseudo R^2 (Cox and Snell =0.285 Nagelkerke = 0.437) demonstrate 28.5% and 43.7% of the variability has been explained by this set of variables (Table 5).

Table 5 : Pseudo R-Square (Undiagnosed Diabetes Mellitus)

Cox and Snell	.285
Nagelkerke	.437

Table 6 demonstrates that there is no collinearity existed among the independent variables in the binary logistic regression models since the Variance Inflation Factor is less than 10. Hence, it is appropriate to proceed with all independent variables to fit the binary logistic regression model.

Table 6 : Results of Multicollinearity Test for all Independent Variables

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Factor	Tolerance	VIF
Age	0.470	2.128
Marital status	0.483	2.072
Gender	0.887	1.128
Physical Activity	0.974	1.027
Residential area	0.943	1.061
Race	0.914	1.094
Occupation	0.782	1.279
Household income	0.878	1.139
Fruit and vegetables consumption	0.984	1.016
Drinking Status	0.922	1.084
Smoking Status	0.987	1.014
Education level	0.810	1.235
BMI Category	0.979	1.021

Table 7 shows the comparison of the predicted values with the observed values. This model presents 99.7% of the cases as no undiagnosed Diabetes Mellitus. Besides, 41.2% are classified correctly as undiagnosed Diabetes Mellitus individuals. In total, 86.8% of the cases are classified correctly.

Table 7: Classification Table

Observed	Predicted		
	No Undiagnosed Diabetes Mellitus	Undiagnosed Diabetes Mellitus	Percent Correct
No Undiagnosed Diabetes Mellitus	13640	37	99.7
Undiagnosed Diabetes Mellitus	2290	1605	41.2
Overall Percentage			86.8%

4. Results and Discussion

The published results from Table 8 provides the evidence and have shown that obese (OR=2.032) and

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overweight (OR=1.716) respondents are found more likely to have undiagnosed Diabetes Mellitus in comparison with normal weight respondents. Hence, the findings of this study shares the similar findings of (Rathmann et al. 2003) that stated obese respondents were 1.9 times more likely to have undiagnosed Diabetes Mellitus in males. Furthermore, significant associations were found among the obese respondents (OR 1.32 95% P<0.001) on the likelihood of having undiagnosed Diabetes Mellitus (Ismail et al. 2016). As a result, maintaining normal weight is essential for Malaysians in order to prevent the risk of having undiagnosed Diabetes Mellitus.

In the perspective of physical activity, it is found that physical inactive respondents are 1.194 times as likely to have undiagnosed Diabetes Mellitus when compared to physically active respondents in this study. The findings of this study are consistent with the previous studies, which showed that there was evidence to recommend that 150 minutes of participation in moderately intense physical activity per week can significantly reduce the risk of Non-Communicable Diseases (NCDs) by approximately 30% (Organization 2008). Similarly, it was also reported that normal-weight individuals were at higher likelihood (OR 1.52 [95% CI 1.25–1.86]) of Diabetes Mellitus. Therefore, the likelihood of having diabetes increased with physical inactivity (Sullivan et al. 2005). As a result, it is suggested that intervention on active lifestyle is necessary to prevent the occurrence of undiagnosed Diabetes Mellitus. As a result, it is suggested intervention on active lifestyle is necessary to prevent the occurrence of undiagnosed Diabetes Mellitus. Appropriate and healthy diet and being physically active are necessary to address and prevent undiagnosed Diabetes Mellitus.

In terms of drinking status variable, the results suggest that current drinkers are less likely (OR: 0.764) to have undiagnosed Diabetes Mellitus. This is inconsistent with that of the previous research which reported that a positive association (P<0.05) was exhibited between diabetes mellitus and alcohol consumption (Joshi et al. 2012). Likewise, this study does not tally with the previous study which reported that among male respondents (BMI > 22 kg/m^2), a small non−significant increase in odds ratio was noted with alcohol consumption (Waki et al. 2005). The probable reason behind this observation may be the different category of drinkers who influence at different levels the likelihood of undiagnosed Diabetes Mellitus.

However, all smoking status, for instance, current and ex-smokers as well as inadequate fruit and vegetables consumption are found to be not statistically significant in affecting the odds of having undiagnosed Diabetes Mellitus. Thus, the finding of this study is agreeable with the previous research finding based on Spain which reported that smoking was not significantly associated with the odds of undiagnosed Diabetes Mellitus (Soriguer et al. 2012).

Next, it is found that females have notably (P<0.001) lower chance (OR=686, CI=0.616-0.763) of having undiagnosed Diabetes Mellitus as compared to Males. This tallied with the previous research which was also found females were less likely to be diabetic than males in Jordan (Ajlouni, Jaddou, and Batieha 1998). Likewise, previous findings had reported that Males have been significantly exhibited a higher likelihood association with undiagnosed Diabetes Mellitus as compared to females (Ismail et al. 2016; Regitz-Zagrosek, Lehmkuhl, and Weickert 2006). It is suggested that females are more health conscious than their male counterparts by practicing healthier lifestyle with less sugar intake and practice regular health screening.

With regard to ethnic variable, the results of this study reveal that other Bumiputra and Chinese have significantly (P<0.001) lower odds (OR=0.688, OR=0.843) respectively of having undiagnosed Diabetes Mellitus as compared to Malay respondents. Meanwhile, Indian respondents on the other hand, have significantly (P<0.001) higher odds (OR=1.346) of having undiagnosed Diabetes Mellitus in comparison to Malay respondents. Therefore, the findings of this study is consistent with Ismail et al. reported that other Bumiputras have significantly (p<0.001) lower likelihood (adjusted OR=0.70) to have undiagnosed Diabetes Mellitus than the Malays in Malaysia. It was suggested may be due to differences in dietary intake, lifestyle and genetic inheritance among races in Malaysia (Ismail et al. 2016).

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In the case of age, all age groups are negatively related with the likelihood of having undiagnosed Diabetes Mellitus. The odds of having undiagnosed Diabetes Mellitus compared to No Diabetes Mellitus are less than 1. It is also found to be 0.005, 0.006, 0.005, 0.004, 0.003 and 0.008 times lower (with p<0.001) among those above 65, 55-64, 45-54, 35-44, 25-34 and 15-24 years individually than the reference group of below 15 years old. The results have shown older aged group is less likely to have undiagnosed Diabetes Mellitus and this is consistent with the previous research which observed that older subjects were less likely to have undiagnosed Diabetes Mellitus compared to younger group in India (Kanungo et al. 2016). This may be due to the urbanization which is also associated with occupation-related physical inactivity in the services sector and involved sedentary behavior and diet among adults (van der Berg et al. 2016). Hence, this will lead to a potential factor to be higher likelihood to have undiagnosed Diabetes Mellitus among younger aged group.

Education levels significantly (P<0.001) influence the likelihood of having undiagnosed Diabetes Mellitus among the respondents. The odds ratio for the respondents with unclassified education, no formal education, primary education and secondary education are more than one (2.949, 1.728, 1.935 and 1.630 respectively), indicating that those with higher education are also less likely to have undiagnosed Diabetes Mellitus. Hence, it is found that respondents with lower education levels will be more likely to have undiagnosed Diabetes Mellitus and this has been supported by the previous study reported that there was a significant inverse correlation between educational level and the undiagnosed Diabetes Mellitus among the Korean women (Rathmann et al. 2003). This finding underlines an urgent need to deliver better Diabetes Mellitus education especially awareness programs by targeting those with lower education level in Malaysia.

In the perspective of occupation, in comparison to government or semi government respondents, retirees have significantly (P<0.001) shown greater likelihood (OR=1.306) of having undiagnosed Diabetes Mellitus. On the other hand, the odds ratio for private workers is less than one (0.749); suggesting that private workers are less likely to have undiagnosed Diabetes Mellitus. The results of this study reveal consistency with the previous research which reported retirees were recorded to have the highest prevalence rate of Diabetes Mellitus among other occupation (Bushara et al. 2015). The occurrence of undiagnosed Diabetes Mellitus among retirees will definitely reduce their quality of life due to the financial burden which they will face when treatment of the disease is needed. Hence, health promotion programs and intervention policies are required to address this particular group. Moreover, in terms of marital status, this study shows that only widow/widower or divorced respondents have significantly (p<0.05) lower likelihood (OR=0.744) of undiagnosed Diabetes Mellitus as compared to those who are single respondents.

There is no significant difference in the odds of affecting the likelihood of having undiagnosed Diabetes Mellitus among all income groups in this study. Additionally, no significant difference is also observed on the likelihood of having undiagnosed Diabetes Mellitus among the urban and rural dwellers in this study.

Table 8: Results for Binary Logistic Regression on Undiagnosed Diabetes Mellitus

							95% C.I.for EXP(B)	
Variable(s)	Co-efficient	Standard Error	Wald	df	P-Value	Odds ratio	Lower	Upper
Age <15 years old			804.078	6	.000			

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>65 years old	-5.232	.226	535.298	1	.000	.005	.003	.008
55-64 years old	-5.170	.213	589.904	1	.000	.006	.004	.009
45-54 years old	-5.210	.211	611.483	1	.000	.005	.004	.008
35-44 years old	-5.495	.212	669.028	1	.000	.004	.003	.006
25-34 years old	-5.873	.209	789.796	1	.000	.003	.002	.004
15-24 years old	-4.844	.196	608.521	1	.000	.008	.005	.012
Marital Status Single			5.312	2	.070			
Widow/widower or Divorced	-.295	.128	5.299	1	.021	.744	.579	.957
Married	-.120	.081	2.194	1	.139	.887	.756	1.040
Gender Female	-.377	.054	47.939	1	.000	.686	.616	.763
Physical Activity Inactive	.177	.049	13.247	1	.000	1.194	1.08 5	1.314
Residential area Urban	.033	.049	.446	1	.504	1.034	.938	1.139
Race Malays (R)			42.131	4	.000			
Others	-.159	.109	2.140	1	.143	.853	.689	1.056

Table 8, continued

Variable(s)	Co-efficient	Standard Error	Wald	df	P-Value	Odds ratio	95% C.I.for EXP(B) Lower	Upper
Other Bumiputra	-.374	.090	17.253	1	.000	.688	.577	.821
Indian	.297	.086	11.909	1	.001	1.346	1.13 7	1.593
Chinese	-.171	.071	5.818	1	.016	.843	.734	.969
Occupation Gov/Semi Gov (R)			50.400	4	.000			

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Retire	.267	.111	5.828	1	.016	1.306	1.052	1.622
Home maker	.131	.090	2.119	1	.145	1.140	.955	1.361
Self-employed	-.052	.086	.369	1	.544	.949	.802	1.123
Private	-.289	.081	12.695	1	.000	.749	.639	.878
Household income RM0-1500 (R)			10.578	4	.032			
Above RM7000	.137	.087	2.475	1	.116	1.146	.967	1.359
RM5001-7000	.121	.088	1.901	1	.168	1.128	.950	1.339
RM3001-5000	-.057	.068	.702	1	.402	.945	.827	1.079
RM1501-3000	-.086	.061	2.018	1	.155	.917	.814	1.033
Fruit & Vege consumption Inadequate	.079	.095	.685	1	.408	1.082	.898	1.303
Drinking status Non-Drinker (R)			12.919	3	.005			
Unclassified	-.571	.298	3.668	1	.055	.565	.315	1.013
Current drinker	-.269	.098	7.460	1	.006	.764	.630	.927
Ex-drinker	-.213	.117	3.321	1	.068	.808	.643	1.016
Smoking status Non-smoker (R)			2.508	2	.285			
Current smoker	.035	.064	.292	1	.589	1.035	.913	1.173
Ex-smoker	-.118	.114	1.067	1	.302	.889	.711	1.111
Education level Tertiary (R)			81.596	4	.000			
Unclassified	1.082	.151	51.142	1	.000	2.949	2.193	3.967
No formal	.547	.123	19.772	1	.000	1.728	1.358	2.199
Primary	.660	.088	56.506	1	.000	1.935	1.629	2.298

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Secondary	.488	.072	46.015	1	.000	1.630	1.415	1.876
Body Mass Index Normal weight (R)			206.325	3	.000			
Obese	.709	.064	123.193	1	.000	2.032	1.793	2.303
Overweight	.540	.055	97.701	1	.000	1.716	1.542	1.910
Underweight	-.360	.100	12.965	1	.000	.698	.574	.849
Constant	3.044	.244	155.874	1	.000	20.994		

5. Conclusions

From the findings of this study, the research objective has been met which some of the predictors among the modifiable risk factors which include respondents who are obese, overweight and physically inactive together with current drinkers are found more likely to have undiagnosed Diabetes Mellitus. Likewise, the non-modifiable risk factors also have been identified which comprise of younger aged, widow/widower/divorced, females, other Bumiputra, Indians, Chinese, private employees, retirees and lower educated respondents are found statistically significant in affecting the odds of undiagnosed Diabetes Mellitus among Malaysians. Thus, through the findings of this study, the prediction of risk factors on undiagnosed Diabetes Mellitus provides guidance and good benchmark for policy makers to allocate resources more efficiently to prevent undiagnosed Diabetes Mellitus in Malaysia. Hence, the promotion of healthy lifestyle and intervention programs by the government especially in younger aged group is an urgent need to monitor and control the prevalence of undiagnosed Diabetes Mellitus among Malaysians. On the other hand, there are some limitations in this study. Firstly, it is tackled in satisfactory level to give better understanding of the survey based on a few available materials, information gathered during the actual data management and published articles of the researchers involved in data collection. Secondly, this study is limited by its cross-sectional nature; therefore, cross-sectional design does not allow us to make any conclusive statement about the temporality of the observed associations.

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Competing interests

The authors declare that they have no competing interests.

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