

ORIGINAL RESEARCH

Obesity and its associated factors among older adults: MyHEBAT (Malaysian HEalth and Well-Being Assessment) study

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Abstract

Background: Despite being a preventable disease, the prevalence of obesity is rising progressively worldwide. However, the prevalence of obesity and its associated factors among older adults remains unclear in Malaysia. The aim of this study was to determine the prevalence of obesity and its associated factors among older adults who voluntarily attended the health screening programs, which were part of the Malaysian HEalth and Well-Being Assessment (My-HEBAT) Study.

Methods: Cross-sectional study was conducted among Malaysian adults, aged ≥ 60 years. A standardized self-administered questionnaire was used to gather information regarding socio-demographic status, personal, family and medical history. Anthropometric indices, blood pressure and physical examinations were conducted on site. Venous blood samples were collected for lipid profile and blood glucose analysis. Participants with BMI of $\geq 30 \text{ kg/m}^2$ or $< 30 \text{ kg/m}^2$ were classified as obese or non-obese respectively. Age was categorized into three subgroups: 60–69, 70–79, and ≥ 80 years old. The factors associated with obesity among older adults were then identified using multiple logistic regression.

Results: A total of 716 older adults aged ≥ 60 years (mean \pm SD: 66.6 ± 6.0 years) were recruited. The prevalence of obesity among older adults was 15.8%, while higher prevalence was found among females (42.9%) compared to males (38.3%). The prevalence of obesity decreased with increasing age (48.5% in 60–69 years, 20.8% in 70–79 years, and 11.8% in ≥ 80 years).

Conclusion: The prevalence of obesity among Malaysian population is higher than that of worldwide prevalence. Current national health promotion and educational programs should focus on identifying factors associated with obesity, and promotion of healthy lifestyle with obesity should be improved and modified, particularly for older adults in Malaysia.

KEYWORDS

Malaysia, obesity, older adults, prevalence

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1 | INTRODUCTION

Currently, the global prevalence of obesity has increased by fourfold, starting from 1975.¹ According to WHO 2020, the global prevalence of obesity among adolescents aged above 18 years old has rapidly increased from just 4% in 1975 to over 18% in 2016.¹ Overall, nearly 13% of the world's adult population were obese during 2016. The prevalence of obesity among older adults was approximately 20% in Japan and Taiwan, in 2012, with 30.5% in men and 21.3% in women.²

In Malaysia, the prevalence of obesity in adults aged >18 years was 17.7% (95% confidence interval [CI]: 16.9–18.5) which was higher than world obesity prevalence, which was 13% in 2016.^{1,3,4} Older adults are defined as those who are aged ≥ 60 years and the prevalence of obesity among this cohort in Malaysia has increased from 14% in 2006 to 15.1% and 20.5% in 2011 and 2015, respectively.⁴ The prevalence of obesity was significantly higher in females compared to males, and the highest prevalence (20.5%) was found in older adults aged between 60 and 70 years.⁴ Another study also reported that the prevalence of obesity in females (57.1%) was higher than in males (50.0%) (OR = 1.3).⁵ However, recent prevalence of obesity among the older adults in this country is not well established.

There were multiple factors associated with obesity which have been shown to increase risk of chronic diseases such as cardiovascular disease (CVD), hypertension, hypercholesterolemia, diabetes, arthritis, and cancer among Malaysian adults aged 24–64 years.⁶ Literatures reported that obesity was significantly associated with smoking, where among older adults, 25.5% were smokers (female 3.0%, male 46.5%).⁶ In addition, the prevalence of diabetes was directly proportional to the increase of body mass index (BMI).⁷ The Malaysia Burden of Disease Report (2009–2015) showed that there was a rapid rise in incidence, mortality, and prevalence of obesity-related chronic diseases in older adults.⁸

In Malaysia, many studies have reported the prevalence of obesity among adults. However the data on obesity in older adults are limited, and the associated factors with obesity within this age group are still unclear.^{6,8} Therefore, the aims of this study were to determine the prevalence of obesity and its associated factors among older adults based on the Malaysian Health and Well-Being Assessment (MyHEBAT) Study, using the health screening program database from 2011 to 2018. By identifying the factors associated with obesity among older adults, further enhancement in control-programs, such as health promotion and education programs, can be implemented for the prevention and control of obesity.

2 | MATERIALS AND METHODS

2.1 | Data

This was a cross-sectional epidemiological study that utilised data derived from the Community Health Screening Programs conducted for the study of non-communicable diseases and their risk factors,

which was part of MyHEBAT study, spanning over an 8-year period between 2011–2018 in Malaysia. The subjects were recruited among community members who attended the health screening programs. The recruitment utilised convenient sampling method, conducted in most states and regions in both East and West Malaysia.

A total of 733 older adults (≥ 60 years) individual data were extracted from the database. The sample size was determined based on the Malaysia National Health and Morbidity Survey (NHMS) 2015, which found that the prevalence of obesity among older adults aged ≥ 60 years was 20.5%. By taking 95% CI, 80% study power, the minimum sample size required in this study was 187.⁴ When 20% of attrition rate was considered, the minimum required sample size was 224. Initially, all 733 older adults (age ≥ 60 years) health screening participants who fulfilled the inclusion criteria and voluntarily provided their participations were included in our study. After exclusion of individuals with missing data, the final sample size was comprising of 716 participants (333 males and 383 females).

2.2 | Data collection

The participants were recruited from a series of nation-wide Community Health Screening Programs organised by the I-PPerForM, UiTM and National Professorial Council, conducted from 2011 to 2018. The written informed consent was obtained from each participant before enrollment into the study. All investigators and interviewers were trained in terms of the study procedures before the commencement of the study in order to standardize the data collection and to minimize data variability. All Malaysian aged above 18 years old were eligible to participate, while participants were excluded if they were unable or unwilling to provide informed consent.

Standardized and validated self-administered questionnaire was used to collect information on sociodemographic features (such as age, gender, ethnicity, gross household income, education level, and marital status), behavioral activities (such as smoking and alcohol intake), pre-existing comorbid diseases (such as diabetes, hypertension, hypercholesterolemia, coronary artery disease, stroke and renal diseases), and family history of diseases including diabetes, hypertension, hypercholesterolemia, coronary artery disease and stroke.

A comprehensive physical examination was done to each of the participants including BMI measurement and blood pressure were recorded on site. The participants were allowed to rest for 10 min before the measurement of blood pressure. Blood pressure was measured by automated blood pressure devices (Omron, Japan) for three times, and the mean blood pressures of the last two readings were calculated and recorded. After anthropometric data collection and blood pressure measurement, fasting venous blood samples (6 ml per individual) were drawn and collected in blood tubes for measurement of serum triglycerides (TG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-c), high-density lipoprotein

cholesterol (HDL-c) and plasma glucose levels, by standardized methods using an automated biochemical analyzer (Cobas Integra 6000 c501; Roche Diagnosis USA).^{9,10}

2.3 | Operational definitions

Obesity was defined according to the World Health Organization (WHO) Western-Pacific criteria, 2017.¹ Height was measured without footwear to the nearest 0.1 centimeter using a stadiometer. Weight was measured by advising participants with minimal clothing without wearing shoes. Data on BMI (weight [kg]/height² [m²]) were calculated. BMI of 18.5–22.9 kg/m² was defined as normal weight, whilst BMI of < 18.5 kg/m², 23–24.9 kg/m², 25–29.9 kg/m² and ≥30 kg/m² were classified as underweight, overweight, pre-obese and obese respectively. For this study, all participants with BMI <30 kg/m² were categorized as “non-obese”. Age classification was done according to WHO Guidelines for “Western Pacific” Values, 2014, where participants were categorized into three subgroups of 60–69, 70–79, and ≥80 years.¹¹ In this study, hypertension was defined as participants with average systolic pressure of ≥140 mmHg and/or diastolic pressure ≥90 mmHg and/or a known case of hypertension. Diabetes was defined as a fasting plasma glucose (FPG) ≥7.0 mmol/L and/or a self-reported history of diabetes and/or on antidiabetic medication. Participants with FPG ≥ 7.0 mmol/L and/or known case of diabetes mellitus were classified as diabetes mellitus in our study (WHO STEPwise approach).¹² Elevated serum TC (>5.2 mmol/L) and TG (>2.3 mmol/L) were classified as obesity-associated factors in this study.¹

2.4 | Ethics approval

All the participants provided written informed consent before commencement of this study. The research ethical approval was acquired from the Institutional Research Ethics Committee (Ref: UiTM 600-IRMI [5/1/6]), which is in accordance to the Declaration of Helsinki.

2.5 | Statistical analyses

Data were analyzed using SPSS Version 24. Individuals without age and BMI variables were treated as incomplete entries, and the final sample size became 716 after exclusion of individuals with missing data. Categorical data associations were evaluated using the χ^2 test to compare data among obese and non-obese participants. Binary logistic regression and multiple logistic regression (MLogR) (backward method) based on the previous literatures were used to analyze the factors associated significantly with obesity.^{13,14} Data were presented as crude and adjusted odds ratio (OR) with the 95% CI and $p < 0.05$ was considered as statistically significant.

3 | RESULTS

In this study, a total of 716 participants were recruited with mean age of 66.6 ± 6.0 years. Out of the total, 333 were males (46.5%) and 338 were females (53.5%). Among them, the proportion of Malay participants was greater than non-Malays (61.9% and 38.1%, respectively). Furthermore, the proportions of participants living in urban areas (53.6%) were higher than those in rural areas (38.1%). Household income was divided into <RM3000 per month (89.6%) and >RM3000 per month (10.4%). Participants with primary level education had the highest percentage (54.3%) of obesity compared to other groups of education levels. Overall, 15.8% (113/716) of recruited subjects were obese, and 84.2% were non-obese (Table A1).

Out of all recruited subjects, 32.2% (226/716) were smokers and the participants who drink alcohol were only 6.3%, while those who did not drink alcohol were 93.7%. Furthermore, 66.8% were hypertensive, 33.7% were diabetic, and only 5.3% had a history of CVD. The percentage of participants with hypercholesterolemia (70.0%) was higher than those with hypertriglyceridemia (51.9%). Out of all participants, only 1.7% declared they had a history of renal disease and only 1.4% had history of stroke (Table A2).

Among the 716 participants, 29.0% had family history of hypertension, 19.3% of the participants stated that they had a family history of diabetes, and only 10.6% had CVD history. In addition, only 53 participants (8.0%) had a family history of stroke, whereas the rest (92.0%) were without it (Table A3).

Simple logistic regression (SLogR) was performed among obese ($n = 113$) and non-obese ($n = 603$) individuals to determine the associated factors of obesity. Obesity was significantly associated with all three age groups, gender, race, income level, education level, hypertension, diabetes mellitus, stroke, family history of hypertension/CVD. (Table A4).

We found that among the 70–79 years age group, the odds of getting obesity were reduced by 0.34 times compared to the 60–69 years age group (OR: 0.34, 95% CI: 0.18–0.65). The odds of getting obese among age ≥80 years were reduced 0.14 times compared to the 60–69 years age group (OR: 0.14, 95% CI: 0.08–1.43). Moreover, the risk of obesity in non-Malays was reduced by 32% compared with Malays (OR: 0.68, 95% CI: 0.43–1.03). The odds of getting obesity was 44% higher with females compared to males (OR: 1.44, 95% CI: 0.96–2.18). Odds of getting obesity in participants whose incomes ≥RM3000 per month were 2.38 times higher compared to those whose incomes were less than RM3000 per month. For the participants with tertiary level education, the odds of getting obese were 2.01 times higher compared to participants who were with primary level education.

In addition, the participants with hypertension showed 2.47 times higher risk of getting obese compared to those without hypertension, whereas those with diabetes showed 93% higher risk of becoming obese compared with non-diabetics. Similarly, there was 2.35 times higher odds of becoming obese among participants who

had positive family history of stroke compared to negative family history. Meanwhile, there was 69% higher risk of becoming obese among participants with positive compared to negative family history of hypertension. Likewise, the risk of obesity was 36% higher among participants with family history of diabetes than those without family history of diabetes. In addition, there was 2.19 times higher odds of obesity among participants with family history of CVD. All the significant findings from SLogR were further analyzed using the MLogR_backward LR method to evaluate the significant associations of variables with obesity.

From the SLogR analysis, six significant variables and another five variables, namely education level, race, gender, stroke history, and family history of diabetes, were included in MLogR. The analysis yielded a p -value of <0.25 . The final model, presented in Table A5, was using MLogR_backward LR method, showed the factors associated with obesity.

The nine variables were significantly associated with obesity. Diabetes, the interactions of "age (70–79 years)*tertiary education" ($p = 0.006$), "age (70–79 years)*family history of hypertension" ($p = 0.043$), "income \geq RM3000 per month*non-Malay participants" ($p = 0.018$), "income \geq RM3000 per month*family history of hypertension" ($p = 0.021$), "hypertension*family history of hypertension" ($p = 0.025$), "family history of hypertension*family history of CVD" ($p = 0.005$), "female*hypertension" ($p = 0.014$), "diabetes*family history of CVD" ($p = 0.006$), were significantly associated with the obesity. We found that in participants with diabetes, odds of obesity were 2.59 times higher compared to non-diabetics (OR: 2.59, 95% CI: 1.00–6.68). There was a significant interaction of "age (70–79)*tertiary education." suggesting that participants aged between 70 and 79 years with tertiary level education had 28.41 times increased in odds of having obesity compared to those in other age groups and education level (OR: 28.41, 95% CI: 2.56–315.08).

Furthermore, participants aged between 70 and 79 years with a family history of hypertension had 0.06 times reduced odds of getting obesity compared to those whose age between 60 and 69 years without a family history of hypertension. Moreover, non-Malay participants whose incomes were \geq RM3000 per month had 6.37 higher odds of getting obesity. We also found that in females who had hypertension, there were 2.09 times increased odds of getting obesity. Whereas, participants whose income \geq RM3000 per month and also had a family history of hypertension had 3.91 times higher odds of obesity.

Then, the hypertensive participants with a family history of hypertension had 2.17 times higher odds of getting obesity. Similarly, the diabetes participants with a family history of CVD showed 7.43 times increased odds of getting obesity. Moreover, the participants who had both family histories of hypertension as well as CVD had 0.07 times reduced odds of getting obesity.

Eight interactions were significantly associated with obesity in MLogR. Multicollinearity problems by linear regression (enter method) using variance-inflation factor (VIF) was further evaluated. VIF of <10 were observed in all independent variables. Therefore,

there was no multicollinearity problem since small VIF values (VIF values less than 3) indicated low association among variables. Hosmer–Lemeshow goodness of fit showed a $\chi^2 = 1.39$ with $df = 6$ and $p = 0.966$ (not significant), indicating that the model fitted well to the logistic regression. Omnibus tests of model coefficients showed $\chi^2 = 56.48$ on $df = 16$ and $p < 0.001$. Therefore, adding variables, such as diabetes and the significant interactions (Table A5), could improve the model. In this study, 11.1% of obesity was explained by the significant independent variables stated in Table A5 based on the Cox & Snell R Square value (0.111) in MLogR.

The sensitivity of 11.4% suggested that the model can predict that if the participant was aged between 70 and 79 years old, female, non-Malay, reached a tertiary level of education, had a monthly income \geq RM3000, had diabetes and hypertension, a family history of hypertension and CVD, there was 11.4% chance of becoming obese. However, the specificity of 99.0% meant that if the participant was male, Malay, age was not within 70–79 years, with a primary or secondary level of education, monthly income $<$ RM3000, had no diabetes nor hypertension, and no family history of hypertension and CVD, there was a 99.0% chance of not becoming obese. Overall, the model predictions were correct, with an 84.6% overall success rate.

According to the receiver operating characteristic (ROC) curve, as shown in Figure 1, the model discriminated 81.2% of the predicted of having obesity. For outliers checking, Cook's influential statistics shown that none was more than 1.0 in the data set. Therefore, there were no influential outliers.

Then, the Z-equation (final model prediction), the probability of obesity can be calculated by using Z-equation, $P(\text{obesity}) = [\exp(z \text{ value})] / [1 + \exp(z \text{ value})]$.

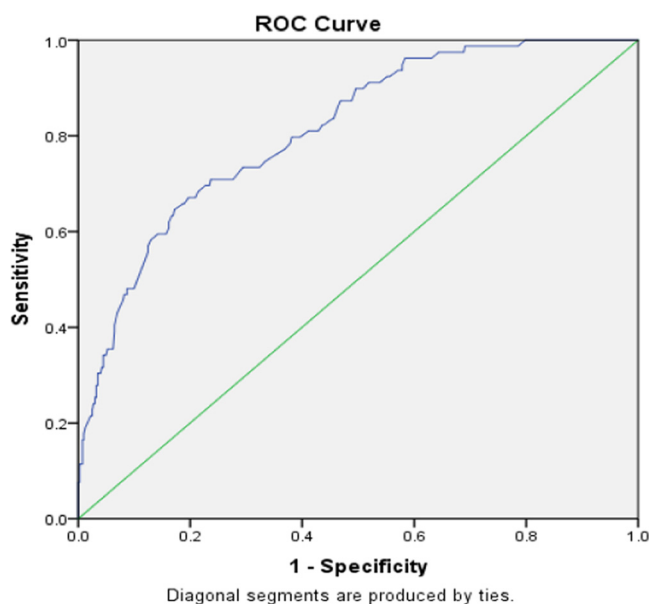


FIGURE 1 Receiver operating characteristic (ROC) curve for prediction of having obesity among participants

Equation, $Z = -2.35 + 0.95$ (Diabetes) $- 2.72$ (Family history hypertension*Family history CVD) $+ 2.01$ (DM*Family history CVD) $+ 0.78$ (Hypertension*Family history Hypertension) $- 0.94$ (DM*Hypertension) $+ 1.36$ (Family history hypertension*Income \geq RM3000 per month) $+ 1.47$ (Female*Family history CVD) $+ 0.74$ (Female*Hypertension) $+ 1.85$ (Income \geq RM3000 per month*Non-Malay) $+ 0.88$ (Age \geq 80 years*Family history hypertension) $- 2.77$ (Age 70–79 years*Family history hypertension) $- 19.59$ (Age \geq 80 years*Tertiary education) $- 18.85$ (Age \geq 80 years*Secondary education) $+ 3.35$ (Age 70–79 years*Tertiary education) $- 0.95$ (Age 70–79*Secondary education).

4 | DISCUSSION

Currently, obesity has become an important worldwide health issue,¹⁵ indicating accumulation of excessive fat in the body.¹⁵ The WHO has approved that obesity to be named as a disease by itself a few years ago, and it was also stated in the Malaysia NCD-10 survey 2015. Furthermore, the dietary structure of Malaysians had been changed recently, in that Malaysian traditional food were being replaced by high sugar, fat, salty diet, and low fiber.¹⁶

Total prevalence of obesity among older adults was 15.8% (61.1% of females; 38.9% of males) in this present study, which is comparable to the NHMS 2015 study in Malaysia, which reported 17.7% of obesity among adults age 18 years and above. In addition, the NHMS 2015 study also showed that the obesity prevalence among females (20.6%) was higher compared to males (15.0%). Furthermore, this study also showed that the obesity prevalence was highest among older adults aged 50–59 years old [22.3% (95% CI: 19.8–25.2)] and prevalence of obesity decreased with increasing age, 20.5% among 60–69 years, 17.3% among 65–69 years, 13.5% among 70–74 years, and only 6.1% among those aged 75 years and above.⁴ In Malaysia, there are multiple possible reasons of increase in prevalence of obesity among older adults compared to Japan and China.^{17,18} First, many Malaysian farmers were not aware of the risk of obesity, while some of them believed that being obese is an indication of a happy and prosperous life in the past.¹⁹ Second, the economy of Malaysia flourished that it negatively affected the level of medical services, becoming significantly lower, especially in Sabah and Sarawak.²⁰ Furthermore, this study showed that the odds of obesity gradually decreased as age increased, and it may be due to the reduction of lean body mass as individuals become older.²¹

Furthermore, obesity was also closely related to increased risk of diabetes and mortality among older adults in Malaysia (adjusted OR = 1.14; 95% CI: 1.01–1.30).⁴ Therefore, the adjusted OR 2.59 (95% CI: 1.00–6.68) for diabetes in this present study was higher than the study performed by Amiri et al.²² According to NHMS (2015), the prevalence of obesity was significantly higher in females [20.6% (95% CI: 19.5–21.8)] compared to males [15.0% (95% CI: 13.9–16.1)]. The similar trend also applies in this present study, wherein the obesity prevalence in older adults females was higher compared to males (crude OR: 1.44, 95%CI: 0.96–2.18).^{23,24}

Interestingly, a previous study had reported that non-Malays had the highest prevalence of obesity.⁴ However, this present study indicated that the risk of obesity in non-Malays was reduced by 32% compared to Malays (crude OR: 0.68, 95% CI: 0.43–1.03). Obese people usually have distribution of abnormal fat in both subcutaneous and visceral adipose tissues, which may disturb the normal insulin production in the body and lead to increased blood glucose level.^{25–27} Therefore, due to this abnormal fat distribution, the link had been proposed between obesity and its related chronic diseases such as hypertension, diabetes, and so forth.^{22,28,29}

Binary logistic regression results (Table A5) showed that obesity was significantly associated with those aged between 70 and 79 years old, female, non-Malay, with tertiary level education, monthly income \geq RM3000, has diabetes, hypertension, family history of hypertension, and a family history of CVD.^{30–32} Collectively, several studies have agreed that obesity is common especially in people with higher income status, which is probably due to higher income people usually consume more fatty and sweet diets, living sedentary lifestyles, and being too busy to cook healthy low-cholesterol meal at home.^{33–35} Moreover, the lifestyles and dietary habits of Malaysians are likely to play a role in causing obesity, especially among elderly adults.^{36,37} Although clinical preventive services and health promotion programs were implemented to identify and control hypertension, diabetes and CVD among older adult females, especially those who had tertiary level of education, a comprehensive nation-wide medical priorities on these risk factors are still have to be taken.^{13,24,26} The literatures predicted that the higher the prevalence of obesity, the greater the likelihood that a nation will encounter upward trend in non-communicable diseases, especially diabetes, CVDs, and hypertension.^{14,38,39}

5 | CONCLUSION

The prevalence of obesity among older adults in Malaysia was higher than the world prevalence in 2016. Therefore, older adults who have multiple comorbid diseases, such as hypertension and diabetes, and those who have a family history of such diseases need to practice stricter healthy lifestyle for the prevention of obesity. National healthcare providers should systematically organize health campaigns and community programs which educate people to recognize the related risk factors and promote corrective health measures.

6 | RECOMMENDATIONS

The rising surge of obesity requires not only implementation of public health policies, but also supportive environment and communities for practicing healthier lifestyle in Malaysia. Furthermore, interventions for the prevention and control of complications due to hypertension and diabetes among older adults need to be addressed. The national control programs for obesity in Malaysia, especially for older adults, are warranted to promote awareness in terms of maintaining body weight with healthy lifestyle including physical activities, and a balanced diet.

This present study only measured the prevalence of obesity and its associated factors based on secondary data of older adults (age ≥ 60 years). Hence, more future research prioritizing the young and middle-aged groups are required to allow better comparisons among age groups. By analyzing the risk factors of all age groups, only then a comprehensive obesity prevention and management strategies can be proposed.

AUTHOR CONTRIBUTIONS

Thin Mon Kyaw: Writing of original draft; review and editing. **Zaliha Ismail:** Data analysis; review and editing. **Mohamad Ikhsan Selamat:** Data analysis; review and editing. **Hapizah Nawawi:** Conceptualization; Funding acquisition; methodology; project administration; supervision; review and editing.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

TRANSPARENCY STATEMENT

The authors affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study unless we explained.

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APPENDIX A

Table A1

Behavioral and pre-existing comorbid diseases distribution profile of the participants Table A2

TABLE A1 Sociodemographic distribution of the participants

Variables	Number (n = 716)	Percentage (%)
Age (mean 66.6 ± 5.98)	-	-
Gender		
Males	333	46.5
Females	383	53.5
Race		
Malay	442	61.9
Non-Malay	272	38.1
Geography		
Urban	384	53.6
Rural	332	46.4
Income (RM/month)		
<RM3000/month	498	89.6
≥RM3000/month	58	10.4
Education		
Primary	336	54.3
Secondary	206	33.3
Tertiary	77	12.4
BMI status		
Underweight (<18.5 kg/m ²)	43	6.0
Normal (18.5–22.9 kg/m ²)	163	22.8
Overweight (23–24.9 kg/m ²)	130	18.2
Pre-obese (25–29.9 kg/m ²)	267	37.3
Obese (≥30 kg/m ²)	113	15.8

TABLE A2 Behavioral and pre-existing comorbid diseases of respondents

Variables	Number (n = 716)	Percentage (%)
Smoking status		
Yes	226	32.2
No	475	67.8
Alcohol drinking		
Yes	44	6.3
No	657	93.7

(Continues)

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TABLE A2 (Continued)

Variables	Number (n = 716)	Percentage (%)
Hypertension		
Yes	490	68.8
No	222	31.2
Diabetes mellitus		
Yes	228	33.7
No	448	66.3
Cardiovascular disease		
Yes	37	5.3
No	663	94.7
Hypertriglyceridemia		
Yes	353	51.9
No	327	48.1
Hypercholesterolemia		
Yes	476	70.0
No	204	30.0
Renal diseases		
Yes	12	1.7
No	683	98.3
Stroke		
Yes	10	1.4
No	687	98.6

TABLE A3 Respondents with family history of chronic diseases

Family history	Number (n = 716)	Percentage (%)
Hypertension		
Yes	191	29.0
No	468	71.0
Diabetes mellitus		
Yes	128	19.3
No	536	80.7
Cardiovascular disease		
Yes	70	10.6
No	593	89.4
Stroke		
Yes	53	8.0
No	613	92.0

Family history of chronic diseases distribution among participants [Table A3](#)

Factors associated with obesity among participants (Simple Logistic Regression: SLogR) [Table A4](#)

TABLE A4 Factors associated with obesity using SLogR (N = 716)

Variables	Crude OR (95% CI)	Wald(df)	p Value
Age			
60–69 years	Ref	12.46 (2)	0.002
70–79 years	0.34 (0.18–0.65)	10.73 (1)	0.001
≥80 years	0.14 (0.08–1.43)	2.17 (1)	0.140
Gender			
Males	Ref	3.07 (1)	0.080
Females	1.44 (0.96–2.18)		
Race			
Malays	Ref	3.34 (1)	0.068
Non-Malays	0.68 (0.43–1.03)		
Income (RM/month)			
<3000RM/month	Ref	7.56 (1)	0.006
≥3000RM/month	2.38 (1.29–4.40)		
Education			
Primary	Ref	5.23 (2)	0.073
Secondary	1.26 (0.78–2.03)	0.89 (1)	0.078
Tertiary	2.01 (1.10–3.68)	5.18 (1)	0.060
Geography			
Urban	Ref	1.23 (1)	0.268
Rural	0.79 (0.53–1.19)		
Smoking Status			
Yes	0.88 (0.56–1.38)	0.29 (1)	0.584
No	Ref		
Alcohol drinking			
Yes	0.86 (0.35–2.09)	0.11 (1)	0.737
No	Ref		
Hypertension			
Yes	2.47 (1.46–4.16)	11.52 (1)	0.001
No	Ref		
Diabetes mellitus			
Yes	1.93 (1.27–2.93)	9.41 (1)	0.002
No	Ref		
Continued (SLogR) variables			
Cardiovascular disease			
Yes	1.27 (0.54–2.96)	0.31 (1)	0.583
No	Ref		
Hypertriglyceridemia			
Yes	1.13 (0.75–1.71)	0.36 (1)	0.546
No	Ref		

TABLE A4 (Continued)

Continued (SLogR) variables	Crude OR (95% CI)	Wald (df)	p Value
Hypercholesterolemia			
Yes	1.05 (0.67–1.65)	0.05 (1)	0.820
No	Ref		
Stroke			
Yes	2.35 (0.59–9.23)	1.49 (1)	0.221
No	Ref		
Renal disease			
Yes	1.08 (0.23–4.98)	0.01 (1)	0.925
No	Ref		
Hypertension family history			
Yes	1.69 (1.09–2.61)	5.68 (1)	0.017
No	Ref		
Diabetes mellitus family history			
Yes	1.36 (0.83–2.24)	1.47 (1)	0.221
No	Ref		
Cardiovascular disease family history			
Yes	2.19 (1.23–3.90)	7.21 (1)	0.007
No	Ref		
Stroke family history			
Yes	0.65 (0.27–1.57)	0.89 (1)	0.344
No	Ref		

Note: Bold values significantly associated with obesity among participants whereby p value beyond 0.05.

Abbreviations: CI, confidence interval; OR, odds ratio.

TABLE A5 Multiple logistic regression (MLogR) (N = 716)

Variables	Adjusted OR (95% CI)	Wald (df)	p Value
Diabetes	2.59 (1.00–6.68)	3.87 (1)	0.049
Age(70–79) *Tertiary education	28.41 (2.56–315.08)	7.43 (1)	0.006
Age (70–79)* Family history of hypertension	0.06 (0.04–0.92)	4.10 (1)	0.043
Income ≥RM3000/month* non-Malay	6.37 (1.37–29.66)	5.05 (1)	0.018
Female*Hypertension	2.09 (1.16–3.77)	6.01 (1)	0.014

TABLE A5 (Continued)

Variables	Adjusted OR (95% CI)	Wald (df)	p Value
Family history of hypertension* Income ≥RM3000/month	3.91 (1.22–12.48)	5.29 (1)	0.021
Hypertension* Family history of hypertension	2.17 (1.10–4.27)	5.04 (1)	0.025
DM* Family history of CVD	7.43 (1.78–30.99)	7.58 (1)	0.006
Family history of hypertension* Family history of CVD	0.07 (0.01–0.43)	8.03 (1)	0.005

Note: Bold values significantly associated with obesity among participants whereby p value beyond 0.05.

Note: Hosmer–Lemeshow (χ^2 of 1.39 with 6 df, p: 0.966), Omnibus–p < 0.001, Cox & Snell R Square (0.111), Sensitivity (11.4%), Specificity (99.0%).

Abbreviations: CI, confidence interval; OR, odds ratio.

Factors associated with obesity among participants (multi-variable analysis) Table A5

APPENDIX B: MyHEBAT - CRES (MALAYSIAN HEALTh AND WELL-BEING Assessment - CORONARY RISK EPIDEMIOLOGICAL STUDY) INVESTIGATORS:

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