FACTORS ASSOCIATED WITH HYPERTENSION STAGES AMONG MALAYSIAN ADULTS:

AN ANALYSIS USING COMPLEX SAMPLE ORDINAL REGRESSION APPROACH

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INTRODUCTION

- High blood pressure is a world's classic problem and remains as a major global health burden.

- The epidemic was responsible for 7.4 million deaths due to coronary heart disease, and 6.7 million deaths due to stroke (WHO,2011;Lim et.al,2013).

- Approximately, 40% of adults age 25 and above in the world had been clinically diagnosed to have HPT (WHO,2008).

INTRODUCTION

- Indonesia (>= 40 years old) ,of the population **34%** were having pre-hypertension and **17.1%** were having hypertension (Hussainet.al ,2014) .

- Demographic factors, lifestyle preferences and existence of co-morbidities play important roles in the rising prevalence of raised blood pressure.

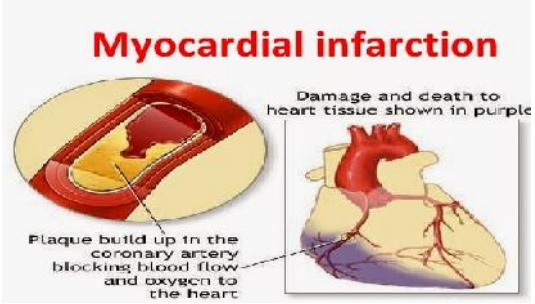
- Hypertension especially uncontrolled and untreated hypertension is associated with increased of cardiovascular disease mortality (Gu *et al*.,2010).

INTRODUCTION

- Extensive researches proved that….

Severe raised blood pressure.

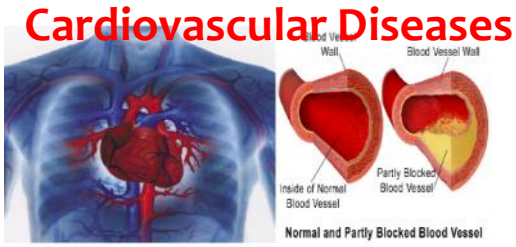
2.5 TIMES



(Yusuf et al., 2004).

Borderline raised blood pressure.

1.5 TIMES at least



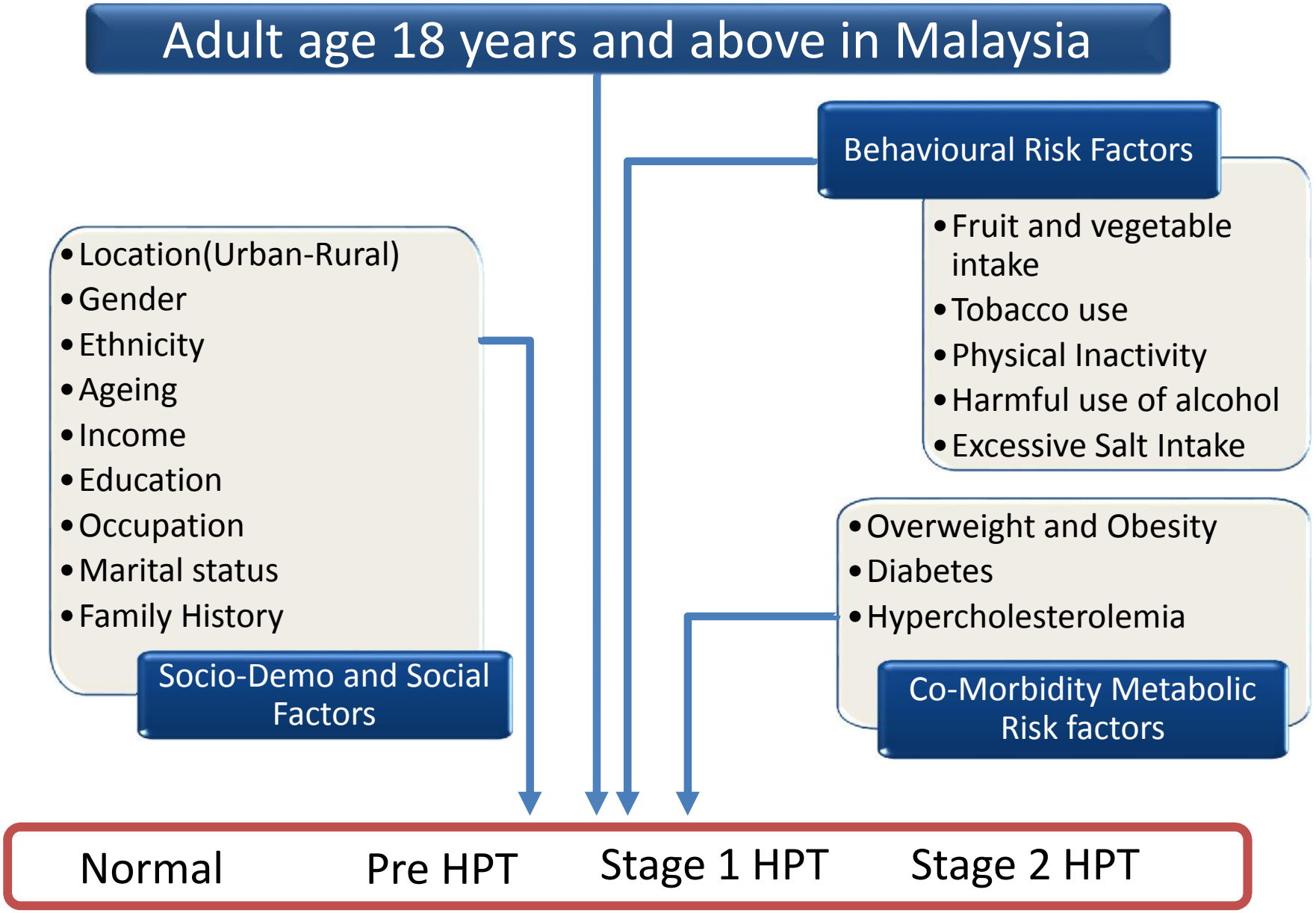
(Liszka et al., 2005; Qureshi et al., 2005; Wang et al., 2006)

OBJECTIVES

- To determine the prevalence of prehypertension, hypertension stage 1 and hypertension stage 2 among adults in Malaysia.

- To examine the factor associated with the stages of hypertension, in extension of defining the potential risk factors.

CONCEPTUAL FRAME WORK



Material & Methods

Material & Methods

- Secondary Data Analysis from National Health & Morbidity Survey 2015 (NHMS 2015)

- Target Subpopulation: Adult aged 18 years and above who consented to blood pressure measurement and not on anti hypertensive prior to the survey.

Material & Methods

Data Source

- The NHMS 2015 is a national health survey.
- Household survey
- Using the sampling frame provided by the Department of Statistics Malaysia.
- Study Design: Cross sectional
- The study was carried out from Mac-Jun 2015.

Material & Methods

- Sampling frame for the NHMS 2015: Enumeration Blocks (EBs).
- Sampling Design:

A two-stage stratified cluster sample design was used.

- The Primary sampling unit(PSU) -EBs

-Secondary Sampling unit (SSU) -Living Quarters (LQ).

-All households and persons within a selected LQ were included in the survey.

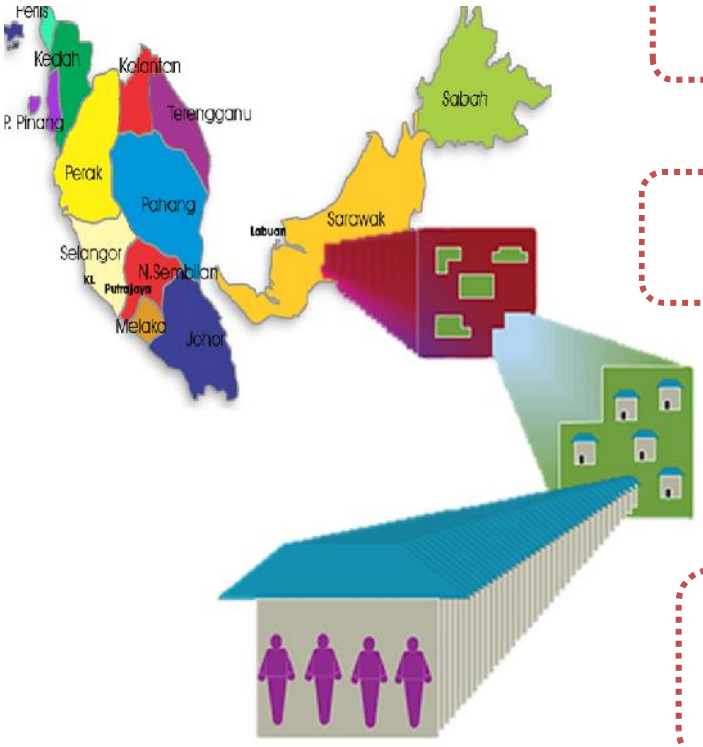
Material & Methods

- Trained research assistants conducted face-to-face interviews and self administered Q for sensitive module.

- After completing the questionnaire, trained nurses obtained biomarkers and anthropometry measurement.

NHMS 2015 OVERVIEW COMPLEX SAMPLING DESIGN

Two stage stratified cluster sampling



STRATIFICATION BY
State-Urban-Rural

30 STRATA

STAGE 1:
SELECT EB(CLUSTER)

869 EBs

=

536 EB Urban
333 EB Rural

STAGE 2:SELECT LQ
*12 LQ WITHIN EB SELECTED

- All eligible members in the Household were included in the study.

EB: Enumeration Blocks ,LQ: Living Quarters

Material & Methods

VARIABLE UNDER STUDY: DEPEDENT VARIABLE

- Blood pressure was taken with the participants seated and after 15 minutes of rest.
- Using a validated digital automatic blood pressure monitor (OMRON)(Gupreet K et al.,2008).
- 3 readings of the systolic and diastolic pressures were taken at 5 minutes apart (IPHa ,2015).

VARIABLE UNDER STUDY: INDEPEDENT VARIABLES

1.Socio-demographic Characteristics:

- Age
- Locality(urban-rural),
- Sex
- Ethnicity
- Education Attainment
- Household income group
- Marital status
- Occupation.

Education Level
- Non Formal
- Primary
- Secondary
- Tertiary
- Others

Ethnicity
- Malay
- Chinese
- Indian
- Other Bumi's
- Others

Occupation
- Government/Semi
- Private
- Self Employed
- Unpaid/Homemaker
- Retiree
- Unemployed
- Student

Marital Status
- Divorce/Divorcee/Widow/Widowed
- Never Been Married
- Married

Income Group:EPU-RMK 10
Low (<RM3860)
Middle (RM3860-RM8320)
High (>RM8321) (EPU, 2010)

VARIABLE UNDER STUDY:INDEPEDENT VARIABLES

2: Behavioural Risk Factor

Current Smoker

- Those that used any tobacco product daily or occasionally (IPHa ,2015).

Alcohol Drinker

- Current -1 standard drink in past 12 m
- Ex-not taking any drink in the past 12m
- Never-never take in whole life. (IPHa ,2015).

Inadequate Fruit and Vegetable Intake

- Fruit : < 2 serving per day.
- Vegetable:< 3 serving per day. (MOH,2013)

Physical Activity

- Physically active or not active by IPAQ definition (IPAQ ,2005).

3. Co-morbidity metabolic risk factor :

- Diabetes Mellitus -(Yes/No) by definition of blood glucose reading and diagnosed status (IPHa ,2015).
- Weight and Height for BMI calculation, than it was categorized to Underweight/Normal/Overweight/Obese)(WHO,1998)
- However, due to small percentage in underweight group, it was then combine to normal group.

- Validated PA CardioChek was used to assess blood glucose(Ani *et al.*,2012).
- FBS≥6.1mmol **OR** RBS>11.1
- **OR** previously diagnosed

Validated and calibrated weighing machines (TANITA HD-319) and Seca Body Meter 206 (Getta et *al.*,2009)

OPERATIONAL DEFINATION

- Blood pressure cut-offs proposed by JNC7 were used to define hypertension stages.
- The use of this reference was acceptable widely for the purpose of international comparison and the basis of this classification were cardiovascular disease effect by 57countries data including Singapore
- The cut off had been used in current Malaysia Hypertension CPG.

Classification	SBP		DBP
Normal	<120	and	<80
Pre HPT	120 -139	or	80-89
Stage I HPT	140-159	or	90-99
Stage 2 HPT	≥160	or	≥100

JNC7 Guideline,(Chobanian et *al*. 2003)

Data Analysis

- Survey data were analyzed using SPSS version 19.0 and Stata version 14.0.
- Complex sample descriptive analysis were used to calculate estimated prevalence of overall hypertension and prevalence of hypertension by the stages. We utilized the Taylor series linearization method for variance estimation.
- Statistical Modeling using Complex Sample Ordinal Logistic Regression was used to determine the factor associated with stages of hypertension.

Ordinal Regression Model

- Ordinal regression is the estimation of relationship between an ordinal dependent and 1 or more independent variable or covariate.
- Various types of models:
    1. Adjacent-category model
    2. Continuation-ratio model
    3. **Propotional odds model**
    4. Unconstrained Partial proportional odds model
    5. Stereotype logistic model

Most commonly used models

Ordinal Regression Model (Proportional odds Logits Model)

- For an ordinal variable with *K* categories, *K* - 1 cumulative logit functions are defined.
- Model predicts *cumulative logits* across K-1 response option categories.
- Each cumulative logit function includes a unique intercept or "cut point," τ_k, but all share a **common set** of regression parameters for the *p* predictors.
- The inference is more on direction of response rather than on specific category
- It gives the log odds of no more severe outcome versus more severe outcome.

PROPERTIES OF COMPLEX SAMPLE

In CS ordinal Regression the model parameter estimates was obtained using Pseudo Maximum Likehood estimation (PLME) and using Maximum Likehood (MLE) was no longer possible for several reason:

1. The probabilities of selection of sample observation were no longer equal, thus sampling weight were required to estimates population value of ordinal logistic regression
2. The stratification and clustering of survey data observation violated the assumption of independence of observation that important to MLE to estimate the sampling variance
3. PLME taking complex design features into account (cluster & strata) in estimating variance-covariance parameter estimate
4. MV Taylor Series Linearization was used to estimate the precision for the survey data (sandwich type estimator)
5. Fixed degree of Freedom Rules(df=total cluster-strata)

(Heeringa et al.,2010)

Differences Between Complex Sample and Standard Regression

Standard Regression

- Based on random sampling selection at 1 stage selection
- Equal probabilities of selection
- Maximum Likehood Ratio(MLE)
- df=based on chi square distribution (C-1)X(R-1)

Complex Sample Regression

- Based on more than 2 stages sampling selection (Involving stratification and/or clustering)
- Unequal Probabilities of selection
- Pseudo-Maximum Likehood Ratio(PLME)
- Taylor Series of Linearization adjustment for the precision
- Fixed df=cluster-strata

Proportional Odds Logit Models (a.k.a. Cumulative Logit Models)

The expression in term of ordinal response probability

$$\text{logit}[P(y \le k) \mid \boldsymbol{x}] = \ln\left[\frac{P(y \le k) \mid \boldsymbol{x}}{P(y > k \mid \boldsymbol{x})}\right]$$

$$= \ln\left[\frac{P(y = 1 \mid \boldsymbol{x}) + \ldots + P(y = k \mid \boldsymbol{x})}{P(y = k+1 \mid \boldsymbol{x}) + \ldots + P(y = K \mid \boldsymbol{x})}\right]$$

$$= B_k - (B_1 x_1 + B_2 x_2 + \ldots + B_p x_p)$$

Logit Probability Transform: Cumulative and Category-specific

The expression in term of ordinal response modeling (y)

$$\hat{\pi}(y \le k \mid \boldsymbol{x}) = \frac{\exp(\boldsymbol{x}\hat{\boldsymbol{B}})}{1+\exp(\boldsymbol{x}\hat{\boldsymbol{B}})} = \frac{\exp[\hat{B}_k - (\hat{B}_1 x_1 + \hat{B}_1 x_2 + \ldots + \hat{B}_p x_p)]}{1+\exp[\hat{B}_k - (\hat{B}_1 x_1 + \hat{B}_1 x_2 + \ldots + \hat{B}_p x_p)]}$$

$$\hat{P}_k(\boldsymbol{x}) = \hat{\pi}(y \le k \mid \boldsymbol{x}) - \hat{\pi}(y \le k-1 \mid \boldsymbol{x})$$

where :

$\hat{\pi}(y \le 0 \mid \boldsymbol{x}) = 0.$

Data Analysis- Cs Ordinal Logistic Regression

- 1, complex sample (CS) simple ordinal logistic regression was used to test for all variables independently.
- 2, all predictors and variables of interests that have the $p<0.25$ in Rao-Scott test were included in the initial multivariate ordinal logistic regression model.
- 3, a CS multiple ordinal logistic regression model was used to examine the effects of socio-demographics factors ,behavioral factors and co-morbidities factor.
- 4, Preliminary assessment for the selected model was done with the evaluation of the fitted model including adjusted Wald Tests to test the contribution of individual model parameters.

Data Analysis- Cs Ordinal Logistic Regression

- **5**, all continuous independent variables were evaluated to ensure they truly linear in each separate binary logit using **weighted fractional polynomial method** and **weighted design variable method**.

- **6.I****nteraction** testing was assessed to ensure whether any interactions were scientifically relevant among the predictors . (effect may arise because 2 IDV simultaneously affect the outcome variable.

- **7.Multicolinearity** were check to detect if there any high correlated variable using collinearity diagnostic test.

Data Analysis- Cs Ordinal Logistic Regression

- 7, The assumption of proportional odd was checked using **Generalized Ordered regression** to verify if the model adequately capture the trend across the categories.
- 8,The overall fitness of the model was check using **Archer and Lemeshow Goodness of Fit (AL Test)** and **weighted under ROC curve analysis.**
- 9,In order to identify poorly fit and influential covariate patterns, 3 measurement were used in the analyses.

I. **Hosmer and Lemeshow Delta chi-square statistics>4**
II. **Hosmer and Lemeshow Delta D influence statistics>4**
III. **Pregibon Delta-Beta influence statistics>1**

Data Analysis- Cs Ordinal Logistic Regression

- **13,**Remedial measures and Model Comparison was done in consideration of choosing the best and stable model
- **14,**The Remedial was checked using percent changes in beta coefficient , If more than 20% the parameter need to be evaluate back and the outliers need to be investigate.

The formula for calculating the percent changes is as below,

- $$\frac{|\beta(without\ outlier)-\beta(with\ outlier)|}{\beta(with\ outlier)} \times 100$$

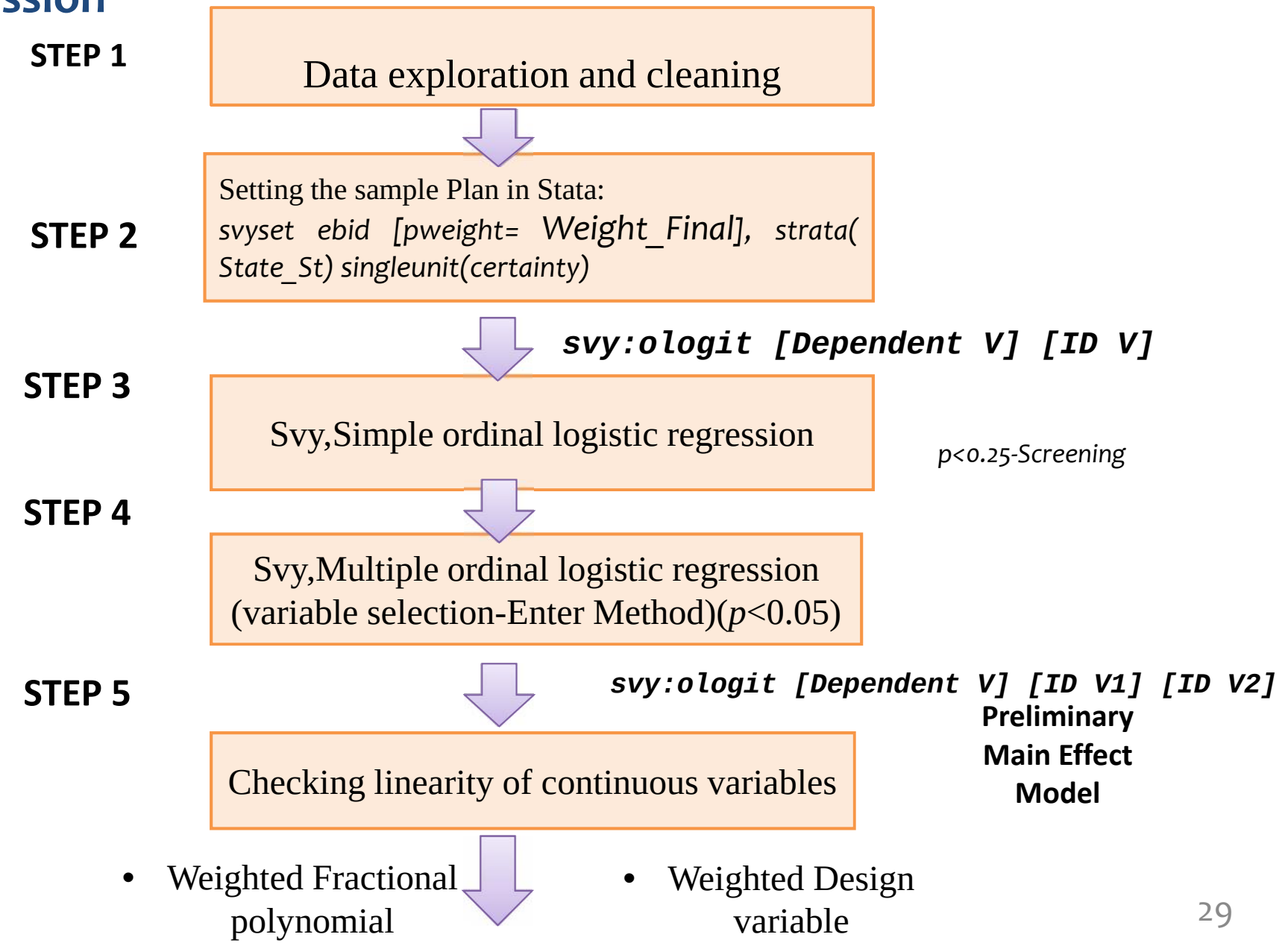
Data Analysis- Cs Ordinal Logistic Regression

- **15,**Model comparison (deleted outlier model vs non deleted outlier model) was done by using AL test, **Pseudo R , Weighted ROC** and **Weighted Classification table** to see which model can predict better.
- **16,** The best model was selected.

- The finding presented as crude and adjusted cumulative odd ratio with 95% confidence interval.

- All analyses were done using complex sampling design to ensure that sample weight and study design were accounted.

Flowchart of Statistical Analysis using CS Ordinal Logistic Regression



STEP 6

Checking multicollinearity and possible interactions

Preliminary Final Model

STEP 7

Checking proportional odds assumption

Proportional Odds Assumption

- Parallel regression line

gologit2[Dependent Variable] [IDVi]…[IDk],svy autotfit

STEP 8

Checking overall fitness of the model

- Archer-Lemeshow test
- Weighted Classification table
- Weighted Area under ROC curve

Regression diagnostic for outliers and influential

STEP 9

- Estimated logistic probability
- Pregibon Delta-Beta influence statistics (db)
- Delta-D influence statistics (dd)
- Covariate patterns
- Leverage
- Delta chi-squared influence statistics (dx2)

Using standard regression.

Remedial measures & Model Comparison

STEP 10

- Archer Lemeshow Test
- Weighted Classification Table
- Weighted ROC
- Percent changes in regression coefficient ≥ 20%
- Pseudo R

Refit in Complex sample regression model.

STEP 11

Data presentation, interpretation and conclusion

Final Model

ETHICAL APPROVAL

1.Human Research Ethics Committee of the School of Medical Sciences, Universiti Sains Malaysia (JEPeM Code USM/JEPeM/170904097): 9th January 2018

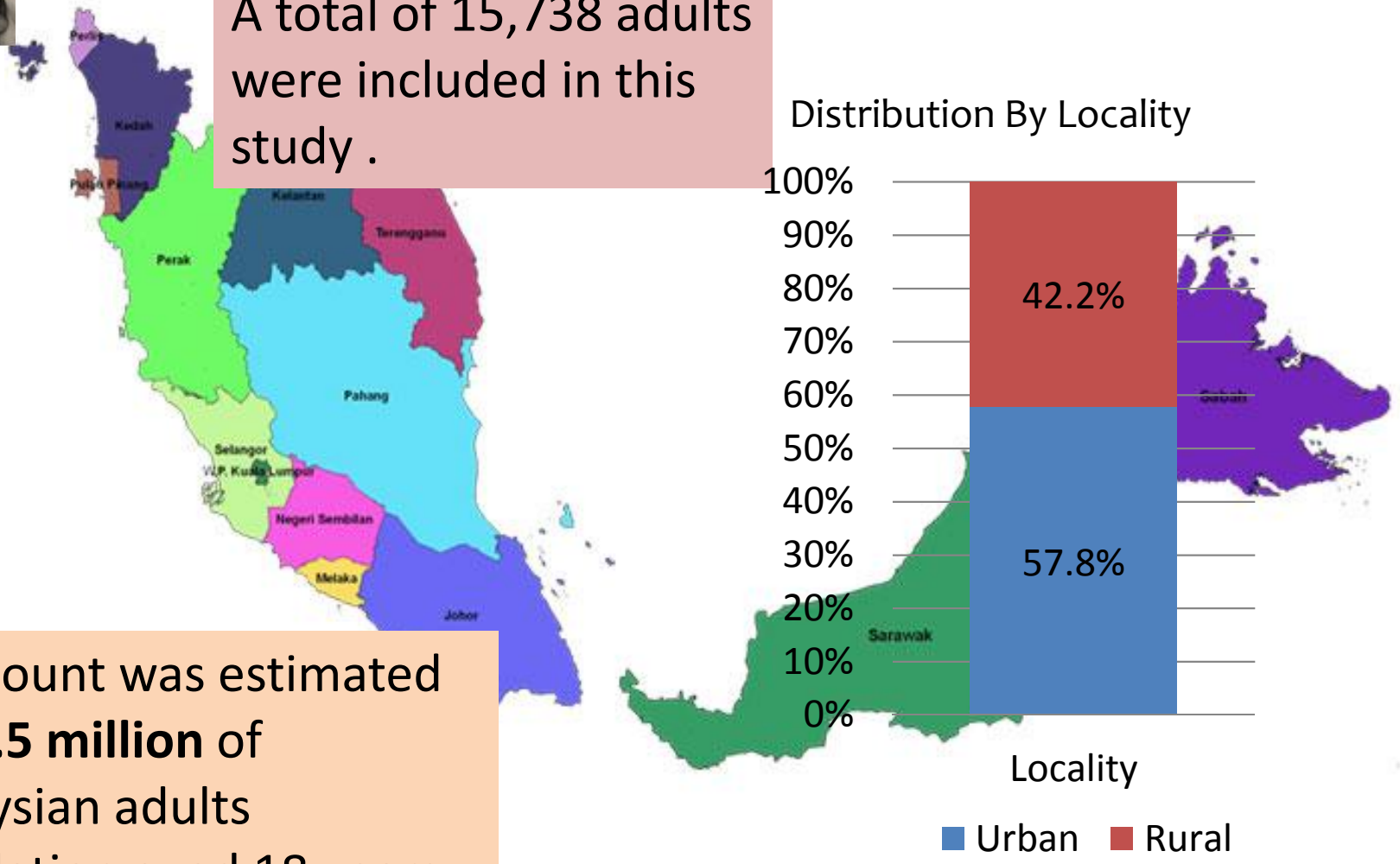
2.Medical Research and Ethics Committee of the Ministry of Health Malaysia (NMMR-17-1989-37492).

All accessed data were fully anonymized after permission was obtained to use the NHMS 2015 dataset from the Director General of Health Malaysia on October 2, 2017.

RESULTS

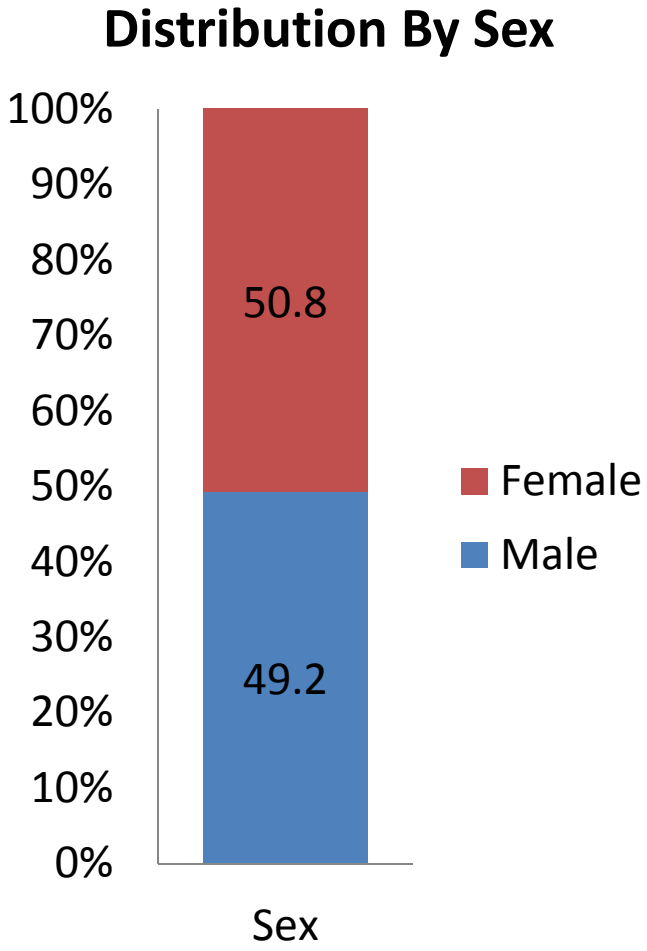
Socio-demographic Profiles

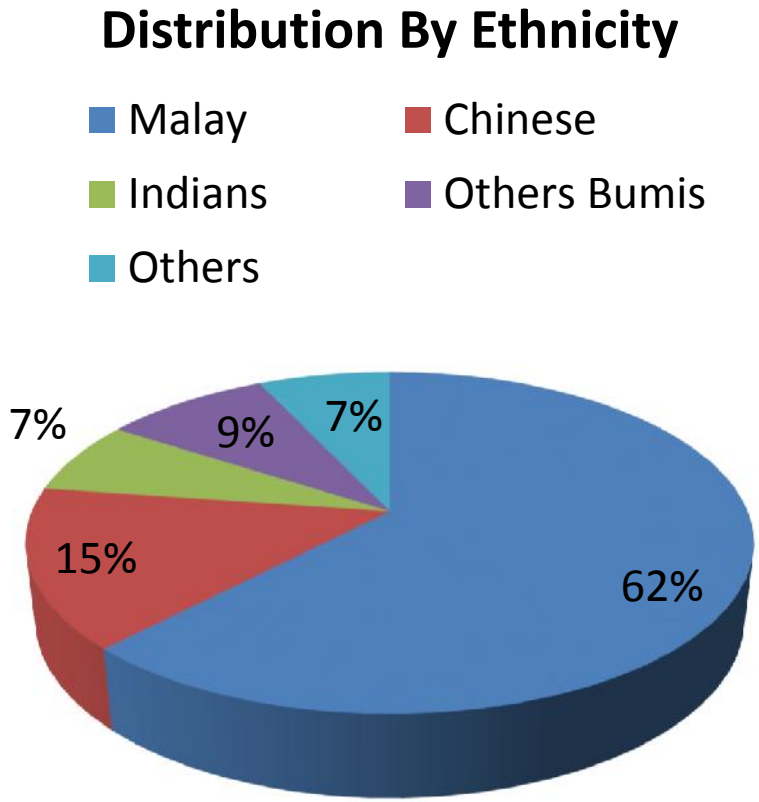
A total of 15,738 adults were included in this study .



This count was estimated to **16.5 million** of Malaysian adults population aged 18 years and above

Socio-demographic Profiles





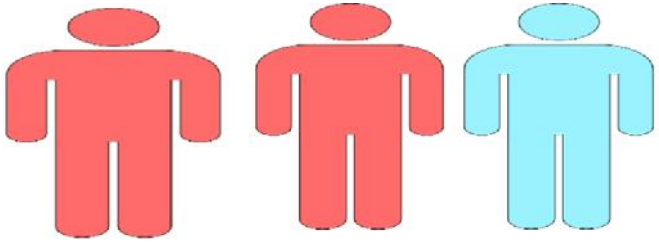
Prevalence of Hypertension

Prevalence of Hypertension Status By Stages Among Malaysian Adults

HPT Stages	Unweighted Count (n)	Estimated Population[a]	Prevalence (%)	95% CI
Normal/Optimal	4576	5,461,046	33.2	32.99, 34.37
Pre HPT	7201	7,544,066	45.8	44.66, 47.97
Stage 1 HPT	2780	2,488,542	15.1	14.34, 15.92
Stage 2 HPT	1181	972,702	5.9	5.44, 6.41

66.8%

[a] the calculation for prevalence in complex sample analysis were based on estimated population (estimated population that affected/total estimated population)



2 out of 3 of the population surveyed were having raised blood pressure (including Pre HPT)

Complex Sample Simple Ordinal Regression

Factor Associated with Hypertension Stages by CS Simple Ordinal Logistic Regression (Socio-Demographic)

Variables	Crude b (SE) [a]	Crude OR (95% CI)	Wald Statistic	*p* value
Age (year) [b]	0.05 (0.001)	1.05 (1.04, 1.05)	34.26	<0.001
Locality[b]				
Urban	0	1		
Rural	0.28 (0.04)	1.32 (1,20, 1.45)	5.82	<0.001
Gender[b]				
Male	0.53 (0.03)	1.69 (1.57, 1.83)	13.27	<0.001
Female	0	1		
Ethnicity[b]				**0.033**
Malay	0.18 (0.06)	1.20 (1.06, 1.36)	2.58	0.004
Chinese	0	1		
Indian	0.061 (0.09)	1.06 (0.88, 1.27)	0.66	0.507
Other Bumis	0.10 (0.09)	1.01 (0.91, 1.33)	1.05	0.294
Others	0.05 (0.08)	1.05 (0.88, 1.24)	0.60	0.548
Education[b]				**<0.001**
Non-formal	1.19 (0.11)	3.29 (2.68, 4.05)	11.34	<0.001
Primary	0.94 (0.65)	2.57 (2.26, 2.92)	14.46	<0.001
Secondary	0.23 (0.53)	1.25 (1.13, 1.39)	4.30	<0.001
Tertiary	0	1		
Others	0.24 (0.168)	1.27 (0.91, 1.77)	1.47	0.143
Marital Status[b]				**<0.001**
Never Married	0	1		
Married	0.65 (0.05)	1.92 (1.74, 2.12)	13.06	<0.001
Widow/Widower/	1.34 (0.09)	3.84 (3.19, 4.61)	14.41	<0.001
Income Group[b]				**<0.001**
Low	0.37 (0.06)	1.45 (1.26, 1.67)	5.37	<0.001
Middle	0.067 (0.07)	1.070 (0.92, 1.23)	0.93	0.354
High	0	1		
Occupation[b]				**<0.001**
Government/Semi	0	1		
Private Sector	-0.19 (0.07)	0.82 (0.71, 0.95)	-2.73	0.007
Self Employed	0.28 (0.07)	1.33 (1.12, 1.53)	3.87	<0.001
Unpaid/Homemaker	-0.46 (0.08)	0.954 (0.81,1.12)	-0.55	0.580
Retiree	1.15 (0.12)	3.16 (2.49, 4.01)	9.54	<0.001
Unemployed	0.40 (0.09)	1.50 (1.25, 1.80)	4.39	<0.001
Student	-0.94 (0.11)	0.38 (0.31, 0.487)	-8.24	<0.001

All socio-demographic variables were included as candidates for preliminary main effect model, p<0.25

Complex Sample Simple Ordinal Regression

Table 5.4: Factor Associated with Hypertension Stages by CS Simple Ordinal Logistic Regression (Behavioural & Co-Morbidities)

Variables	Crude b (SE) [a]	Crude OR (95% CI)	Wald Statistic	*p* value
Current Smoker[b]				
No	0	1		
Yes	-0.11 (0.44)	0.90 (0.83, 0.98)	-2.38	0.017
Alcohol Drinker				**0.331**
Non Drinker	0	1		
Ex Drinker	-0.13 (0.22)	0.87 (0.56, 0.75)	-0.61	0.541
Current Drinker	-0.12 (0.84)	0.88(0.75, 1.04)	-1,40	0.161
Fruit Intake				
Adequate	0	1		
Inadequate	-0.23 (0.06)	0.97 (0.85, 1.11)	-0.36	0.721
Vegetable Intake				
Adequate	0	1		
Inadequate	-0.004 (0.06)	0.99 (0.87, 1.13)	-0.08	0.939
Physical Activity[b]				
Active	0	1		
Inactive	-0.10 (0.49)	0.90 (0.82, 0.98)	-2.30	0.022
Diabetes Mellitus[b]				
No	0	1		
Yes	0.69 (0.06)	1.99 (1.80, 2.22)	12.31	<0.001
BMI Status[b]				**<0.001**
Normal/Underweight	0	1		
Overweight	0.82 (0.04)	2.29 (2.08, 2.51)	17.59	<0.001
Obese	1.38 (0.06)	3.97 (3.54, 4.47)	23.29	<0.001

[a] Regression coefficient (standard error)
[b] Variables with p-value less than 0.25
[c] Analysis performed using complex sample ordinal regression univariate analysis

Alcohol drinker, Fruit intake and Vegetable intake variables were not included as candidates for preliminary main effect model, p>0.25.

Establishing Final Model

Factor Associated with Hypertension Stages Among Malaysian Adults (df = 839, cluster = 869, strata = 30)

Variables	CS Full Model of Multiple Ordinal Logistic Regression			
	b (SE)	Adjusted OR (95 % CI)	Adjusted Wald Statistics	p-value
Age Group				
18-29 years		1		
30-39 years	0.52 (0.07)	1.68 (1.47, 1.93)	7.5	<0.001
40-49 years	1.07 (0.07)	2.92 (2.53, 3.36)	14.88	<0.001
50-59 years	1.54 (0.08)	4.67 (3.97, 5.49)	18.68	<0.001
≥60 years	2.09 (0.10)	8.09 (6.70, 9.76)	21.84	<0.001
Locality				
Urban		1		
Rural	0.14 (0.06)	1.15 (1.02, 1.28)	2.39	0.017
Gender				
Male	0.77 (0.05)	2.15 (1.95, 2.38)	15.05	<0.001
Female		1		
Ethnicity				
Malay	0.21 (0.07)	1.23 (1.07, 1.41)	3	0.003
Chinese		1		
Indian	-0.08 (0.10)	0.92 (0.76, 1.12)	-0.85	0.396
Other Bumis	0.10 (0.11)	1.10 (0.89, 1.36)	0.88	0.377
Others	0.21 (0.11)	1.24 (1.01, 1.53)	2	0.046

Final Model

Factor Associated with Hypertension Stages Among Malaysian Adults (df = 839, cluster = 869, strata = 30)

Education Attainment				
Non-formal	0.55 (0.12)	1.73 (1.37, 2.20)	4.54	<0.001
Primary	0.34 (0.08)	1.41 (1.21, 1.64)	4.5	<0.001
Secondary	-0.01 (0.06)	0.99 (0.88, 1.11)	-0.23	0.819
Tertiary		1		
Others	0.06 (0.20)	1.06 (0.72, 1.56)	0.31	0.754
Marital Status				
Never Married		1		
Married	-0.15 (0.06)	0.86 (0.77, 0.98)	-2.36	0.018
Widow/Widower/	0.11 (0.11)	1.11 (0.90, 1.37)	1.03	0.316
Income				
Low	0.27 (0.08)	1.31 (1.12, 1.53)	3.45	0.001
Middle	0.08 (0.08)	1.08 (0.92, 1.27)	0.99	0.322
High		1		
Diabetes Mellitus				
Yes	0.21 (0.06)	1.24 (1.10, 1.39)	3.6	<0.001
No		1		
BMI Status				
Normal		1		
Overweight	0.72 (0.05)	2.06 (1.88, 2.26)	15.19	<0.001
Obesity	1.52 (0.07)	4.58(4.03, 5.21)	23.19	<0.001

Summary in Establishing Final Model

Factor Associated with Hypertension Stages Among Malaysian Adults (df = 839, cluster = 869, strata = 30)

1.The Complex Sample Enter method was used for variable selection.

2.Occupation, smoking and physical activity variable were drop during enter selection method.

3. Age was found not linear thus it was categorized to 5 group according to previous LR.

4.Multicollinearity and interaction were unlikely.

5.The assumption of proportional odd was met: model adequately captures trends across the category and share a common b coefficients.

6.Overall fit of the model for each binary logit was checked accordingly: correctly weighted classified table (first binary models, 68%; second binary model,79%; third binary model, 89%),Weighted Area under ROC curve (first binary models, 0.72; second binary model, 0.84; third binary model, 0.72).

7.Models were considered fit based on the classification table and area under the curve.

8.A regression diagnostic was performed, model comparison was done and no influential outliers affected the overall model. Hence, no observations were removed from the model.

CS ORDINAL REGRESSION RESULT

1 Advanced age were likely to have more severe hypertension up to **8** times

2 Rural folks had **15%** more chance to develop more severe hypertension

3 Male had more than **2 times** greater chance in having more severe hypertension

4 Malays: **23%** more chance in developing more severe hypertension compared to Chinese

.

5 Those from lower socioeconomic status **were more prone** in having more severe hypertension compared to higher socioeconomic status.

6 Those who were married were **14%** lower chance in having more severe hypertension

7 Those with DM had **24 %** increasing the chance in having more severe HPT

8 Those who have overweight were **2 times** and obese were more that **4 times** in having more severe Hpt as compare to those who were normal.

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DISCUSSIONS

1 The burden of high blood pressure in Malaysia is in a worrisome state.

2 2 out of 3 adults in Malaysia are in prehypertensive or hypertensive condition.

3 Clearly shown that same pattern had occurred in rapidly worldwide.

4 Previous study showed that rural residents had 5 times higher odds of having uncontrolled hypertension and a 70% lower likelihood of having been treated for hypertension possibly due to less access to healthcare facilities (Wang et al., 2013; Ho et al., 2014, (Hussain et al., 2016).).

5 Excessive sodium intake leads to uncontrolled blood pressure among adults. A cross-sectional study performed by Rashidah A et al involving 471 respondents (>90% of Malay ethnicity) showed that the mean sodium intake of both male and female subjects exceeded the recommended amount by at least **70%** (PS et al., 2014). .

6 According to WHO, those with lower socio-economic status have a higher risk of developing mental health problems such as stress and depression, which could lead to high blood pressure (WHO,2011)

7 In addition, the Malaysian Adults Nutrition Survey in 2014 found that those with lower socio-economic status were more prone to eat at food stalls, which are comparatively cheaper and well known for foods with higher salt content (IPH,2014).

8 Interestingly, our findings showed that those who were married had 14% lower odds of more severe hypertension. According to the NHMS 2015 main report, individuals who had never married had a higher prevalence of mental illness (depression, anxiety, and stress) compared to those who were married, which could increase their blood pressure (IPH, 2015b). .

10 Those with DM had **2-fold higher chance** in having evaluated blood pressure (Wang et al., 2006) and possibly due to higher macro albuminuria and microalbuminuria in DM patients & microvascular damage due to chronic hyperglycaemia (Awoke et al. al 2017 ;Wenyu et.al 2006)

11 Being overweight and obese emerged as having the most impact and correlated to more severe hypertension. A study in South Africa reported that those who were overweight had more than **twice** the likelihood of having **Stage 1 hypertension** and more than **3** times higher chance of having **Stage 2 hypertension** (Gebreselassie and Padyab, 2015)

12 According to Sjostrom. A maintained weight loss for 2 years will reduce incidence of HPT by 62% (Sjöström et al., 1999).

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CONCLUSIONS

Conclusion

- Alarming situation of the chronic prevalence of raised blood pressure.
- High prevalence of pre-HPT gives a clear vision of the future incurable burden of disease.
- Multiple ordinal regression analysis revealed that increasing age, residing in the rural, male, Malay ethnic, lower socio-economic status, never been married, having Diabetes Mellitus and having excessive weight were more likely in having more severe hypertension.

CONCLUSION & RECOMMENDATION

Recommendation

- Intervention should start at pre-HPT level and younger age.
- Physical activity and weight loss intervention program should be implemented in community setting.
- In terms of study design, prospective cohort need to be conducted in order to establish the causal effects
- More variables included such as sodium intake, genetic history, blood sample and urine sample.

Limitations

- This study was a cross-sectional study; therefore, causal and effect relationships could not be measured directly.
- Genetic factors, family history, dietary factors (sodium intake), and clinical parameters such as blood and urine samples was not considered in this study, resulting in an inability to examine the possible associations with the risk of having hypertension.

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Thank You