RISK FACTORS OF NON-COMMUNICABLE DISEASES IN MALAYSIA

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RISK FACTORS OF NON-COMMUNICABLE DISEASES IN MALAYSIA

ABSTRACT

The invasion of urbanization and western lifestyle have led to an increasing trend of Non-Communicable Diseases (NCDs) in Malaysia. Therefore, it is essential to tackle modifiable risk factors of NCDs based on NCD non-modifiable risk factors from different cultural backgrounds and to provide insight for policy makers to develop the most cost-effective strategies for the prevention and control programs of NCDs in Malaysia. This study is targeted to explore the (i) modifiable risk factors of NCDs, (ii) non-modifiable risk factors of NCDs by examining the odds of the risk factors and finally, (iii) to examine the odds of modifiable and non-modifiable risk factors on different outcome levels of NCDs in Malaysia. A nationwide representative secondary data consisting of 28,498 respondents has been used. Odds ratio with 95% confidence interval has been estimated using multinomial logistic regression. The main findings suggest that, obese, overweight and physically inactive respondents increase the likelihood of having all outcome levels of Diabetes Mellitus: Impaired Fasting Glucose (IFG), Newly Diagnosed and Known Diabetes Mellitus (DM). Inadequate fruit and vegetables consumption respondents are more likely to be diagnosed as Newly Diagnosed Diabetes Mellitus patients. However, higher chance of being exposed to Known DM has been observed among ex-smokers. Lower educated group, higher income earners, Indians and retirees are found more likely to be diagnosed as Newly Diagnosed and Known DM patients. Likewise, home makers reveal higher likelihood of having Known DM. Obese and overweight respondents exhibit increased likelihood of having all outcome levels of Hypertension: Newly Diagnosed and Known Hypertension. Physically inactive, ex-smokers and unclassified drinkers are found more likely to be diagnosed as Known Hypertensive patients. However, current drinkers are found to have higher likelihood of Newly Diagnosed Hypertension. With regard to non-modifiable risk factors, elderly, retirees, home makers and lower educated respondents have been identified as more likely to be diagnosed as new hypertension patients. Likewise, the likelihood of having Known Hypertension also has been found to increase significantly among the elderly and other Bumiputra. Physically inactive, current drinkers, unclassified drinkers, ex-drinkers and inadequate fruit and vegetables consumption respondents are found more likely to be diagnosed to have Known Hypercholesterolemia. On the other hand, current smokers, obese and overweight respondents reveal higher likelihood of having Newly Diagnosed Hypercholesterolemia. Among the non-modifiable risk factors, the results of this study exhibit that Indians, lower educated group and retirees show higher likelihood of having Known Hypercholesterolemia. Widows/widowers/divorced respondents and home makers are more likely to be diagnosed as Newly Diagnosed Hypercholesterolemia patients. However, females and higher income earners reveal higher likelihood of having Newly Diagnosed and Known Hypercholesterolemia. The occurrence of different outcome levels of NCDs among the elderly and retirees as well as lower educated group would undeniably create deadweight loss and reduce welfare, utility and their quality of life. This would eventually increase the burden on healthcare cost for Malaysians in the future. Hence, these findings serve as a good benchmark for the Government to allocate resources more efficiently especially to elderly and retirees in Malaysia.

Keywords: Diabetes Mellitus, Hypertension, Hypercholesterolemia, modifiable risk factors, non-modifiable risk factors.

FAKTOR-FAKTOR RISIKO UNTUK PENYAKIT TIDAK BERJANGKIT DI MALAYSIA

ABSTRAK

Penerajuan urbanisasi dan gaya hidup barat telah membawa Malaysia mengalami trend penyakit tidak berjangkit yang semakin meningkat. Oleh itu, adalah penting untuk mengatasi masalah faktor-faktor risiko penyakit tidak berjankit yang boleh diubahsuai berdasarkan faktor risiko penyakit tidak berjangkit (tidak dapat diubahsuai) iaitu latar belakang budaya yang berlainan dan memberi garis panduan kepada para pembuat dasar untuk menyediakan strategi yang kos efektif supaya melancarkan program pencegahan dan kawalan penyakit tidak berjangkit di Malaysia. Kajian ini bertujuan untuk menerokai (i) faktor-faktor risiko yang boleh diubahsuai untuk penyakit tidak berjangkit, (ii) faktor-faktor risiko penyakit tidak berjangkit (tidak dapat diubahsuai) dan (iii) untuk mengkaji kemungkinan faktor-faktor risiko yang boleh diubahsuai dan tidak boleh diubahsuai pada tahap penyakit tidak berjangkit yang berbeza di Malaysia.

Data sekunder yang terdiri daripada 28,498 responden telah digunakan. Regresi logistik multinomial telah digunakan dengan anggaran kadar berselang keyakinan 95%. Penemuan yang utama telah mencadangkan responden gemuk, berlebihan berat serta tidak aktif menunjukkan kemugkinan yang lebih tinggi menghidapi semua tahap hasil kencing manis iaitu pra-kencing manis serta jenis kencing manis (diagnosis baru dan dikenalpasti). Pengguna buah-buahan dan sayur-sayuran (tidak cukup) lebih cenderung didiagnosis sebagai pesakit kencing manis (diagnosis baru). Walaubagaimanapun, bekas perokok mendedahkan lebih kemungkinan menghidapi kencing manis (dikenalpasti). Berpendidikan rendah, berpendapatan tinggi, kaum India, dan pesara lebih cenderung menghidapi kencing manis (diagnosis baru dan dikenalpaspti). Malah, suri rumah tangga mendedahkan lebih kemungkinan menghidapi kencing manis (dikenalipasti). Responden gemuk, berlebihan berat dan peminum semasa lebih cenderung menghidapi

hipertensi (diagnosis baru) dan hipertensi (dikenalpasti). Responden tidak aktif, bekas perokok dan peminum (tiada klasifikasi) didapati lebih cenderung didiagnosis sebagai pesakit hipertensi (dikenalpasti). Tetapi, peminum semasa didapati lebih berkemungkinan menghidapi hipertensi (diagnosis baru). Faktor-faktor risiko (tidak dapat diubahsuai) seperti warga tua, pesara, suri rumah tangga dan berpendidikan rendah telah didapti lebih mungkin didiagnosis sebagai pesakit hipertensi (diagnosis baru). Seterusnya, kemungkinan menghidapi hipertensi (dikenalpasti) didapati lebih meningkat di kalangan warga tua dan Bumiputra lain. Responden tidak aktif, peminum semasa, peminum (tiada klasifikasi), bekas peminum dan pengguna buah-buahan dan sayur-sayuran (tidak mencukupi) didapati lebih cenderung menghidapi kolesterol tinggi (dikenalpasti). Walaubagaimanapun, perokok semasa, responden gemuk dan berlebihan berat lebih mugkin menghidapi kolesterol tinggi (diagnosis baru). Didapati kaum India, berpendidikan rendah dan pesara mempunyai lebih kemungkinan menghidapi kolesterol tinggi (dikenalpasti). Balu/bercerai dan suri rumah tangga akan lebih cenderung didiagnosis sebagai pesakit-pesakit kolesterol tinggi (diagnosis baru). Walaubagaimanapun, wanita dan berpendapatan tinggi lebih mungkin menghidapi kolesterol tinggi (diagnosis baru dan dikenalpasti). Kemunculan pelbagai jenis tahap penyakit tidak berjankit di kalangan warga tua dan pesara serta berpendidikan rendah telah mencetuskan 'deadweight loss' dan mengurangkan kebajikan dan utiliti serta kualiti hidup di kalangan mereka. Ini pasti akan meningkatkan beban kos kesihatan untuk rakyat Malaysia kelak. Maka, penemuan kajian ini merupakan penanda aras yang bagus bagi kerajaan untuk memperuntukkan sumber yang lebih cekap terutamanya untuk warga tua dan pesara di Malaysia.

Kata kunci: Kencing manis, hipertensi, hypercholesterolemia, faktor-faktor boleh diubahsuai, faktor-faktor tidak boleh diubahsuai**.**

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LIST OF SYMBOLS AND ABBREVIATIONS

BMI	:	Body Mass Index
BP	:	Blood Pressure
CI	:	Confidence Interval
CVD	:	Cardiovascular Diseases
DM	:	Diabetes Mellitus
EBs	:	Enumeration blocks
GDP	:	Gross Domestic Products
HC	:	Hypercholesterolemia
HDL	:	High-density lipoprotein cholesterol
HIV	:	Human Immunodeficiency Virus
HP	:	Hypertension
IFG	:	Impaired Fasting Glucose
IGT	:	Impaired Glucose Tolerance
MI	:	Multiple Imputation
MLE	:	Maximum Likelihood Estimation
MLR	:	Multinomial Logistic Regression
MRFs	:	Modifiable Risk factors
MSE	:	Mean Square Error
NCDs	:	Non-Communicable Diseases
NHMS III	:	The Third National Health and Morbidity Survey
NHMS IV	:	The Fourth National Health and Morbidity Survey
OR	:	Odds Ratio
SPSS	:	The Statistical Package for the Social Sciences
UN	:	United Nations
VIF	:	Variance Inflation Factor
WHO	:	World Health Organisation

CHAPTER 1: INTRODUCTION

1.1 Introduction

The World Health Organisation has defined health as a circumstance of full physical, mental and social welfare and not only just the absence of disease (WHO & Organization, 2003). The United Nations (UN) Sustainable Development Goals: comprises of seventeen goals and the third goal states that: "Good Health and Well-being" is directly related to health and indicates that it is a fundamental element and an important contributor to productivity. In consequence, it creates a civil society, social and cultural growth to generate economic growth and sustainability for the overall development of the nation. Therefore, a healthy nation is an important foundation of a country to generate income and higher level of Gross Domestic Product (GDP). Likewise, it has been identified that health status plays a significant role in the productivity of individuals which leads to the improvement and progress of a society (Atun, Weil, Eang, & Mwakyusa, 2010).

However, diseases could reduce productivity and Gross Domestic Product (GDP) of a country and ultimately cause an economic contraction (Burton, Conti, Chen, Schultz, & Edington, 1999; Peto, Jenkinson, Fitzpatrick, & Greenhall, 1995). There are two types of diseases, communicable and non-communicable diseases (Organization, 2008). The examples of communicable diseases are Malaria, Tuberculosis, Human Immunodeficiency Virus (HIV), etc. Non-Communicable Diseases (NCDs) on the other hand, are prolonged conditions which do not result from an (acute) infectious process and hence are "not communicable". They have a persistent course that does not resolve naturally, as a result, a complete cure is seldom achieved. Types of Non-Communicable Diseases (NCDs) may include cardiovascular disease (e.g. coronary heart disease or stroke), diabetes, hypertension and hypercholesterolemia. These NCDs (Diabetes Mellitus, Hypertension and Hypercholesterolemia) are caused by modifiable or behavioral risk factors which can be monitored and tackled through lifestyle management. Modifiable risk factors are defined as behavioral risk factors that can be reduced or controlled by intervention, thereby reducing the probability of disease. Besides, non-modifiable risk factors comprise of non-changeable socio-economic and demographic factors, such as age, gender, race, residential area, education level, occupation, household income and marital status.

1.2 Background of study

Non-Communicable Diseases (NCDs) is the leading cause of functionary impairment and death worldwide. Addressing this issue that threatens the economies of a nation has become one of the major concerns among all the countries globally. According to, World Health Organization, more than 36 million people die annually due to NCDs (63% of global deaths), more than 14 million among them die between the ages of 30 and 70 (Dye, Reeder, & Terry, 2013). It has also been identified that the low and middle-income countries have already bore 86% of the burden from these premature mortalities. This resulted in aggregate economic losses of USD$7 trillion over the next 15 years and millions of people are expected to be trapped into poverty.

As a result, NCDs already poses an extensive economic burden and this burden will evolve into an incredible one over the next two decades. For example, stemming from the following diseases, cardiovascular disease, chronic respiratory disease, cancer, diabetes, and mental health respectively, the macroeconomic simulations suggested a cumulative output loss of US$ 47 trillion over the next two decades. This loss represented 75% of global Gross Domestic Product (GDP) in 2010 (US$ 63 trillion)

(Bloom et al., 2014).

In addition to that, NCDs have created enormous strain on household budget. For example, 15-25% of household income of total disposable income was spent on the treatment of diabetes in the poorest households of some developing countries (Mundial, 2006).

1.2.1 The overview of NCD issues and NCDs risk factors in Malaysia

In Malaysia, NCDs such as cardiovascular diseases, Diabetes Mellitus (DM), Hypertension (HP) and Hypercholesterolemia (HC) are the major health burden of the country. According to the Disease Burden Study conducted in the year of 2004 which took into account of both mortality and morbidity, diabetes mellitus has been identified as one of the eight leading burden of disease in Malaysia. 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). Furthermore, it was estimated that 8.1% of Malaysian population are diabetics according to a local study which was done in the year of 2000. The Fourth National Health Morbidity Survey also reported that the prevalence of diabetic patients has increased to 15.2% (Tahir & Ani, 2012). This dramatic increase was in fact due to the increased proportion of "newly diagnosed Diabetes Mellitus (DM)" (Kaur, Tee, Ariaratnam, Krishnapillai, & China, 2013). Hence, the increased prevalence of newly diagnosed Diabetes Mellitus has substantially added on the total prevalence of Diabetes Mellitus in Malaysia.

On top of that, 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 economic loss among individuals and their respective nations (Thomas et al., 2013). Even though, Malaysia has an equivalent public and private system, the mainstream of treatment for chronic diseases is offered by the public health system which is greatly subsidized by the government. For instance, the cost of treating Diabetes Mellitus (DM) and its complications in the nation was significant. Based on a macro-economic study in 2011, it can be seen that the cost was approximately RM 2 billion and was potentially representing 13% of the healthcare budget for the year of 2011.

Based on the latest World Health Organisation (WHO) data published in May 2014, Known Hypertension deaths in Malaysia have extended to 1,684 or 1.32% of total deaths. In addition, the increasing trend of the national prevalence of Known Hypertension among Malaysian adults was 32.2% (NHMS, 2008) and has increased to 32.7% according to the Fourth National Health and Morbidity Survey (NHMS IV) report (Tahir & Ani, 2012). Therefore, it can be noticed that the increasing trend of the prevalence rates of Known Hypertension was at an alarming stage. Besides, it was found that the prevalence of newly diagnosed hypertension was 19.8% (95% CI: 19.0-20.7). This was comparatively higher than the prevalence of known hypertension which was 12.8% (95% CI: 12.2-13.5) among adults above 18 years old (Institute for Public Health, 2011).

Malaysia has a higher prevalence of hypertension than the USA (38% vs. 30%), a parallel rate of diabetes (10.7 %) on a worldwide scale, but a lower rate of being overweight and obese (37% vs. 52%). Western cut-offs for abdominal obesity is employed in the USA (Cheong et al., 2013). Although Malaysia has begun its Healthy Lifestyle Campaign back in 1991, there has been no decrease in the prevalence of

Hypertension. For example, about RM215.9 million was spent on anti-hypertensive medicines alone in year 2005 in Malaysia (Sameerah et al., 2007). In addition to that, there were 37,580 hypertension-related admissions to government hospitals. This provides evidence that NCD patients are burdened by high treatment cost (Alwan, 2011).

Likewise, the prevalence of Hypercholesterolemia (HC) in Malaysia has doubled to 57.5% in the time span of five years among adults of 18 years and above. It has increased from 20.7% in 2006 to the prevalence of 32.6% or 6.2 million adult Malaysians in 2011 (Tahir & Ani, 2012). Additionally, it was observed that the prevalence of newly diagnosed hypercholesterolemia was 26.6% (95% CI: 25.6-27.7) and was comparatively higher than the prevalence of known hypertension which was 8.4% (95% CI: 7.8-9.0) among adults above 18 years old (Institute for Public Health, 2011).

Notably, it has revealed that the stated three major Non-Communicable Diseases (NCDs) namely Diabetes Mellitus (DM), Hypertension (HP) and Hypercholesterolemia (HC) continues to rise and pose new challenges on the health system in Malaysia. Therefore, there is urgent need for appropriate intervention in reducing and monitoring the prevalence of NCDs.

Table 1.1 given below, depicts the prevalence of selected NCDs risk factors for Malaysian adults with an age range of 18 years and above from 2006 to 2011. An increasing trend of prevalence of NCDs risk factors is observed. Consequently, it can be concluded that the high prevalence of NCDs risk factors would further add to the burden of disease of NCDs in Malaysia. Therefore, in response to this epidemic, Malaysia needs to tackle the continuous increasing trend of NCDs risk factors by investigating and analysing the odds ratio of NCD risk factors at various outcome levels of Diabetes Mellitus, Hypertension and Hypercholesterolemia.

Table 1.1 Prevalence of Selected NCD Risk Factors in Malaysia (2006 -2011)

	2006 NHMS III	**2011 NHMS IV**
Age group (years)	18 years	18 years
Smoking*	21.5%	23.1%
Physically Inactive	56.3%	35.2%
Overweight (BMI >25 kg/m^2 & <30 kg/m^2)	29.1%	29.4%
Obesity (BMI >30 kg/m^2)	14.0%	15.1%
Drinking (current drinker)	11.4%	11.6%

***Note:** Data for population of 15 years and above
Source: Ministry of Health, 2011

To reduce the burden of NCDs, improved healthcare and early detection has been some of the effective approaches. On the other hand, non-modifiable health risk factors such as age, gender, education level, marital status, residence areas, household income and ethnic also need to be investigated. This is due to socio-demographics factors have been recognized to play a considerable role of NCD risk factors in both developed and developing countries (Chimed, 2014).

In essence, modifiable risk factors are very important and can be investigated by studying the high prevalence of the NCDs namely Diabetes Mellitus and Hypertension in Malaysia. This study is very much needed for the purpose of NCD prevention and control in Malaysia and in order to address the rising cost in healthcare system and increased resources.

1.3 Statement of Problem

The World Health Organisation (WHO) has prioritized physical inactivity, tobacco use, alcohol consumption and unhealthy diets as the main four modifiable risk factors of NCDs. All these modifiable risk factors are related to behavioral risk factors which are changeable. Consequently, this enables people to have control over their health and to make choices in order to promote and sustain good health in their life style. Risk factors are referred as aspects of personal behavior or lifestyle, an environmental exposure, or a hereditary characteristic that is associated with an increase in the occurrence of a particular disease, injury, or other health condition (Control & Prevention, 2006).

To begin with, modifiable risk factors are recognized as behavioral risk factors which are controllable and preventable. Many of the modifiable risk factors such as physical inactivity, Body Mass Index (BMI): overweight/obesity, inadequate fruit and vegetables consumption, excess alcohol consumption/drinking and smoking are related to heart disease and diabetes mellitus. These unhealthy health behaviors are the predominant causes for the occurrence of NCDs. As a result, change in lifestyle is necessary which in turn means alterations in all the above mentioned personal habits (Scheffler & Paringer, 1980).

It is known that, the modifiable risk factors are preventable and "prevention is better than cure." This is because prevention is the best solution to reduce unnecessary demand on the healthcare system which ultimately increases economic burden of the nation. Thus, prevention leads to a positive result by involving least cost in terms of medication (Pandve, 2014).

Physical inactivity has been recognized as one of the five major risk factors for NCD-associated deaths and is projected to be accountable for nearly 80% of cardiovascular diseases, 27% of diabetes and 21% to 25% of breast and colon cancer. It has been reported that the 3.2 million deaths caused due to physical inactivity has had a major health impact on the world (Organization, 2012). It has also been found that the elimination of physical inactivity would remove between 6% and 10% of the major NCDs of coronary heart diseases, type 2 diabetes, and breast and colon cancers and thus increase life expectancy (Lee et al., 2012).

Similarly, smoking-related disease such as cardiovascular disease has been reported as the main cause of premature death globally (Abougalambou & Abougalambou, 2013; Beaglehole et al., 2011). Furthermore, smoking-related diseases have been known to be the primary cause of death for the past three decades in Malaysia (Lim et al., 2013). Therefore, it is necessary for the Malaysian government to implement health intervention programmes to reduce and monitor the current smoking status to prevent the occurrence of smoking-related NCDs such as hypertension and diabetes mellitus.

In addition to that, based on the Malaysian Clinical Practice Guidelines on Management of Obesity (2004) classification, it has been estimated that more than 60% of Malaysian adults were pre-obese and obese (Ismail, Wan Bebakar, & Noor, 2003). Similarly, the report of Malaysian National Health and Morbidity Survey which monitors NCD risk factors indicated a three-fold rise in the prevalence of obesity. This equates to approximately 2.5 million Malaysians in 2011 and consequently meets the criteria for obesity (Mustapha et al., 2014). These obese individuals have been identified as one of the major factors which increase the risk of having Hypercholesterolemia (Basulaiman et al., 2014).

If the health systems and public policies respond more effectively and equitably on the health-care needs of people with NCDs, by tackling the shared NCDs risk factors—namely tobacco use, unhealthy diet, physical inactivity and the harmful use of alcohol, most of the premature mortalities resulting from NCDs can be prevented (Organization, 2013). This consequently will reduce government spending on health intervention programmes.

The second problem stems from the fact that Malaysia is a multi-racial country with various ethnic cultures and lifestyles. The racial groups in Malaysia have various cultures, religions and upbringing personalities (Johnson & DaVanzo, 1998). This substantially forms interesting multicultural lifestyles which include different eating habits and practices among the ethnics like Malays, Chinese, Indians, Bumiputra and others. The comparison among these racial groups may disclose differences in the NCDs prevalence and patterns. For example, Indian males had the highest prevalence of diabetes and also experience the lowest life expectancy (Teh, Tey, & Ng, 2014). At the same time, it has also been observed that vegetable consumption differs among various ethnics and the results showed that Indians were highly interested to consume vegetables than other races (Othman et al., 2012). This may be due to the cultural cooking practices and vegetarianism among the Indian society (Kittler, Sucher, & Nelms, 2011).

Similarly, Indians had the highest prevalence at 24.9% among the diabetes population in Malaysia, this was followed by the Malays at 16.9% and finally, the Chinese diabetes population was at 13.8% (Tahir & Ani, 2012). Although these non-modifiable risk factors cannot be the major objectives of interventions, it is important to consider them as they influence the total burden of NCDs (Bloom et al., 2014). Almost all NCDs increase in prevalence with age (Dey, Nambiar, Lakshmi, Sheikh, & Reddy, 2012; Van Minh, Byass, Chuc, & Wall, 2006; Zhao et al., 2013). Likewise, it was reported that, men were more likely to have hypertension than women in Vietnam (Van Minh et al., 2006). Hence, it is essential to look into the socio-demographics and socio-economic factors which are recognized as non-modifiable risk factors among the individuals in order to tackle the NCDs prevalence issues. Different ethnic groups must be addressed for policy implementation in Malaysia.

The third issue that prevails is that NCDs consists of various stages and different outcome levels. The prevalence of known NCDs has resulted from the progression of newly diagnosed NCDs. For instance: Impaired Fasting Glucose may progress to Newly Diagnosed Diabetes Mellitus and subsequently may develop to Known Diabetes Mellitus. The progression from the early abnormal glucose metabolism which precede Impaired Fasting Glucose (IFG) and Impaired Glucose Tolerance (IGT) to Diabetes Mellitus may take many years; however existing estimates shows that up to 70% of individuals with Impaired Fasting Glucose (IFG) and Impaired Glucose Tolerance (IGT) will ultimately develop Diabetes Mellitus (Nathan et al., 2007; Shaw et al., 1999; Tuomilehto et al., 2001).

Besides, the NHMS III report also showed that the prevalence of known diabetes has increased from 6.5% in 2006 to 10.7% in NHMS IV report. On the other hand, it also revealed that the frequency of newly diagnosed diabetes was 5.4% in 2006 and rose to 10.1% in 2011. Since the prevalence of pre-diabetes is currently 8.3% and expected to increase to 9.3% by 2035, the intervention to control the epidemic of diabetes should begin at the early stage of development of Diabetes Mellitus (Perreault et al., 2014). Thus, it is urgent to tackle the prevalence of Diabetes Mellitus at an early stage.

Moreover, early detection of impaired fasting glucose and newly diagnosed diabetes mellitus may prevent the development of known diabetes mellitus.

Evidently, newly diagnosed hypertension patients have greater chance of developing Known Hypertension (Rathmann et al., 2003). Since Hypertension has a silent nature, early identification of the Newly Diagnosed Hypertension will help to prevent and reduce the progression of this disease to Known Hypertension which may eventually lead to serious complications like stroke and heart disease (Bushara, Noor, Elmadhoun, Sulaiman, & Ahmed, 2015).

1.4 Research Questions

Catering to the issues identified, general research questions are set as follows: Firstly, what are the modifiable risk factors influencing the likelihood of the NCDs (Diabetes Mellitus, Hypertension and Hypercholesterolemia) among individuals in Malaysia? Secondly, what are the non-modifiable risk factors influencing the likelihood of the NCDs (Diabetes Mellitus, Hypertension and Hypercholesterolemia) among individuals in Malaysia? Thirdly, how do the modifiable and non-modifiable risk factors vary depending on the different levels of NCD outcomes (Diabetes Mellitus: Impaired Fasting Glucose, Newly Diagnosed DM and Known DM; Hypertension: Newly Diagnosed HP and Known HP; Hypercholesterolemia: Newly Diagnosed HC and Known HC) among individuals in Malaysia?

1.5 Research Objectives

The general research objective that emerged from the above research questions is to examine the odds ratio of risk factors (modifiable and non-modifiable) on Non-Communicable Diseases among individuals in Malaysia.

The specific objectives of this study are as follows: To start with examining the odds ratio of modifiable risk factors on the NCDs (Diabetes Mellitus, Hypertension and Hypercholesterolemia) among individuals in Malaysia. Next is to investigate the odds ratio of non-modifiable risk factors on the NCDs (Diabetes Mellitus, Hypertension and Hypercholesterolemia) among individuals in Malaysia. And finally, this study compares the odds ratio of modifiable and non-modifiable risk factors on the different levels of NCD outcomes (Diabetes Mellitus: Impaired Fasting Glucose, Newly Diagnosed DM and Known DM; Hypertension: Newly Diagnosed HP and Known HP; Hypercholesterolemia: Newly Diagnosed HC and Known HC) among individuals in Malaysia.

1.6 Significance of the Study

Catering to the specific objectives set for this research as mentioned above, the purpose of this study is to tackle modifiable risk factors of NCDs effectively and to provide insight for policy makers to develop the most cost-effective strategies for the prevention and control programs of Non-Communicable Diseases (NCDs) in Malaysia using the estimated odds ratio of modifiable risk factors on NCDs.

Furthermore, this study will contribute to the needs of the related authorities by helping them to gauge their lifestyle intervention based on NCD non-modifiable risk factors from different cultural backgrounds. This consequently will result in effective prevention. Hence, this study will facilitate the Government while addressing certain ethnic groups on prevention programmes. This is because there are different socio-economic and demographic factors such as age, gender, occupation and education level on NCDs among individuals in Malaysia.

At the same time, the findings of this research will also enable the Government to look into the different odds ratio of modifiable and non-modifiable risk factors which in turn will serve as an indicator/benchmark for programme guidance decisions and resource allocation during policy implementation based on different level of NCD outcomes.

1.7 Organisation of the Chapters

Chapter 1 presents the introduction of this research study, it includes a brief introduction of the background of study, statement of problem, research questions, research objectives and the significance of the study.

Chapter 2 includes the literature review which consists of the findings of current and previous empirical studies related to the modifiable and non-modifiable risk factors on different levels of NCD outcomes: Impaired Fasting Glucose (IFG), Newly Diagnosed DM, Known DM, Newly Diagnosed HP, Known HP, Newly Diagnosed HC and Known HC. This chapter also reviews theories related to modifiable risk factors on NCDs and the importance of prevention on NCDs. In addition to that, this chapter also includes literature on statistical techniques used in NCD findings.

Chapter 3 introduces the data source and the variables used in this study. This chapter also offers conceptual framework with a brief explanation of the statistical techniques used in this study.

Chapter 4 reports the findings on modifiable and non-modifiable risk factors on different levels of NCD outcomes by using SPSS 23 to build a multinomial logistic regression model.

Chapter 5 presents the empirical findings of this research and it also identifies risk factors on different levels of NCDs outcomes and explores the difference of odds ratio on different levels of NCD outcomes.

Chapter 6 provides a brief summary, policy implications and limitation of the study. Additionally, this chapter also involves recommendations for potential research.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter examines to review the literature of previous findings which relates to Non-Communicable Diseases (NCD)'s risk factors and how it affects and contributes to the prevalence of different levels of non-communicable diseases outcomes namely Impaired Fasting Glucose, Newly Diagnosed Diabetes Mellitus, Known Diabetes Mellitus, Newly Diagnosed Hypertension, Known Hypertension, Newly Diagnosed Hypercholesterolemia and Known Hypercholesterolemia.

The review of previous investigation focuses on modifiable and non-modifiable risk factors of Diabetes Mellitus, Hypertension and Hypercholesterolemia. NCD modifiable risk factors are those traits, characteristics, experiences of life style patterns, that could be adjusted or altered to prevent the development of the NCDs (Ibekwe, 2015). They refer to common, preventable risk factors that underlie most of the non-communicable diseases. These were the four-particular behavior (tobacco use, physical inactivity, unhealthy diet, and the harmful use of alcohol) that leads to four key metabolic/physiological changes (raised blood pressure, overweight/obesity, raised blood glucose and raised cholesterol).

On the other hand, the non-modifiable risk factors are attributes or characteristics in individual that cannot be reformed or adjusted, hence they are out of our control and little or nothing can be done to control them; such factors include age, sex, race, family history, genetic composition, etc. (Ibekwe, 2015). The review of literature covers a few core major issues which are divided into the following sections. Section 2.2 reviews theories associated to welfare economics and the importance of health promotion which is derived from the Levels of prevention model and also rational choice theory in relation to lifestyles that is determined by individuals resulted in positive and negative health outcomes (suffers from NCDs). Section 2.3 reviews the empirical evidence on the impact of risk factors (modifiable and non-modifiable) on different levels of NCD outcomes. Section 2.4 reviews the literature on the statistical techniques and methodology relevant to this study, especially multinomial logistic regression. Finally, the chapter concludes with the summary of identified research gaps from the literature in this section.

2.2 Literature Review on Theoretical Framework

2.2.1 Welfare Economics Theory

Welfare economics has been identified as a branch of economics concerned with maximizing social welfare. It refers to the distribution and its effects on economy's overall well-being (Raftery, 1998). Welfare economics uses microeconomic practices to evaluate well-being (welfare) at the collective (economy-wide) level (Deardorff, 2014). In terms of allocation of resources, different optimal states exist in an economy and welfare economics seeks a state, that will create a highest overall social satisfaction level among its members. The process could start with the notion of a social welfare function, which was used to rank the allocation of resources to the social well-being. The stated function includes measures of economic efficiency and equity together with wider range of measures, for example, economic freedom is used in order to quantify social welfare. Additionally, the social welfare function is a function which ranks social states (alternative complete descriptions of the society) as less desirable, more desirable, or indifferent, for every possible pair of social states. The inputs of function include any variables considered to influence the social welfare of a society (Sen, 2017).

There are two major related types of social function which consist of Bergson-

Samuelson social welfare function and Arrow social welfare function. Bergson-Samuelson social welfare function showed how welfare economics could describe a standard economic efficiency which makes no assumptions regarding interpersonal comparability of utility. This was considered welfare for a given set of individual welfare rankings, introduced by Bergson in 1938. Bergson had described an "economic welfare increase" (a Pareto improvement) based on the fact that at least one individual moves to a preferred position with everyone else indifferent. Then, the social welfare function could be specified in a substantively individualistic sense to derive Pareto efficiency (optimality). However, this has been argued by Paul Samuelson (2004) who claimed that even if Bergson's social welfare function could define interpersonal normative equity but it is not sufficient. As noted, that a welfare improvement from the social welfare function could be originated from the 'position of some individuals' improving at the expense of others which could be categorized as an equity dimension (Bergson, 1968).

Arrow social welfare function analysis was generalized by Arrow (1963) and it's also known as 'constitution' which maps a set of individual orderings (ordinary utility functions) for each individual in the society, a rule of ranking alternative states. Furthermore, the social ordering would depend on the set of individual orderings. After that, Arrow has proved the general impossibility theorem, which stated, that, it was impossible to have a social welfare function that satisfies a certain set of "apparently reasonable" conditions.

Additionally, the welfare economics includes two fundamental theorems. The first one comprises the first mentions, that with the given assumptions, competitive markets produce (Pareto) efficient outcomes (Hindriks & Myles, 2013). This took the logic of

Adam Smith's invisible hand which describes the unintended social benefits of an individual's self-interested actions (Mas-Colell, Whinston, & Green, 1995). Second theorem stated that any Pareto efficient outcome could be supported as a competitive market equilibrium at given restrictions (Hindriks & Myles, 2013).

2.2.1.1 Deadweight Loss

Deadweight loss (DWL) is recognized as loss in economic welfare and it is also identified as excess burden or allocative inefficiency, is an economic term used to explain the net loss in total economic welfare which can be attributed to the introduction of new tax, price floor or tax increase (Lal et at., 2017). The tax will lead an increase in price and this will discourage people from buying the product and leads to an efficiency loss (Zee, 1995). As a result, demand will decrease. Consumers and producers will both experience decreased benefits.

This will lead to a reduction in both consumer and producer surplus. In the context of negative health outcomes, exposure to non-communicable diseases risk factors and suffering from non-communicable diseases (NCDs) will lead to deadweight loss. The total loss of economic welfare represents the reduced quality of life among the diabetic, hypertensive and hypercholesterolemic patients. This will consequently increase the economic burden of the country. Hence, behavioral responses and healthy lifestyles will be required to prevent and control of NCDs.

2.2.1.2 Taxes and Non-Communicable Diseases (NCDs)

Previous literature showed that fiscal measures on NCDs risk factors, for example like the implication of taxation has certain impact on the prevalence of Non-Communicable Diseases (NCDs) as general. Taxes are an underused instrument for the prevention of premature death and disease which are associated with nearly 10 million premature deaths each year because they can discourage consumption of products like tobacco, alcohol, and sugary beverages which contribute to diabetes mellitus, cardiovascular diseases, cancers, mental health problems and injuries (Summers, 2018). Taxes on tobacco, alcohol, and sugar have been, or are now being , introduced in various contexts, including United Kingdom, India, Mexico, Chile, Ecuador, Botswana, South Africa, Nigeria, Peru, and the United Arab Emirates (Marten et al., 2018).

It is due to the estimated optimal real excise tax rate is 0.216 sen or 0.262 nominal excise tax rate per stick, which is 16.5% higher than the excise tax rate in 2009. It is observed that the rise in real revenue that can be earned after imposing an optimal excise tax is 18% and 23.6% in the short run and long run respectively meanwhile the expected reduction in consumption per capita for cigarette is 6.4% in the short run and 11.6% in the long run (Mohamed Nor, Raja Abdullah, Rampal, & Modh Noor, 2013). Therefore, the collected tobacco taxation revenue in Malaysia would be able to reduce cigarette consumption and potentially provide fund for better health care and services for the Malaysian population.

Besides, tobacco use, which includes active smoking and exposure to tobacco smoke, is one of the leading risk factors for premature mortality and disability from non-communicable diseases in China The reformation of the fiscal and tax system which includes strengthening the regulatory function of excise tax will provide an excellent opportunity to address the economics of tobacco control in China (Yang, Wang, Wu, Yang, & Wan, 2015). Additionally, tax increases between 1994 and 2007 raised cigarette excise from 60% to 80% of wholesale prices in Thailand (Organization & Control, 2008).

The World Bank reviewed and concluded the evidence on the effectiveness of tobacco taxation in a 1999 report, a 10% rise in the prices of tobacco products would decrease their use by about 4% in developed countries and by about 8% in developing countries (W. The, 1999).

The consumption of alcohol is one of the risk factors for health and NCDs that disproportionately affect people with low socioeconomic status and low-income countries, which are least prepared and alcohol taxation has been recognized as a cost effective way to reduce alcohol consumption and harm (Marten et al., 2018).

However, when Finland reduced taxes on alcohol in 2003, the alcohol-related mortality had been increased by 31% among women and by 16% among men (Herttua, Mäkelä, & Martikainen, 2008).

There are a number of studies which examined food taxes for other countries. For instance, it was found that taxing sources of saturated fat may lead to a reduction in the intake of saturated fats (Mytton, Gray, Rayner, & Rutter, 2007). In addition, Cash et al. (2008) made an experimental exploration into the impact of fat taxes, and their findings suggested that consumers are less likely to choose a product with a stigmatizing warning label attached to it. On the other hand, Kim, Kawachi (2006) and Powell et al. (2009) found that there was no significant association between taxes and obesity in their study when introduced taxes of around 1–8% on sweetened drinks in United States of America was introduced. It might be due to the taxes being too low to observe any effect on consumers' health.

Furthermore, Mytton et al. (2012) examined the evidence on whether taxes on unhealthy food and drinks really improve health. The analysis of Smed (2012) suggests that the introduction of the tax on saturated fat had some effects on consumption patterns with consumption of fats dropping by 10 to 20% in the first three months. With the implementation of fat tax by the government, it is hoped that the change of healthier eating habits and lifestyle would prevent the occurrence of Non-Communicable Diseases (NCDs) in Malaysia.

Sugar taxes have identified as another fiscal tool to promote nutrition and health with growing evidences (Guerrero-López, Unar-Munguía, & Colchero, 2017). It was found that Mexico's sugar tax reduced sugar-sweetened beverage sales by 5% in the first year, with a nearly 10% further decrease in the second year (L. D. E. The, 2017). The World Health Organization (WHO) has recommended the "implementation of an effective tax on sugar-sweetened beverages" as one of the several key measures to address childhood obesity which focused on fiscal policy for improving diets and preventing non-communicable diseases (Organization, 2016).

The World Health Organization (WHO) has recommended salt reduction as a "best buy", recognizing it as one of the most cost effective and feasible approaches to prevent Non-Communicable Diseases such as Hypertension (Alwan, 2011). From the evaluation of the United Kingdom's salt reduction strategy has demonstrated a 15% reduction in population salt intake between 2003 and 2011 (Sadler et al., 2012). Fiji is one of the country has adopted a tax related to salt particularly on monosodium glutamate (MSG) which it increased from 5% to 32% in 2012 Additionally, Portugal has a value-added tax (VAT) on processed or packaged foods in general which covers food high in salt, compared to reduced VAT for non-processed foods (Sadler et al., 2012). From the experience, it has shown that even a modest reduction in salt intake can result in major improvements in public health and lead to cost reduction in health-care expenditures especially in the treatments for Non-Communicable Diseases particularly Hypertension

2.2.2 Levels Prevention Model

Advocated by Leavell and Clark in 1975, this model delineates three levels of the application of preventive measures that can be used to promote health and arrest the disease process at different points along the continuum. The goal is to maintain a healthy state and to prevent disease or injury. Prevention has been defined by public health in four levels: primordial, primary, secondary and tertiary (Leavell & Clark, 1958). Primordial prevention includes, prevention of the emergence of risk factors in which they have not yet existed. For example, discouraging individuals to adopt unhealthy lifestyle such as drinking.

Primary prevention sought to prevent the onset of specific diseases via risk reduction, by changing behaviors or exposures which could lead to the disease, or by enhancing resistance to the effects of exposure to a disease agent (Pandve, 2014). It has the purpose to avoid illness and disable conditions. To achieve these objectives, health behaviors will be promoted, for example physical activities, healthy diet, quit smoking and drinking and maintaining healthy weight.

Secondary prevention was concerned with early detection and intervention in the potential development or the existence of a disease (Leavell & Clark, 1958). The purpose of secondary prevention is early diagnosis and prompt treatment and limitation of disabilities. Actions are emphasized on early detection and treatment, for example, health screenings for Hypertension and Diabetes Mellitus and Hypercholesterolemia. Next, the initiative or referral treatment for identified illness, will be required to complete the process (Bomar, 2004).

Lastly, tertiary prevention is emphasized on treatment of a disease to lessen its effect and to prevent further deterioration (Leavell & Clark, 1958). The aim for tertiary prevention is rehabilitation, which returns to the highest level of functioning possible. Actions involve rebuilding function and developing additional resistance (Bomar, 2004). The basis of NCD prevention is the identification of the major risk factors and their prevention and control. From a primary prevention perspective, the surveillance of the major risk factors known to predict the disease is an appropriate starting point (Labarthe, 1999). Hence, this will finally help policy makers to emphasis on NCDs and design strategic strategy to address the prevention of these diseases.

Primary prevention has been identified and was necessary to implement in national strategies for type 2 diabetes (Ramachandran, Snehalatha, Shetty, & Nanditha, 2012). Additionally, previous researches have indicated primary prevention of NCDs, for example, diabetes was possible by modifying risk factors such as obesity and insulin resistance (Group, 2002; Pratley & Matfin, 2007). This has been identified that lifestyle intervention could have 43% reduction in the incidence of diabetes, sustained over a 20-year period (Li et al., 2008).

The usual classification system for prevention initiatives is to divide them into primary, secondary, or tertiary (Caplan, 1964; Cowen, 1983). More current conceptualization have moved towards a classification system centering on two kinds of programs, universal and targeted. The advantages of universal program of this model will recognize society influences individual behavior. Risk reduction could be achieved at population rather than individual level. In situations where there is a dose-response relationship in terms of risk and exposure, shifting the entire population distribution towards lower levels of exposure is effective.

With respect to targeted programs of this model, it may be more cost-effective than population wide approaches. It is easier for health professionals to promote change on an individual basis. Similarly, society prefers focusing on individuals to change rather than a whole population.

2.2.3 Rational Choice Theory

Rational Choice Theory is a framework used in understanding and often formally modeling social and economic behavior (Blume & Easley, 2008). It is recognized as a tool of social change, which supposes that every individual evaluates his/her behavior by that behaviors worth (Coleman & Fararo, 1992). The Rational Choice Theory is an approach used by social scientists to grasp human behavior which has become more widely used in other disciplines such as Sociology, Political Science, and Anthropology. The choice determination of the Rational Choice Theory presumes that individual decision-making unit in question is representative of larger group, for example buyers or sellers in a particular market. The analysis normally examines how individual choices interact to produce outcomes (Green, 2002).

The premise of Rational Choice Theory is an aggregate behavior in society which reflects the sum of choices made by individuals. Meanwhile, each individual makes their choice based on their own preferences and the constraints they face. These preferences are based on the axioms relating to customer preferences (Kreps, 1990; Mas-Colell et al., 1995). Firstly, the consumer faces a known set of substitute choices. Secondly, for any pair of alternative choices (for example, P and Q), the consumer either prefers P to Q or Q to P, or is indifferent between A and B which is recognised as the axiom of completeness. Thirdly, these preferences are transitive because if a consumer prefers P to Q and Q to R, then he/she necessarily prefers P to R. If she is indifferent between P and Q, and indifferent between Q and R, then she is necessarily indifferent between P and R. Fourth, the consumer will choose the most preferred alternative (Mas' Collel, Whinston, & Green, 1995). If the consumer is indifferent between two or more alternatives that are preferred to all others, he or she will choose one of those alternatives, where the specific choice from the alternatives will remain indeterminate.

The rational choice theories usually represent preferences with a utility function which the consumer's utility function is given by $U = U(x,y)$, where the function U assigns a number ("utility") to any given set of values for x and y which assumes that x is the good of interest and y is a "composite good" representing consumption of everything *but* good x. Moreover, the function U is normally assumed to have certain properties. First, it is normally assumed that *more is preferred to less* – so that U increases with the rises in x as well as with increases in y. It may also mention that marginal utility is positive. The second property of U indicates that the (positive) marginal utility of each good gets smaller and smaller with the increase in amount of good being consumed.

However, there may be an absence of information for consumers to make rational and proficient choices, often compounded by hesitation or miscommunication on the health benefits and harms of different lifestyle choices. Meanwhile, people do not always act rationally when making choices, occasionally their own behaviors may be addictive, or habit-forming, as with smoking and gambling. However, they might prefer to 'enjoy' an unhealthy lifestyle by disregarding their future risk or by failing to modify future behavior even though they intend to. Choices are also changed by the way in which products are advertised or demonstrated in shops or by peer pressures within their social circles. It has been revealed that most people will make choices to develop their lifestyles for the purpose to minimize their cost or from which will gain more of what they use in tangible and/ or intangible terms (Milio, 1976).

Based on previous studies related to application of rational choice theory, understanding the problem within a rational utility maximization framework to address obesity is necessary (Asfaw, 2007). This was because the satisfaction obtained from eating more and exercising less could be higher than the costs related to maintaining a lower body weight and the future (discounted) health costs which is related to obesity (Philipson & Posner, 1999; Suranovic, Goldfarb, & Leonard, 2003).

Besides, previous research which was related to rational choice theory has assumed that people would use the risk aversion coefficient and the time preference rate to calculate utility of alternatives. Smokers has been studied to detect facts and factors which explains the behavior of smokers from the perspective of rational choice theory (Krstić & Krstić, 2000).

The rational choice models are still being widely used because of its flexibility and tractability (Levin & Milgrom, 2004). Besides, Becker (1976) has explained the rational choice model as “a integrated framework for understanding all human behaviour”. Therefore, it is very appropriate to apply this theory in this study. There are some other advantages of the rational choice theory as summarized by (Ogu, 2013) as the following:-

(i) Generality: It is the most general theory of social action which can be used to understand all human behavior which means that one set of assumptions relating to each type of action in a given situation, is compatible with any set of structural assumptions about the environmental background in which the actor is present.

(ii) Parsimony: It is a principle to which an explanation of a thing or event is made with the fewest possible assumptions. The assumption of isomorphic and self-regarding utility function, when merged with the rational optimization model, allow rational choice theories to treat alternatives in choices among actors and by an actor over time as entirely a function of their structural position. Preferences and beliefs are simply perceived as the only relevant variables for determining action.

(iii) Predictive: Assumptions of the rational choice model have been used to produce a wide variety of decisive theories, whose predictions about the measurable real world phenomena rule out a much larger set of outcomes than what is already generally accepted to be unlikely. The decisiveness of rational choice theories depends on structural as well as the individual actor's assumptions. That decisions of individuals depend on the structures and assumption.

2.3 Empirical Analysis and Evidence

2.3.1 Modifiable Risk Factors and Non-Communicable Diseases

As mentioned by Centre for Disease Control and Prevention (2006), risk factors refer to aspect of personal behavior or lifestyle, an environmental exposure, or a heredity characteristic that is associated with an increase in the occurrence of a particular disease, injury, or other health condition. Risk factors like physical inactivity, drinking, smoking, inadequate fruit and vegetables consumption and Body Mass Index (BMI): overweight and obesity are changeable and modifiable.

Impaired glucose tolerance and impaired fasting glucose form an intermediate stage in the natural history of diabetes mellitus. Impaired glucose tolerance is defined as two-hour glucose levels of 140 to 199 mg per dL (7.8 to 11.0 mmol) on the 75-g oral glucose tolerance test, and impaired fasting glucose is defined as glucose levels of 100 to 125 mg per dL (5.6 to 6.9 mmol per L) in fasting patients. These glucose levels are above normal but below the level that is diagnostic for diabetes (Rao, Disraeli, & McGregor, 2004). Furthermore, Impaired Fasting Glucose is not a clinical entity, but it is a potential risk factor for future diabetes and cardiovascular disease (Association, 2010).

2.3.1.1 Physical Inactivity and Non-Communicable Diseases

Impaired glucose tolerance (IGT) and impaired fasting glucose (IFG) would identify individuals at increased risk for developing diabetes and cardiovascular disease (CVD) (Mustapha et al., 2014; Harris 1996; Association, 2010). It was found that men within the low-fitness group had a 1.9-fold risk (95% CI, 1.5- to 2.4-fold) for impaired fasting glucose compared with those in the high-fitness group (Wei et al., 1999). On the other hand, exercise during their free time at least once a week was not significantly associated with the odds of Impaired Fasting Glucose in Spain (Soriguer et al., 2012).

Moreover, it was also reported that inactive normal-weight individuals were at higher chance (OR 1.52 [95% CI 1.25–1.86]) of having Diabetes Mellitus. Therefore, the likelihood of having diabetes increases with physical inactivity (Sullivan, Morrato, Ghushchyan, Wyatt, & Hill, 2005).

For Physical Activity, previous study had shown that there was an evidence to suggest that 150 minutes of participation in moderately intense physical activity per week can extensively decrease the risk of Non-Communicable Diseases (NCDs) by about 30% (Organization, 2008). Besides, Blair et al. (2001) also pointed out that physical inactivity is one of the major contributors to the global burden of chronic diseases. On the other hand, it has been shown that the risk of suffering from chronic diseases and mental health problems could be reduce through regular engagement in physical activity (Batty & Lee, 2004). Besides, it has been stressed that women with high income, tends to become less physically active compared to men of the same income group which explains the higher risk of having Known Diabetes Mellitus (Oli, Vaidya, & Thapa, 2013). Similarly, there was study which exhibited men in the low-fitness group had a 3.7-fold risk (CI, 2.4-5.8-fold) for diabetes compared with those in the high-fitness group (Wei et al., 1999).

Malaysia is experiencing an upsurge in morbidity and mortality resulted from the emergence of cardiovascular disease in which Known Hypertension has been identified as the number one cardiovascular risk factor. The increasing trend of Hypertension prevalence has been caused by the risk factors either modifiable or non-modifiable risk factors. Physical inactivity was found significantly associated with increased odds of Newly Diagnosed Hypertension among urban Chinese adults (Zhang et al., 2017). It was exhibited that moderate physical activity had significantly higher odds [AOR = 1.9; (95 % CI, 1.2–3.0)] of Known Hypertension in Kenya (Olack et al., 2015). Physical activities prevent hyperlipidemia and improves the lipid profile (Gordon, Chen, & Durstine, 2014; Kodama et al., 2013; Mann, Beedie, & Jimenez, 2014).

Adequate capacity to promote physical activity is essential and the implementation of effective interventions is necessary to encourage in schools, primary health-care sector and other appropriate settings to prevent the prevalence of NCDs namely Diabetes Mellitus, Hypertension and Hypercholesterolemia (Bloom et al., 2011).

2.3.1.2 Drinking and Non-Communicable Diseases

The global cost of harmful use of alcohol in 2002 has been estimated to be between USD$210665 billion (Organization, 2008). A positive association ($P<0.05$) was exhibited between diabetes mellitus and alcohol consumption (Joshi et al., 2012). Previous studies have indicated that alcoholics were at higher risk of diabetes (Balkau et al., 2008). However, a small non-significant increase in odds ratio was observed with alcohol consumption among men with a BMI > 22 kg/m2, in Japan (Waki et al., 2005). However, no effect was observed in regular or former drinkers with the prevalence of Diabetes Mellitus (Choi & Shi, 2001).

Based on previous research, alcohol drinking was found significantly associated with increased odds of Newly Diagnosed hypertension in China (Zhang et al., 2017). There was a statistical significant association between drinking ($p<0.001$) and Hypertension. Respondents who were hypertensive and consumes alcohol were 33.1% (39/118), compared to 66.9% (79/118) who did not consume alcohol (Ibekwe, 2015). Similarly, it was found that frequent alcohol consumption, also increases the probability of Hypertension (OR = 1.25, CI = 1.04-1.52, $P < .01$) in China (Hou, 2008). On the other hand, alcohol consumption was not found to have a significant association risk on Hypertension (Cuschieri, Vassallo, Calleja, Pace, & Mamo, 2017). Subsequently, alcohol drinking was found to be positively associated with hypercholesterolemia (Song et al., 2017).

2.3.1.3 Smoking and Non-Communicable Diseases

Tobacco use has been identified as a leading cause of preventable death and disease worldwide and it is responsible for almost 6 million deaths annually, accounting for 71% of lung cancers, 42% of chronic obstructive pulmonary disease, and nearly 10% of cardio- vascular disease cases (Sturke, Vorkoper, Duncan, Levintova, & Parascondola, 2016).

It was observed that ex-smoker was associated with higher risk for Impaired Fasting Glucose when compared with non-smokers because the multivariate-adjusted relative risk was 1.62 (95% CI, 0.85 to 3.10) for ex-smokers (Nakanishi, Nakamura, Matsuo, Suzuki, & Tatara, 2000). However, smoking has no significant difference on the likelihood of having Impaired Fasting Glucose in Spain (Soriguer et al., 2012). There has been significantly higher prevalence rate of Newly Diagnosed Diabetes Mellitus among the current smokers than the non-smokers (Ismail et al., 2016). In contrast, smoking was not significantly associated with the odds of Newly Diagnosed Diabetes Mellitus in Spain (Soriguer et al., 2012). It was revealed that smoking habits were the major contributor for Diabetes Mellitus (Bener et al., 2009). Additionally, ex-smoking habit were found positively associated to Known Diabetes Mellitus when compared to current smoking behavior (Akhtar & Dhillon, 2017). Current and former smokers were also found to be associated with a higher prevalence of diabetes (Choi & Shi, 2001).

The prevalence of hypertension was higher at 33.3% among those who were in the habit of chewing tobacco for more than 5 years as compared to 31.6% who had this habit for less than 5 years (Kannan & Satyamoorthy, 2009). Regular and long cigarette smoking was associated with hypertension (Abdulsalam, Olugbenga-Bello, Olarewaju, & Abdus-Salam, 2014; Alikor, Emem-Chioma, & Odia, 2013; Onwuchekwa, Mezie-

Okoye, & Babatunde, 2012). On the other hand, smoking was shown to have no significant relationship ($p<0.05$) associated with Known Hypertension (Abba, 2016). It was reported that smoking has been recognized as one of the primary risk factors accompanying Hypertension in urban areas (Metintas, Arikan, & Kalyoncu, 2009). Besides, smoking was identified to have statistical significant association ($p<0.001$) with Hypertension (Ibekwe, 2015). In contrast, there are studies which showed smoking was not found to have a significant association risk on Hypertension (Cuschieri et al., 2017).

The previous empirical findings reported that there were no significant associations between respondents with unknown diabetes or hypercholesterolemia with smoking (Lim et al., 2016). It was found that sensitivity on Hypercholesterolemia was lower among ex-smokers than for those who have never smoked (Chun, Kim, & Min, 2016).

2.3.1.4 Inadequate Fruit and vegetables Consumption and Non-Communicable Diseases

It was observed that fruit and vegetables-rich nutrition did not affect the prevalence of Impaired Fasting Glucose among females in Spain (López-González et al., 2016). Similarly, from the meta-analysis study it was also demonstrated that fruit and vegetables-rich nutrition had not exert an influence on the Impaired Fasting Glucose (Cooper et al., 2012). The previous findings indicated important public health message on the benefits of a diet rich in fruit and vegetables. The study found the odds ratio of diabetes in the top quintile of fruit and vegetable consumption was 0.78 (95% confidence interval, 0.60-1.00) (Harding et al., 2008). In Finland, fruit and vegetable intake reduced the risk of suffering type-2 Diabetes Mellitus (Mursu, Virtanen, Tuomainen, Nurmi, & Voutilainen, 2013).

A high intake of fruit and vegetable was found inversely proportional with blood pressure levels in Mediterranean population with an elevated fat consumption. After adjusting for Hypertension and other dietary exposures, the prevalence odds ratio was 0.23 (95% CI 0.10-0.55; P1/40.001) by comparing those in the highest quintile of both fruit and vegetable consumption with those in the lowest quintile of both food groups (Alonso et al., 2004). For respondents who were eating ≥2 servings of fruit and vegetables per day were found to have lower odds (OR 0.72, 95% CI 0.56 to 0.94) than others with hypertriglyceridemia (Kjøllesdal et al., 2016). Fruit and vegetables intake had been identified to have no association with Hypercholesterolemia (Song et al., 2017).

2.3.1.5 Body Mass Index: Overweight and Obesity and NCDs

The World Health Organization (WHO) has defined a person to be overweight if his or her Body Mass Index (BMI) is >25 kg/m^2, and obese of BMI is ≥ 30 kg/m^2 (WHO, 2000). It had been identified that overweight and obesity were risk factors for many chronic diseases (Neupane et al. 2015), for example 44% of the diabetes burden were attributable to overweight and obesity (WHO, 2013).

Obesity could be a predictor for high prevalence of Impaired Glucose Tolerance (IFG) in Germany (Rathmann et al., 2003). It was revealed that overweight (24 kg/m2 ≤ BMI < 28 kg/m2) and obesity (BMI ≥ 28 kg/m2) were strongly associated with 2.32 times higher risk (OR = 2.32, 95%CI: 1.86-2.88) and 4.63 times more likely to have IFG, respectively, than those with normal weight respondents in China (Qian et al., 2010). Besides, Body Mass Index (BMI) was found associated with IFG which significantly showed 1.482 times more likely to be IFG (OR=1.482; 95% CI=1.288–1.705) (Kim et al., 2006). The maintenance of body weight was necessary for the prevention of Impaired Fasting Glucose to decrease the risk for developing diabetes and cardiovascular disease (Mustapha, 2014; Harris, 1996; Association, 2010).

Obese respondents were 1.9 times more likely to have Newly Diagnosed Diabetes Mellitus in males (Rathmann et al., 2003). Furthermore, significant associations were found among the obese respondents (OR 1.32 95% P<0.001) on the likelihood of having Newly Diagnosed Diabetes Mellitus (Ismail et al., 2016). The prevalence of diabetes was significantly higher in men, older groups, married, subject of low educational, past smokers and subject with obesity (Dajani et al., 2012). Obesity increased the risk of prevalence of non-communicable diseases such as cardiovascular diseases and diabetes (Fontaine, Redden, Wang, Westfall, & Allison, 2003; Hill, Wyatt, Reed, & Peters, 2003; Solomon & Manson, 1997).

Similarly, the risks were greatly increased in subjects with BMI above 29 kg/m^2 for Diabetes Mellitus (Ishikawa-Takata, Ohta, Moritaki, Gotou, & Inoue, 2002; Willett, Dietz, & Colditz, 1999). Additionally, previous studies also reported that overweight and obesity had significantly higher risk towards diabetes (Ahmad et al., 2011; Ather Ali, 2009). It was revealed that increasing weight would lead to increased prevalence of Newly Diagnosed Hypertension, which exhibited obese respondents achieved highest prevalence of 46.5% in Newly Diagnosed Hypertension (Bushara et al., 2015).

Based on the report of World Health Organization, the risk for Hypertension was moderately increased (relative risk, two to three times) in subjects with a BMI more than $30kg/m^2$ (WHO, 1997). Furthermore, overweight and obesity, high sodium intake, physical inactivity, heavy alcohol intake, low potassium intake, and a Western-style diet made up the major modifiable risk factors for hypertension (Chobanian et al., 2003; Forman, Stampfer, & Curhan, 2009). Obesity had also been identified as a well-established risk factor for cardiovascular disease among general population as stated by Rampal et. al. (2007). This had been agreed by (Flack, Ferdinand, & Nasser, 2003) that obesity has been linked to raised blood pressure, salt-sensitivity, as well as glucose intolerance, and dyslipidemia. Olack et al. (2015) also claimed that body mass index was one of the important risk factors associated with hypertension. Overweight and obese participants were approximately 2.0 times more likely to be hypertensive than their counterparts with normal Body Mass Index (Mbochi, Kuria, Kimiywe, Ochola, & Steyn, 2012).

Based on the research done by Ahmed, Rhmtallah and Eledum (2014), it was revealed that obesity and overweight had significant higher odds of Hypercholesterolemia. Similarly, Song et al. (2017) also claimed that overweight/obesity were positively associated with hypercholesterolemia. There has been a great increase in the risk of Hypercholesterolemia (HC) for subjects with a Body Mass Index (BMI) above 29 kg/m^2 (Ishikawa-Takata et al., 2002). Furthermore, Hypercholesterolemia was more likely to be present among overweight (OR=1.44; 95% CI=1.38-1.50) and obese (OR=1.54; 95% CI=1.46-1.62) respondents (Churilla, Johnson, & Zippel, 2012). Compared to normal weight respondents, obese respondents were also found to be significantly associated with high cholesterol and had an adjusted odds ratio of 3.45 (95% CI, 1.68-7.10) (Zindah, Belbeisi, Walke, & Mokdad, 2008).

2.3.2 Non-Modifiable Risk Factors and Non-Communicable Diseases

2.3.2.1 Gender and Non-Communicable Diseases

It was observed that the prevalence of Impaired Fasting Glucose was about two times more in males than in females (9.8% vs 4.5%) (Rathmann et al., 2003). This was agreeable by Regitz-Zagrosek, Lehmkuhl, & Weickert (2006) who also claimed that impaired glucose tolerance was observed more frequently in German men. Similarly, it was observed that the age-standardized prevalence of Impaired Fasting Glucose was higher (8.2% vs 6.9%; p=0.008) in men than in women (Gu et al., 2003). Males has a higher significance and likelihood association with Newly Diagnosed Diabetes Mellitus (Ismail et al., 2016). Similarly, it was observed that Newly Diagnosed Diabetes Mellitus was found to be more frequent in men than in women in Germany (Regitz-Zagrosek, Lehmkuhl, & Weickert, 2006). Females has been identified as less likely to have Known Diabetes Mellitus in the previous studies. For example, it was reported male respondents have a higher proportion of diabetes (46% females, males 54%) among Canadian patients (Choi & Shi, 2001). At the same time, it was also found females were less likely to be diabetic than males in Jordan (Ajlouni, Jaddou, & Batieha, 1998).

Socio-demographics factors play an important role as a determinant of daily activities among individuals. It was found females have 39.3% prevalence which is slightly higher than males 36.7% of Newly Diagnosed Hypertension (Bushara et al., 2015). However, male respondents have an increasing odds of Newly Diagnosed Hypertension among Chinese urban adults in China (Zhang et al., 2017). Similarly, it was found that Maltee males are more likely (64.01% CI 95%: 58.56–69.13) to have Newly Diagnosed Hypertension (Cuschieri et al., 2017).

On the other hand, statistically female were found to have significant lower level of

Blood Pressure (BP) control across all cardiovascular risk subgroups (Oteh et al., 2011). Similar outcomes were depicted from a previous research done in China, which revealed that the number of males with hypertension is significantly higher than the females with 29.2% vs 24.1% respectively ($p<0.001$) (Gao et al., 2013). Additionally, significant association was found in gender and the prevalence of Hypertension among young adults. Males were found to have an increased odd [(aOR: 1.72 (95% CI: 1.52 – 1.96)] of Hypertension in comparison to females [(aOR: 1.49 (95% CI: 1.33 – 1.67)] in Malaysia (Azimi-Nezhad et al., 2008).

Statistically, it was revealed that female respondents have significant higher odds of Hypercholesterolemia in the age group range between 50-59 years old (Ahmed et al., 2014). A previous finding also reported a greater proportion of females suffered from hypercholesterolemia (Amiri et al., 2014). Similarly, this study also has been agreeable to the previous research which reported female was positively associated with hypercholesterolemia (Song et al., 2017).

2.3.2.2 Ethnics/Race and Non-Communicable Diseases

The Indians (5.2%, 95% CI: 4.3– 6.1) and the Chinese (5.1%, 95% CI: 4.5–5.7%) respondents were found significantly higher prevalence of IFG when compared to Malays (4.0%, 95% CI: 3.6–4.3%) (Letchuman et al., 2010). Other Bumiputras had notably ($p<0.001$) lesser likelihood (adjusted OR=0.70) to have Newly Diagnosed Diabetes Mellitus than the Malays in Malaysia (Ismail et al., 2016). However, with regard to race, there was significant association between prevalence of diabetes and race. It was found Indians had 1.54 times the odds of having diabetes (adjusted OR = 1.54; 95% CI = 1.20, 1.98) compared with Malays. However, Chinese had 29% lesser odds (adjusted OR = 0.71; 95% CI = 0.56, 0.91) (Jan Mohamed et al., 2015). Indians consistently showed the highest prevalence for hypercholesterolemia (Khor, 1994). Other Bumiputras exhibited 1.55 times more likely to have hypertension when compared to Malays (Omar et al., 2011). It was found that Indian population are more likely (OR = 1.41, CI 1.05–1.89) to exhibit low high-density lipoprotein cholesterol (HDL) (Tan, Dunn, & Yen, 2011).

2.3.2.3 Age and Non-Communicable Diseases

The previous findings showed age was one of the significant risk factors (OR 1.2 [95% CI 1.1,1.3, $p < 0.001$]) of Impaired Fasting Glucose (Anjana et al., 2011). Similarly, it was observed that the prevalence of Impaired Fasting Glucose increased with age among men and women (Gu et al., 2003).

Previous research revealed that increasing age will lead to a higher occurrence of Newly Diagnosed Diabetes Mellitus (Ismail et al., 2016). Similarly, it was also observed that the newly diagnosed Diabetes Mellitus increased with age, 1.6% among the respondents aged 34-year-old or younger to 20.9% among the respondents aged 65-year-old or older (Hernández-Mijares et al., 2009). In contrast, it was observed that older subjects were less likely to have Newly Diagnosed Diabetes Mellitus compared to younger groups in India (Kanungo et al., 2016).

In terms of age, the prevalence of diabetes was significantly related to increase in age, central obesity and male gender and it was higher among those with least education (Dajani et al., 2012). Next, Diabetes Mellitus was also found to have the highest prevalence in the oldest age (age more than 60 years, 22.9%) in Iran (Rahmanian, Shojaei, & Jahromi, 2013). However, other studies have revealed that the occurrence of Diabetes Mellitus was not limited to elderly but was also in existence among younger age group (Agborsangaya et al., 2012; Barnett et al., 2012).

It was observed that the lowest newly diagnosed hypertension was detected among the age of 18–25 years, and the highest prevalence was recorded for participants above 65 years. Hence, there was significant associations between newly diagnosed hypertension and increasing age ($p < 0.05$) (Bushara et al., 2015). Furthermore, previous study also exhibited, Newly Diagnosed Hypertension increases with age from 0.8% among the respondents aged 34-year-old and younger age group and to 13.1% among the respondents aged 55-64-year-old (Hernández-Mijares et al., 2009). Additionally, older age was found associated with higher likelihood of having ~~of~~ Newly Diagnosed Hypertension in China (Zhang et al., 2017).

Evidence of relationship between age and Known Hypertension was documented in Cheah, Lee, Khatijah, & Rasidah (2011), El Fadil, Suleiman, & Alzubair (2007) and Gao et al. (2013). It was found that population with 60 years of age and above was more likely to have Known Hypertension when compared to respondents below 15 years old (Cheah, Lee, Khatijah, & Rasidah, 2011). Similarly, this was tallied with a previous study which indicated an increase in age was more likely to have Known Hypertension (Cuschieri et al., 2017). At the same time, previous study also reported the prevalence of hypertension with increase in age (El Fadil, Suleiman, & Alzubair, 2007). Moreover, it was found that prevalence of hypertension has increased according to higher aged group with 13.0%, 36.7%, and 56.5% among respondents aged 20 to 44 years (young people), 45 to 64 years (middle-aged people), and ≥65 years (elderly people), respectively (Gao et al., 2013).

Previous research also reported that the Newly Diagnosed Hypercholesterolemia had higher odds in younger age group (Cooper et al., 2000). It was found Hypercholesterolemia was the highest among middle-aged adults who were in their 40's (Amiri et al., 2014). Similarly, it was reported that the increase in occurrence of Hypercholesterolemia was higher among those aged above 55 years when compared with younger age groups (Song et al., 2017).

2.3.2.4 Education level and Non-Communicable Diseases

Education plays an important role in guarding against disease influenced by lifestyle, such as Diabetes Mellitus (DM), Hypertension and Hypercholesterolemia. It was found that there was a significant inverse correlation between educational level and the Newly Diagnosed Diabetes Mellitus among the Korean women (Rathmann et al., 2005). It was suggested that education level was significantly related to Diabetes Mellitus (DM) because Diabetes Mellitus was at high prevalent for respondents with low education groups (17.9%, $P < 0.001$) in Iran (Rahmanian et al., 2013). It was also revealed that low educational level may lead to inadequate diet quality, unhealthy behaviours and physical inactivity which resulted in higher incidence of Diabetes Mellitus (Drewnowski, Almiron- Roig, Marmonier, & Lluch, 2004). In contrast, there was no significant relationship between education and the prevalence of Known Diabetes Mellitus (Azimi-Nezhad et al., 2008; Rathmann et al., 2005).

The lower educational status and illiterate were observed to have a higher prevalence of 34.9% Newly Diagnosed Hypertension (El Fadil et al., 2007) and more likely to have Known hypertension (Bushara et al., 2015; Chun et al., 2016; Naing et al., 2016; Shapo, Pomerleau, & McKee, 2003). In contrast, education did not play a role in predicting the prevalence of Known Hypertension (Cuschieri et al., 2017; Hou, 2008). Higher education level was found significantly ($p<0.05$) more prone to have Hypercholesterolemia in China (Zhang et al., 2018). In addition, previous research also revealed that highly educated group was more aware and showed less likelihood of Hypercholesterolemia (Chun et al., 2016). However, education levels had no association with Hypercholesterolemia (Song et al., 2017).

2.3.2.5 Residential area and Non-Communicable Diseases

However, it was noted that the age-standardized prevalence of impaired fasting glucose was observed to have not much differences (7.7% vs 7.4%; p=0.48) in urban and rural residence (Gu et al., 2003). It was observed that the age-standardized prevalence of newly Diagnosed Diabetes Mellitus was higher (5.0% vs 4.1%; p=0.02) in urban than in rural residence (Gu et al., 2003). Pradeepa et al. (2008) claimed that subjects residing in urban areas had significantly higher rates of self-reported diabetes compared to rural residents. Furthermore, urban respondents were significantly associated with diabetes (pooled OR 1.21, 95% CI 1.09, 1.34, $p < 0.001$) (Zuo, Shi, & Hussain, 2014). On the contrary, it was observed that the prevalence of diabetes was slightly higher for respondents staying in rural areas (5.0% vs 4.5%) than respondents who stays in urban area (Dinca-Panaitescu et al., 2011). Similarly, it was also claimed that subjects residing in urban areas had significantly higher rates of self-reported diabetes (7.3%, odds ratio (OR) for urban areas: 2.48, 95% confidence interval (CI): 2.21–2.79, $p < 0.001$) compared to rural residents in India (Mohan et al., 2008).

Moreover, it was found that Newly Diagnosed Hypertension rate was significantly higher in rural areas than in urban areas, with rural adults being 64.0% more likely to have Newly Diagnosed Hypertension (OR = 0.61, CI = 0.44-0.86, $P < .001$) (Hou, 2008). It was found that urban adults have a higher probability of being hypertensive

(OR=1.19, p < .1) in China (Hou, 2008). In contrast, the previous research also exhibited that the prevalence of hypertension was significantly higher among rural dwellers than among urban dwellers (31.3% vs 29.2%, p=0.001)(Gao et al., 2013). On the other hand, it was found that rural dwellers were less likely to be aware of Hypercholesterolemia (Chun et al., 2016). Hence, rural dwellers were more likely to have Hypercholesterolemia. Evidently, the prevalence of Hypercholesterolemia was also found significantly higher in urban area than in rural areas in all regions except Maharashtra in India (Joshi et al., 2014).

2.3.2.6 Household income and Non-Communicable Diseases

It was revealed that lower income was associated with increased odds of Impaired Fasting Glucose in Tianjin, China. In comparison with higher income (≥ 2000 yuan, $243.3/month), lower income (< 1000 yuan, $121.70/month) showed odds ratios (95% confidence intervals) of 3.31 (2.48–4.41) for Impaired Fasting Glucose, (Zhang et al., 2013). It was also found that income status has been recognized as one of the significant risk factors (OR 1.2 [95% CI p < 0.001]) of Impaired Fasting Glucose (Anjana et al., 2011). The odds ratio was decreased with higher income among women (adjusted OR: 0.7; 95% CI 0.5–1.03) of Newly Diagnosed Diabetes Mellitus (Rathmann et al., 2005). Additionally, previous study indicated that Diabetes Mellitus as one of the risk factors in the prevalence of cardiovascular disease was higher in people with low income (Kanjilal et al., 2006).

The income and the prevalence of diabetes has a negative relationship as lower-income groups exhibited higher likelihood of diabetes and the odds ratio almost twice for males (OR=1.94, 95% CI=1.57-2.39) and almost triple for females (OR=2.75, 95% CI 2.24-3.37) in the lowest income group (no income or less than $15,000) than highest income group (at least $80,000 or >$80,000) respectively (Dinca-Panaitescu et al., 2011).

It was found that the respondents with higher income had lower odds (OR=0.71, 95% CI=0.56 - 0.91) of Newly Diagnosed Hypertension (Zhang et al., 2017). Amiri et al. (2014) revealed that lower income was associated with a higher risk of hypercholesterolemia in Malaysia. On the contrary, the higher annual household income per capita was identified as risk factor associated with hypercholesterolemia and was more likely to have hypercholesterolemia (P<0.05) (Zhang et al., 2018).

2.3.2.7 Occupation and Non-Communicable Diseases

Retirement was associated with increased odds (OR=1.90; 95% CI=1.47–2.46) of Impaired Fasting Glucose in Tianjin (Zhang et al., 2013). Retirees were recorded to have the highest prevalence rate among other occupation (Bushara et al., 2015). On the other hand, retirees had shown statistically significant lower odds of Known Hypertension and it was suggested that retirement may be beneficial for blood pressure due to more relax environment (Xue, Head, & McMunn, 2017). However, employment status was not found to have significant association with risk by Hypertension (Cuschieri et al., 2017).

The previous study showed that housewife had been exposed to a greater risk to suffer from multiple cardiovascular risk factors, including diabetes, hypercholesterolemia and being overweight (Ghazali et al., 2015). Similarly, a local cross-sectional study which focused on metabolic syndrome among the rural Malay population also reported that the unemployed and the housewives had higher odds for metabolic syndrome (Jan Mohamed, Mitra, Zainuddin, Leng, & Wan Muda, 2013).

2.3.2.8 Marital Status and Non-Communicable Diseases

It was found that divorced respondents were more likely (OR=1.615, 95% CI=1.190-2.193) to have Impaired Fasting Glucose when compared to single respondents in Saudi Arabia (Al-Baghli et al., 2010). However, married respondents were found 1.63 times more likely to have Newly Diagnosed Diabetes Mellitus than the single respondents in Malaysia (Ismail et al., 2016). On contrary, it was observed that divorced/separated/widowed/widowers had lower odds (aOR=0.49(0.26-0.95) of having uncontrolled (known) diabetes in India (Kanungo et al., 2016).

Divorced respondents exhibited statistically significant and highest odds (OR=2.401, 95% CI=2.068-2.787) of Known Diabetes Mellitus as compared to single respondents in Saudi Arabia (Al-Baghli et al., 2010). In contrast, it was claimed that marital status was not significantly related to diabetes mellitus (P= 0.37) in Iran (Rahmanian et al., 2013).

Meanwhile, it was noted that married adults were less likely to have high blood pressure objectively in United States of America (Mosca & Kenny, 2014). It was because married individuals may be more concerned about their health due to the influence from their partners and responsibilities towards their families (He et al., 2014). On contrary, marital status was not significantly associated with the risk of Hypertension (El Bcheraoui et al., 2014). Previous studies among Malaysian adults, mentioned that, married people were more likely to have Hypercholesterolemia (Ghazali et al., 2015; Karunaratne & Perera, 2015).

2.4 Statistical Tools and Techniques Review

2.4.1 Logistic Regressions

Logistic regression has been identified as the most popular multivariable method applied in health science (Tetrault, Sauler, Wells, & Concato, 2008). The logistic regression is great in its ability to estimate the individual effects of continuous or categorical independent variables simultaneously on the categorical dependent variables. Logistic regression is used primarily with dichotomous dependent variables, the technique can be extended to situations involving outcome variables with 3 or more categories (polytomous, or multinomial, dependent variables) (Wright, 1995).

2.4.1.1 Multinomial Logistic Regression

Multinomial Logistic Regression is the extension of (binary/binomial) (Hosmer & Lemeshow, 2000), where the categorical dependent outcome has more than one level. When there are more than two classifications, the techniques are stated to multinomial logistic regression and if the multiple categories are in order, ordinal logistic regression will be used (Bender & Grouven, 1997; Chan, 2004). This is to establish multinomial logistic regression model by developing the relationship with the predictor variables for the purpose to estimate and assess the prediction of independent variables on dependent variables. In multinomial logit model, data over the individual are analyzed, the effects of the explanatory variables were allowed to differ for each outcome (Long, 1997; Porter, 1999). One of the advantages to apply multinomial logistic regression (MLR) is that it does not assume normality, linearity, or homoscedasticity (Starkweather & Moske, 2011).

Numerous NCDs risk factors studies have used multinomial logistic regression in their study (Al-Maqbali, Temple-Smith, Ferler, & Blackberry, 2013; de Matos Nascimento, de Melo Mambrini, de Oliveira, Giacomin, & Peixoto, 2015; Okwechime & Roberson, 2015; Viswanathan et al., 2012; Zahangir, Hasan, Richardson, & Tabassum, 2017) to deal with categorical variables.

2.5 Research gaps

According to the previous literature review of modifiable and non-modifiable risk factors on NCDs (Diabetes Mellitus, Hypertension and Hypercholesterolemia), the following research gaps have been deduced and recognized from empirical perspective:

Firstly, most previous studies have investigated the prevalence of NCDs in common, for instance Diabetes Mellitus, Hypertension and Hypercholesterolemia. Therefore, it would be more comprehensive if the study can investigate the the likelihood on the prediction of NCDs for the purpose to prevent and control the NCDs prevalence and the NCDs occurrence in Malaysia.

Secondly, there were some studies that have examined the predictors (risk factors) for NCDs outcomes generally, for example, the estimation of predictors for Diabetes Mellitus, Hypertension and Hypercholesterolemia in common. Therefore, the investigation of predictors (risk factors) on different level of NCDs outcomes in this study is essential for the design of strategy formulation on the control of NCDs in Malaysia.

Thirdly, some studies have examined the predictors (risk factors) on different levels of particular NCDs outcomes. For example, the estimation of predictors for pre-diabetes and diabetes in Florida by Okwechime & Roberson (2015). This study fills the gap to provide a detailed research analysis to estimate the predictors (risk factors) of three stated NCDs based on different NCDs outcome levels: Impaired Fasting Glucose, Newly Diagnosed Diabetes Mellitus, Known Diabetes, Newly Diagnosed Hypertension, Known Hypertension, Newly Diagnosed Hypercholesterolemia and Known Hypercholesterolemia.

Lastly, previous literature review has shown the estimation of predictors of NCDs outcomes was not only focused on modifiable risk factors but also affected by the socio-demographics and socioeconomic factors (non-modifiable risk factors) simultaneously. Hence, this study is determined to fill in the gap by analyzing and identifying the predictors (modifiable risk factors) on different levels of NCDs outcomes, which directly refers to the one to one relationship. At the same time, the analysis of non-modifiable risk factors would also be carried out directly to identify the predictors (non-modifiable risk factors) on different levels of NCDs outcomes directly. This is specifically to tackle the issues and design appropriate policies and strategies for the prevention of NCDs in Malaysia.

With regard to the methodological gap from the previous literature review, most previous studies have examined predictors (risk factors) for either undiagnosed hypertension, diagnosed hypertension, impaired fasting glucose, newly diagnosed diabetes mellitus and known diabetes in separate models. Hence, this study will be the leader among the researches to investigate the potential predictors (modifiable and non-modifiable risk factors) of different levels of NCDs outcomes in one model by investigating more than two levels on the dependent variables in the same model to estimate the association of each level of polytomous variables with potential risk factors. In addition, for the exposure to NCDs, outcomes are not limited to two dichotomous categories except Diabetes Mellitus (yes or no). The different levels of Diabetes Mellitus outcomes (Impaired Fasting Glucose, Newly Diagnosed Diabetes Mellitus and Known Diabetes Mellitus) deserve more attention using multinomial logistic regressions.

2.6 Conclusions

This chapter has emphasized on the theories underpinning the importance on different levels of prevention model and the initial discussion of welfare economic as well as rational choice theory in the application based on the context of this study. The review of the relevant literature which are related to the empirical evidence of risk factors on different levels of NCDs outcomes are discussed according to the objectives of this study. The relevant theories will be further discussed in the following chapter and to be connected in order to conceptualize the framework of this study.

CHAPTER 3: METHODOLOGY

3.1 Introduction

Non-Communicable Diseases such as Diabetes Mellitus, Hypertension and Hypercholesterolemia are preventable. The literature review in Chapter 2 has demonstrated the various issues related to risk factors and has formed a foundation for the development of conceptual framework in this chapter. This chapter provides seven main sections. **Section 3.1** briefly introduces the outline of this chapter. In **section 3.2**, it demonstrates the conceptual framework with a brief explanation of this study. **Section 3.3** explains variables of this study. **Section 3.4** describes the data analysis techniques and model specification applied in this thesis. **Section 3.5** explains the diagnostic tests for multinomial logistic regression. **Section 3.6** gives a brief explanation of the data description which includes data source of this research. **Section 3.7** summarizes the methodology applied in this study.

3.2 Conceptual Framework on Non-Communicable Diseases

From the discussions of the previous section above pertaining to the theories, a conceptual framework has been derived which explains the reasons behind forming the social and economic behavior which influences the different level of NCDs outcomes.

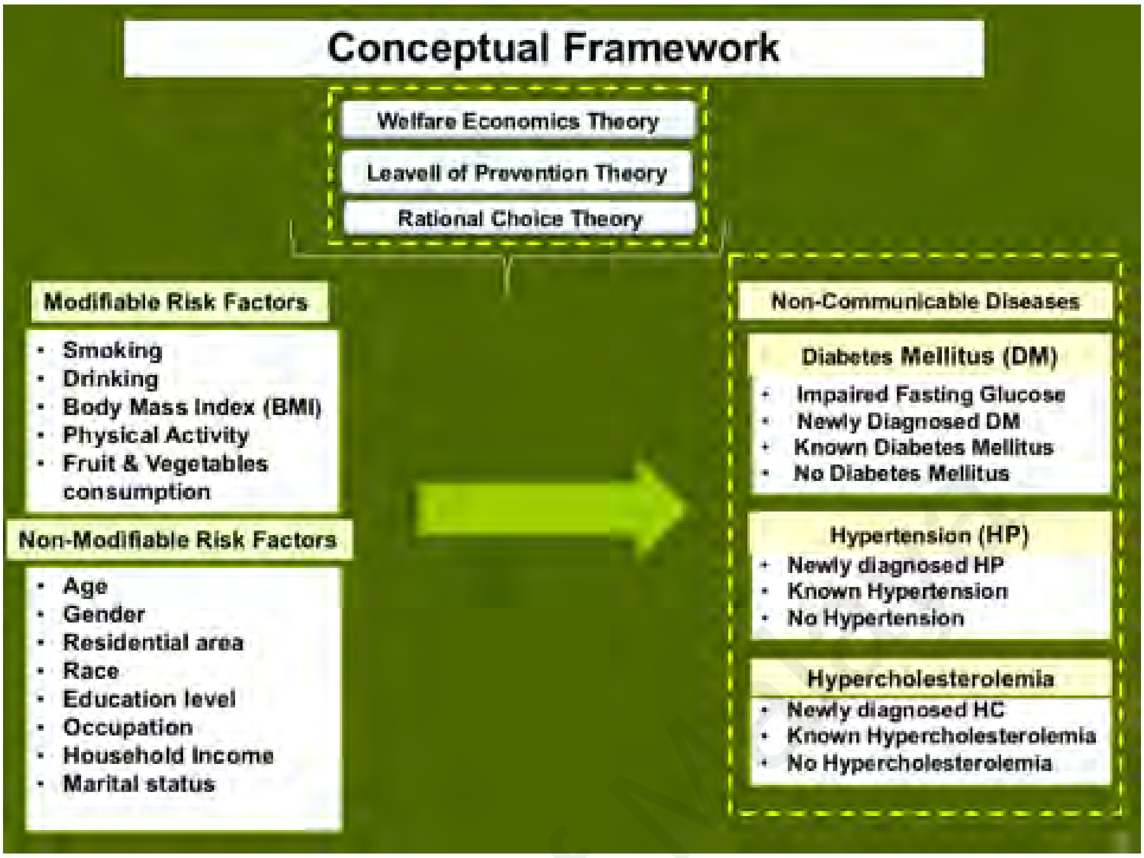

Figure 3.1 Conceptual Framework for this study

From **Figure 3.1**, this study is conceptualized based on three main studies; the Welfare Economics Model; the Rational Choice Theory and the Prevention Model framework of Leavell and Clark. Based on the research objectives of this study, this study assesses the predictors of three NCDs, namely Diabetes Mellitus, Hypertension and Hypercholesterolemia. The predictors comprise of modifiable risk factors which include Body Mass Index (BMI), alcohol consumption (drinking), physical inactivity, inadequate fruit and vegetables consumption and smoking. Besides, predictors also include non-modifiable risk factors that consist of age, gender, race, educational level, household income, residential area, occupation and marital status.

The welfare economics framework identified the importance of health which is free from suffering of any of the NCDs as the basic social welfare among individuals in Malaysia. Next, prevention model framework explains the primary prevention, where the major focus is in NCDs prevention, which involves cost effectiveness on the medical cost for the country. In this study, prevention of NCDs will require some changes in the health behavior among Malaysians. Prevention is based on the choices made by people. Application of model will be necessary to guide the changes of behavior among Malaysians which could lead them to make right choices. Dobe (2012) mentioned that for changes to be effective, it is necessary to understand and apply the model which have been widely used to encourage people to make healthy choices. Since Buse (2007) has pointed out that the aggressive use of lifestyle modifications can reduce or delay the need for medical intervention. Thus, appropriate lifestyle and medical interventions will definitely reduce the occurrence of CVD and allow people with diabetes to live healthier and longer lives.

Rational choice theory was used to shape this study in understanding how individuals make their rational choice about modifiable risk factors, for example like smoking, drinking, physical activity, fruit and vegetables consumption and body mass index (overweight/obesity) and what other non-modifiable risk factors/ socioeconomic demographic factors influence their decision. To achieve the purpose of better health outcomes and free from NCDs, individuals are required to make choices rationally and this can be explained further by the practice of rational choice theory among individuals in Malaysia.

The rational choice theory states the importance of rationality of decision making in the choices of application in healthy lifestyles, for example physically active, maintain healthy weight, reduce drinking and smoking and adequate of fruit and vegetables consumption in order to prevent Diabetes Mellitus, Hypertension and Hypercholesterolemia based on the estimation of odds ratios on different level of NCDs outcomes, namely, Impaired Fasting Glucose, Newly Diagnosed DM, Known DM, Newly Diagnose HP, Known HP, Newly Diagnosed HC and Known HC. As a result, it is essential to investigate by examining the likelihood of all predictors which include modifiable and non-modifiable risk factors based on the different levels of NCDs outcomes.

Relevant intervention strategies, for example behavioral interventions for Malaysians are required to help them develop skills to enhance health literacy and problem solving, in order to enhance their awareness of available resources and decreasing the perceived cost of making healthy choices to prevent the development of NCDs (Cha, Crowe, Braxter, & Jennings, 2016).

3.3 Variables of this study

3.3.1 Coding of variables

The coding of risk factors in this study involves k categories. It is necessary to select one category as a base- line and code the remaining (k −1) categories as binary (0 or 1) indicators of being in each category. Selection of the baseline category is arbitrary, but it is important to realize that statistical packages will only routinely supply tests of the effect of being in one of the other categories relative to the chosen baseline category. Categorical variables require special care. For a risk factor with k categories we must select one category as a baseline and code the remaining (k -1) categories as binary (0 or 1) indicators of being in each category.

3.3.1.1 Dependent variables (Non-Communicable Diseases: Diabetes Mellitus, Hypertension and Hypercholesterolemia)

For three dependent variables which consists of Diabetes Mellitus, Hypertension and Hypercholesterolemia have been coded as Diabetes Mellitus (Categorical, coded 3: Known Diabetes Mellitus, 2: Newly Diagnosed Diabetes Mellitus , 1: Impaired Fasting Glucose, 0: No Diabetes); Hypertension (Categorical, coded 2: Known Hypertension, 1: Newly Diagnosed Hypertension, 0: No Hypertension) and Hypercholesterolemia (Categorical, coded 2: Known Hypercholesterolemia, 1: Newly Diagnosed Hypercholesterolemia, 0: No Hypercholesterolemia). **Table 3.1** shows the coded dependent variables in this study for the purpose of statistical analysis.

Table 3.1 Categorical Variable Coding for Dependent Variables

Dependent Variable(s)	Variable Coding(s)	Definition
Diabetes Mellitus	3=Known Diabetes Mellitus	Self-reported by subject, as having diagnosed with diabetes previously by medical personnel.
	2=Newly Diagnosed Diabetes Mellitus	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).
	1=Impaired Glucose Tolerance	Not known to have diabetes and has a fasting capillary blood glucose (FBG) between 5.6 and to less than 6.1 mmol/L.
	0 = No Diabetes	Individuals with no diabetes mellitus and has a fasting capillary blood glucose (FBG) less than 5.6 mmol/L.
Hypertension	2= Known Hypertension	Self-reported by subject, as having diagnosed with hypertension previously by medical personnel.
	1=Newly Diagnosed Hypertension	Not known to have hypertension and has an average systolic blood pressure equal to or more than 140 mmHg and/or diastolic blood pressure equal to or more than 90 mmHg.

Table 3.1, continued

Dependent Variable(s)	Variable Coding(s)	Definition
Hypertension	0=No Hypertension	Individuals with no hypertension and has an average systolic blood pressure less than 140 mmHg and/or diastolic blood pressure less than 90 mmHg.
Hypercholesterolemia	2=Known Hypercholesterolemia	Self-reported by subject, as having diagnosed with hypercholesterolemia previously by medical personnel.
	1=Newly Diagnosed Hypercholesterolemia	Not known to have hypercholesterolemia and has a total blood cholesterol equals to or more than 5.2 mmol/L.
	0=No Hypercholesterolemia	Individuals with no Hypercholesterolemia and has a total blood cholesterol less than 5.2 mmol/L.

3.3.1.2 Independent Variables

For multivariable analyses, multinomial logistic regression models (inclusion criteria: p value of the score test, 0.05) was used to analyse the effect of following potential predictor variables : BMI (Categorical, coded 0: Obese, 1: Overweight, 2: Underweight, 3: Normal), Physical activity (Categorical, coded 1: Inactive, 2: Active), Drinking status (Categorical, coded 0: unclassified, 1: Current drinker, 2: Ex-drinker, 3: Non-drinker), smoking status (Categorical, coded 0: current smoker, 1: Ex-smoker, 2: Non-smoker) and Fruit and Vegetables Consumption (Categorical, coded 1: inadequate, 0: adequate) as shown in **Table 3.2** below.

Table 3.2: 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. The selected MET values were derived from work undertaken during the IPAQ Reliability Study undertaken in 2000-2013. Using the Ainsworth et al. Compendium (Med Sci Sports Med 2000) an average MET score was derived for each type of activity. For example: all types of walking were included and an average MET value for walking was created. The same procedure was undertaken for moderate-intensity activities and vigorous-intensity activities. The following values continue to be used for the analysis of IPAQ data : Walking = 3.3 METs, Moderate PA = 4.0 METs and Vigorous PA = 8.0 METs. Using these values, four continuous scores are defined:- Walking MET-minutes/week = 3.3* walking minutes*walking days Moderate MET-minutes/week = 4.0* moderate-intensity activity minutes*moderate days Vigorous MET-minutes/week = 8.0* vigorous-intensity activity minutes* vigorous-intensity days Total physical acivity MET-minutes/week=sum of Walking + Moderate + Vigorous MET minutes/week scores.
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.

Table 3.2, continued

Modifiable Risk Factor(s)	Variable Coding(s)	Definition
Drinking Status (define and analysis based on respondent's answer)	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. Respondent who reported to have smoked 100 or more cigarettes in lifetime but not smoking in the past one month preceding the survey (CDC definition)
	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.
Body Mass Index (BMI) Status (WHO1998)	0=Obese	≥30.0 kg/m^2
	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

Table 3.3: Categorical Variable Codings for Non-Modifiable Risk Factor

Non-Modifiable Risk Factors	Variable Coding(s)	Definition
Gender	1=Female	The respondent is female.
	2=Male	The respondent is male.
Race	0=Others	The respondent's race is others (especially foreigner)
	1=Other Bumiputra	The respondent's race is Other Bumiputra which refers to other native ethnic groups, not including the Malays (Ethnic of Sabah, Sarawak and Orang Asli).
	2=Indian	The respondent's race is Indian.
	3=Chinese	The respondent's race is Chinese.
	4=Malays (Reference)	The respondent's race is Malay.
Age	0=>65 years old	The respondent is aged more than 65 years.
	1=55-64 years old	The respondent is aged 55-64 years.
	2=45-54 years old	The respondent is aged 45-54 years.
	3=35-44 years old	The respondent is aged 35-44 years.
	4=25-34 years old	The respondent is aged 25-34 years.
	5=15-24 years old	The respondent is aged 15-24 years.
	6=below 15 years old (Reference)	The respondent is aged below 15 years.
Education level	0=Unclassified	The respondent has unclassified education (below 7 years old).
	1=No formal	The respondent as no formal education, never been to school.
	2=primary	The respondent does not complete primary or completed standard 6.
	3=secondary	The respondent has completed form 3 or form 5.
	4=others	The respondent has others form of education.
	5=tertiary (Reference)	The respondent has completed form 6/certificate/diploma and above.
Residential Area	0=Urban	The respondent lives in an area with a population 10,000 and above.
	1=Rural (Reference)	The respondent lives in rural area with a population below 10,000.
Marital Status	0=Widow/widower or divorced	The respondent is widow/widower/divorced.
	1=Married	The respondent is married.
	2=Single (Reference)	The respondent is single.

Table 3.3, continued

Non-Modifiable Risk Factors	Variable Coding(s)	Definition
Household Income (RM)	0=Above RM7000	Monthly individual income is above RM7000.
	1=RM5001-7000	Monthly individual income is in the range of RM5001-7000.00
	2=RM3001-5000	Monthly individual income is in the range of RM3001-5000.00
	3=RM1501-3000	Monthly individual income is in the range of RM1501-3000.00
	4=RM0-1500 (Reference)	Monthly individual income is in the range of RM0-1500.00
Occupation	0=Retiree	The respondent is a government and private retiree.
	1=Home maker	The respondent is a housewife (homemaker, take care of children).
	2=Self-employed	The respondent is self-employed (no employer).
	3=Private	The respondent is a private employee and works in a private sector.
	4=Government/Semi Government (Reference)	The respondent is government/Semi Government worker.

For independent variables which consist of non-modifiable risk factors have been coded as the following: Gender (categorical, coded 1: Male, 2: Female), Ethnicity/Race (categorical, coded 0: others, 1: other Bumiputra, 2: Indian, 3: Chinese, 4: Malays), Age (categorical, coded 0=>65 years old, 1: 55-64, 2: 45–54, 3: 35–44, 4: 25–34, 5: 15–24, 6=below 15 years old), Educational level (categorical, coded 0: Unclassified, 1: No formal, 2: Primary, 3: Secondary, 4:Tertiary), Residential area (categorical, coded 0: Urban, 1: Rural), Household income (categorical, coded 0: Above RM7000, 1: RM5001-7000, 2: RM3001-5000, 3: RM1501-3000, 4: RM0-1500), Occupation (categorical, coded 0: Retiree, 1: Home maker, 2: Self-employed, 3: Private, 4: Government/Semi Government) and Marital status (Categorical, coded 0: Widow/widower or divorced, 1: Married, 2: Single).

3.4 Data Analysis Techniques and Model Specification

This section includes description of data analysis technique and the model specification of the study. It includes the variables used in the study, the main analysis used to identify the predictors of different NCDs outcome levels and the diagnostic tests used to check the accuracy of the analysis.

3.4.1 Multinomial Logistic Regression (MLR)

From the regression analysis, multinomial logistic regression is used to model the different possible outcomes (dependent variables) to predict the outcomes by estimating the odds of the modifiable and non-modifiable risk factors (polytomous variables) in this study. One category of dependent variables will be selected as the reference category when using this multinomial logistic regression. The reference category will be omitted when the odds of an event occurring in the presence of a factor, compared to the odds of an event occurring in the absence of that factor are determined for all independent variables for each category of the dependent variables. The specification for multinomial logistic regression will be as follows:

When the outcomes of a response variable are polytomous with *k* nominal categories 2, *k* >2, the multinomial logistic regression model with the multinomial response variable, *Y* and multiple predictor variables, X_1, X_p consists of *k*-1 non-overlapping logit models (Ghazali, Ali, Noor, & Baharum, 2015).

$$\log_e\left(\frac{P(Y_i = 1|X_{i1}, \dots, X_{i,p})}{P(Y_i = k|X_{i1}, \dots, X_{i,p})}\right) = \beta_{1o} + \beta_{11}X_{i1} + \dots + \beta_{1,p}X_{i,p} = \beta_1' X_i$$

$$\log_e\left(\frac{P(Y_i = 1|X_{i1}, \dots, X_{i,p})}{P(Y_i = k|X_{i1}, \dots, X_{i,p})}\right) = \beta_{2o} + \beta_{21}X_{i1} + \dots + \beta_{2,p}X_{i,p} = \beta_2' X_i$$

⋮

$$\log_e\left(\frac{P(Y_i = k-1|X_{i1},\ldots,X_{i,p})}{P(Y_i = k|X_{i1},\ldots,X_{i,p})}\right) = \beta_{k-1,o} + \beta_{k-1,1}X_{i1} + \cdots + \beta_{k-1,p}X_{i,p} = \beta'_{k-1}X_i$$

Since Y_i is the response in the ith trial, X_{i1}, …, $X_{i,p}$ are the values of the *p* predictor variables in the ith trial, $\beta_{k-1,o}$, $\beta_{k-1,1}$, … , $\beta_{k-1,p}$ are parameters of the model, the *k*th category is the reference category, i = 1, 2,… , n.

Basically the jth logit:

$$\log_e\left(\frac{P(Y_i = 1|X_{i1},\ldots,X_{i,p})}{P(Y_i = k|X_{i1},\ldots,X_{i,p})}\right) = \beta_{jo} + \beta_{j1}X_{i1} + \cdots + \beta_{j,p}X_{i,p} = \beta'_{j}X_i \quad (3.1)$$

is the logistic regression model when restricting to categories *j* and *k*.

3.4.1.1 Maximum Likelihood Estimation

The method of maximum likelihood, estimates the parameters of the multinomial logistic regression model by maximizing the likelihood function and it is used to assess the regression coefficients (logit model). Maximum Likelihood Estimation (MLE) seeks to maximize the log-likelihood that reflects the odds of observed values of dependent variables that may be predicted from the observed values of independent variables (Long, 1997). The MLE can be obtained from the dependent variable joint probability function and can be solved using Newton-Raphson method for non-linear equation (Myung, 2003). The MLE function is expressed as the following:

$$L(\beta_0, \beta_1, \ldots \beta_p) = L(\beta) = \prod_{i=1}^{n}\prod_{j=1}^{k}(p_{ij})^{Y_{ij}}$$

Where $\mathbf{p_{ij}} = \mathbf{P}(\boldsymbol{Y}_{\mathbf{i}} = \boldsymbol{j}|\boldsymbol{X}_{\mathbf{i1}},\ldots,\boldsymbol{X}_{\mathbf{i,p\text{-}1}}) = \frac{\mathbf{exp}(\boldsymbol{\beta}'_{\mathbf{j}}\mathbf{X_i})}{\mathbf{1}+\sum_{\mathbf{j=1}}^{\boldsymbol{k}\text{-}\mathbf{1}}\mathbf{exp}(\boldsymbol{\beta}'_{\mathbf{j}}\mathbf{X_i})}$ (3.2)

3.4.1.2 Odds Ratio

Odds ratio (OR) is used to assess the contribution of individual predictors. It represents the constant effect of a predictor X, on the likelihood that one outcome will occur. It is a successful likelihood ratio and failure likelihood ratio that can be used to explain the coefficient regression in the logistic regression model (Kleinbaum, Klein, & Pryor, 2002). Odds ratio is used to compare two groups, X_k and X_{k+1} can be written as the following equation:

$$\log_e(\text{odds}_2) - \log_e(\text{odds}_1) = \log_e\left(\frac{\text{odds}_2}{\text{odds}_1}\right) \tag{3.3}$$

$$= (b_o + b_1X_1 + \cdots + b_kX_k + \cdots + b_KX_K)$$

$$- (b_o + b_1X_1 + \cdots + b_k(X_k + 1) + \cdots + b_KX_K)$$

$$= b_kX_k - b_k(X_k + 1) = b_k$$

As a result, the estimated odds ratio (OR) is given as :

$$\text{OR} = \frac{\text{odds}_2}{\text{odds}_1} = e^{b_kX_k} \text{-} e^{b_k(X_k+1)} = e^{b_k} \tag{3.4}$$

3.5 Diagnostic Tests of Multinomial Logistic Regression

3.5.1 Univariate Analysis

Univariate analysis will be carried out to test the association of one explanatory variable at a time with different NCDs outcome levels in this research. This is for the purpose to shortlist variables for multivariate analysis, especially if there are large number of explanatory variables.

3.5.2 Correlation Matrix

Two-way correlations between the predictors which include modifiable and non-modifiable risk factors, will be assessed using Pearson's correlation coefficient to avoid highly correlated predictor variables in this study.

3.5.3 Multicollinearity Test

It is important to check on multicollinearity problems which may arise when the predictor variables for the regression model are highly correlated among themselves. This is because multicollinearity can cause unstable estimates and inaccurate variance which affects the confidence intervals and hypothesis tests. The multicollinearity can be detected by examining the standard errors for the regression coefficients (Allison, 2012). There will be multicollinearity problem if the standard errors of the independent variables are >2.00 (El-Habil, 2012). Besides, multicollinearity can be tested by using correlation matrix between the variables (Chan, 2004).

To be free from multicollinearity, the association between any two variables are within the tolerance level which is between 0.001 to 0.805, which is less than the threshold of 0.85. Next, the variance inflation factor (VIF) of independent variables which is <10.0 also considered to have no multicollinearity. The outliers could be identified using standard residuals. The residuals are the difference between the actual probability and the predicted probability for a case. An outlier is considered if a standardized residual is bigger than 3.0 or smaller than -3.0 (Sarkar, Midi, & Rana, 2011). Influential outliers are detected using Cook's Distance, D_i (Jacoby, 2005). The influential outlier is identified to the data if Cook's distance, D_i is greater than 1.0 (Gordon, 2015).

$$D_i = \frac{e_i^2}{pMSE}\left[\frac{h_{ii}}{(1-h_{ii})^2}\right] \qquad (3.5)$$

e_i is the residual, p is the parameters in the model, MSE is the mean square error of the regression model, h_{ii} is the leverage value for the i^{th} case.

3.5.4 Testing of Goodness Fit

Model goodness-of-fit will be assessed using the goodness-of-fit test to determine and approximates the behavior of the selected data (Fagerland, 2012). The Goodness-of-fit Tests of the multinomial logistic regression procedure reports Pearson and Deviance goodness-of-fit statistics. The Pearson chi-square (χ^2) and the deviance-based inferential tests of goodness-of-fit are assessed for the multinomial logistic regression to show whether the model sufficiently fits the data. The Pearson chi-square test statistic used Pearson residuals. In the meantime, deviance function which is identified as a likelihood ratio test is used in the deviance chi-square test statistic (Maydeu-Olivares & Garcia-Forero, 2010).

Pseudo R-Squares (Cox & Snell, Nagelkerke, and McFadden) are used to examine to what extent the proposed model is an enhancement over the null model and the overall classification accuracy (Kwak & Clayton-Matthews, 2002). For logistic regression, Pseudo R-Squares shows the percentage of variation in the outcome variable that is clarified by the logistic model (Demand, 1975). Pseudo R-Squares have been developed in logistic regression to provide measures for the usefulness of the model. On the other hand, they do not represent the amount of variance in the outcome variable accounted by the predictor variables. Higher values will indicate a better fit in the model. Meanwhile, Cox and Snell's R-square has the disadvantage that for discrete models for example, logistic regression, it may not achieve maximum value of one, even when the model predicts all the outcomes perfectly. As cited by Aziz, Ali, Nor Baharum, & Omar (2016), Nagelkerke's R-Square is an improvement over Cox and Snell's R-square which can attain a value of one when the model predicts the data perfectly. The Cox and Snell's R-square is given as follows:

$$R^2 = 1 - \left[\frac{L(M_{intercept})}{L(M_{full})}\right]^{2/n} \tag{3.6}$$

The Nagelkerke's R-Square is given as follows :

$$R^2 = \frac{1 - \left[\frac{L(M_{intercept})}{L(M_{full})}\right]^{2/n}}{1-[L(M_{intercept})]^{2/n}} \tag{3.7}$$

$L(M_{intercept})$ is the likelihood of the intercept model, $L(M_{full})$ is the likelihood of the full model.

3.5.5 Likelihood Ratio Tests

A likelihood ratio test shows whether the model fits the data better than a null model. Behavior of predictors/independent variables in terms of significance, direction, and standardized impact is also examined based on the method and model. The significance of each of the predictors (independent variables) is assessed using the likelihood ratio test and Wald test (Fit, 2010). Likelihood ratio test for some parameters compares the likelihood to obtain the data when zero parameter, L_0 with likelihood L_1 is obtained from the parameter maximum likelihood method which is based on a statistical test:

$$G^2 = -2\log\left(\frac{L_0}{L_1}\right) = -2[\log(L_0)\text{-}\log(L_1)] \tag{3.8}$$

Statistical test compare the distribution χ^2 with q degree of freedom. H_o is rejected if:

$G^2 > \chi^2(1)$

The confidence interval for a single parameter β_k :

$$b_k \pm \left(z_{\frac{\alpha}{2}}\right) s\{b_k\} \tag{3.9}$$

where b_k is the estimation value for the model parameter and $s\{b_k\}$ is the standard error for b_k.

The Wald statistic is the proportion of the square of the regression coefficient to the square of the standard error of the coefficient and is asymptotically distributed as a chi-square distribution (Menard, 2002)

It is used to test a single predictor variable in logistic regression as shown below:

$$W_k = \left(\frac{\hat{\beta}}{\text{standard error}\,(\hat{\beta})}\right)^2 \qquad (4.0)$$

3.5.6 Overall Classification Accuracy

The classification table is a method to evaluate the predictive accuracy of the logistic regression model (Garson, 2009). Further, it is for the purpose to assess the correct and incorrect classifications of the multinomial response variables (Garson, 2009). This shows the percentage of cases that are accurately classified by the models and the better models will have greater of correct classifications (Menard, 2002).

3.6 Data description and source

This thesis utilised data from the cross sectional survey: The Fourth National Health and Morbidity Survey in 2011 which was conducted by the Disease Control Division at Ministry of Health, Malaysia and employs secondary data analysis. The sample size is approximately 28,498 people in Malaysia from the survey done by the Ministry of Health in 2011. The target population of this survey covered both urban and rural areas of every state in Malaysia. The definition of urban area is a gazetted area which has a combined population of 10,000 or more at the time of census 2010. However, rural area is defined as a gazetted area which has a combined population of less than 10,000. The selection criteria were determined by the Ministry of Health Malaysia. The target population consists of all non-institutionalized individuals residing in Malaysia for at least 2 weeks prior to data collection. In contrast, institutional population such as those staying in hotel, hostels, hospitals etc. were excluded from this survey.

The sampling frame of The Fourth National Health and Morbidity Survey was provided by the Department of Statistics Malaysia. Based on the sampling frame of this survey which was updated in year 2010 prior to the National Population and Housing Census 2010, Malaysia was divided into Enumeration Blocks (EB) which are geographically continuous areas with identified boundaries. There were approximately 75,000 EBs in Malaysia in the year 2010 and each EB had between 80 to 120 Living Quarters with an average population of 500 to 600 people. The EB in the sampling frame was classified into either rural or urban areas by the Department of Statistics based on the population size of gazette and residential areas. A two-stage stratified sampling design was used to ensure national representativeness. 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 (Institute for Public Health, 2011). Additionally, Structured questionnaires with face-to-face interviews as well as other administered methods were used to collect data by the Ministry of Health, Malaysia.

The sample size was determined using Sample Size Calculation Formula for a prevalence study.

$$n_{SRs} \geq \frac{z^2_{\alpha/2} P\,(1-P)}{e^2} \qquad (4.1)$$

The adjusted n(srs) for the total number of target population (N) (Based on estimated 2010 population) :

$$n \geq \frac{n_{SRS}}{1+\frac{n_{SRS}}{N}} \qquad (4.2)$$

From this survey, the sample size calculation was based on the following criteria :

1. Margin of error (e) (Between 0.01 to 0.05)
2. Expected prevalence of diseases or health related problems in the population (based on NHMS III).
3. Confidence Interval of 95%.

Ethical approval from the Medical Research Ethics Committee of Ministry of Health was obtained to conduct this research (NMRR-12-324-11225). Data is analyzed by using SPSS Version 23. Multivariate analysis was performed by using multinomial logistic regression and results of logistic regression was expressed as odds ratio and 95% Confidence Interval (CI). A two-sided p value of less than 0.05 (two-sided) was considered as statistically significant.

After the data screening, missing data are found in this study due to the failure of the respondents to answer the relevant questionnaire. Less than 4% missing data has been indicated as very low amount, 10% missing data supposedly, would not create a problem to the results (Cohen, Cohen, West, & Aiken, 1983). The single missing values were imputed using the multiple imputation (MI) procedure in SPSS Version 23.

3.7 Conclusions

This chapter explains concepts and theories applied in the thesis through the conceptual framework. Next, data and variables used in this research have been described. Statistical analysis techniques and model specification are provided and thereafter the explanation of diagnostic tests for multinomial logistic regression is displayed. Finally, this chapter summarizes the methodology and relevant theoretical framework which are demonstrated in this study.

CHAPTER 4: RESULTS

4.1 Introduction

In this chapter, the findings of the study which addresses its objectives have been presented. Tables and figures are used to display the findings. The findings are also interpreted and discussed based on the output of the analysis conducted. This chapter consists of ten sections. The first section covers an overall introduction of the findings, followed by the second section which provides descriptive statistics of the respondents' profiles. The third part describes the empirical findings of diagnostic test which includes multicollinearity tests and correlation matrix of Diabetes Mellitus, Hypertension and Hypercholesterolemia. Fourth section presents Full Model Fitting Assessment for multinomial logistic regression on Diabetes Mellitus. It includes Goodness-of-Fit, likelihood ratio test, Pseudo R-Square and model classification. The fifth section reports the results for all predictors of Diabetes Mellitus. Sixth section on the other hand, explains the full model fitting assessment for multinomial logistic regression on Hypertension which consists of Goodness-of-Fit, likelihood ratio test, Pseudo R-Square and model classification. The seventh section reports the results for all predictors of Hypertension. Section eight provides full model fitting assessment information for multinomial logistic regression on Hypercholesterolemia which incorporates the Goodness-of-Fit, likelihood ratio test, Pseudo R-Square and model classification. Next, the ninth section reports the result findings for all predictors of Hypercholesterolemia. Lastly, tenth section concludes the findings of this chapter.

4.2 Demographic Profile of Respondents

The demographic profile of respondents has been shown in **Table 4.1**. A total of 28,498 respondents from the Fourth National Health and Morbidity Survey (NHMS IV) are used in this study. Sample socio-demographics factors comprises of age, gender, race, education level, household income, marital status, occupation and residential area. Other independent variables include Body Mass Index (BMI), physical activity, fruit and vegetables consumption, drinking and smoking. Approximately 51.7% of the respondents are males and 48.3% are females. Socioeconomically, most of the respondents have secondary education (33.3%), works in private sectors (31.9%), and have household income from RM 0 to RM1500 (33.1%). Likewise, the race breakdown of the sample is as follows: 59.6% Malays, 17.3% Chinese, 10.3% other Bumiputra, 7.4% Indians and 5.3% others. The majority of the respondents are between the age of 0 to 15 years (30.2%), single (50.8%) and urban residents (57.4%).

Table 4.1: Demographic Profile of Respondents

Variable(s)	Level(s)	Frequency (n)	Percent (%)
Gender	Male	14741	51.7
	Female	13757	48.3
Education level	Unclassified	5516	19.4
	No formal education	1559	5.5
	Primary education	8065	28.3
	Secondary education	9485	33.3
	Tertiary education	3873	13.6
Occupation	Retire	3370	13.7
	Home maker	5180	21.0
	Self employed	5110	20.7
	Private	7858	31.9
	Government/Semi Government	3114	12.6
Household income	RM0-1500	9442	33.1
	RM1501-3000	7741	27.2
	RM3001-5000	5730	20.1
	RM5001-7000	2566	9.0
	above RM7000	3019	10.6
Residential area	Urban	16372	57.4
	Rural	12126	42.6
Race	Malays	16975	59.6
	Chinese	4944	17.3
	Indian	2122	7.4
	Other Bumiputra	2933	10.3
	Others	1524	5.3
Age	< 15 years old	8602	30.2
	15-24 years old	4558	16.0
	25-34 years old	3986	14.0
	35-44 years old	3643	12.8
	45-54 years old	3482	12.2
	55-64 years old	2460	8.6
	>65 years old	1767	6.2
Marital Status	Widow/widower/ Divorced	1470	5.2
	Married	12537	44.0
	Single	14463	50.8
Total		28498	100.0

4.3 Empirical Application: Multinomial Logistic Regression

4.3.1 Results of Multicollinearity Tests on Diabetes Mellitus, Hypertension and Hypercholesterolemia

Multinomial Logistic Regression (MLR) has been used in this study because the dependent variables are nominal and there are more than two categories. MLR has been stated as a good choice for this data because it does not assume normality, linearity, or homoscedasticity (Starkweather & Moske, 2011). It is found that there is no issue of multicollinearity among the independent variables because the VIF < 10. As a result, it is appropriate to proceed with all independent variables to fit the multinomial logistic regression model **(Appendix A)**.

4.3.2 Results of Correlation Matrix on Diabetes Mellitus, Hypertension, and Hypercholesterolemia

Appendix B shows the correlation among all independent variables. As the range of absolute correlation coefficients is 0.001 to 0.805, which is less than the threshold value 0.85, it can be concluded that there is no multicollinearity issue among the independent variables.

4.4 The Full Model Assessment and Model Fitting for Multinomial Logistic Regression on Diabetes Mellitus

4.4.1 Frequency of Diabetes Mellitus

In total, 10, 942 respondents in the study has diabetes with 6095 (24.7%) “known” cases. Among those respondents whose disease status is not known, 15.9% (3915 out of 10,942) of them respondents are newly diagnosed with Diabetes Mellitus, and 3.8% (932 out of 10,942) are classified as having Impaired Fasting Glucose **(Table 4.2)**.

Table 4.2: Frequency of Diabetes Mellitus

Diabetes Mellitus	Frequency	Percent (%)
No DM	13687	55.6
Impaired Fasting Glucose	932	3.8
Newly Diagnosed DM	3915	15.9
Known DM	6095	24.7
Total	24629	100.0

4.4.2 Results of Univariate Analysis for Diabetes Mellitus

From the association between each independent variables and the dependent variable (Diabetes Mellitus), **Table 4.3** shows that all independent variables: gender, education level, occupation, household income, residential area, race, age, marital status, Body Mass Index (BMI), drinking, physical activity, fruit and vegetables consumption and smoking have significant statistical evidence with the Diabetes Mellitus because results suggest that p-value < 0.05.

Table 4.3: Univariate Analysis of All Independent Variables with Diabetes Mellitus

Variable(s)	Level(s)	Diabetes Mellitus				Total N (%)	χ^2	P- value
		Impaired Diabetes Mellitus	Newly Diagnosed Diabetes Mellitus	Known Diabetes Mellitus	No Diabetes Mellitus			
Race	Malays	580 (62.2%)	2420 (61.8%)	3835 (62.9%)	7628 (55.7%)	14463 (58.7%)	265.010	<0.001
	Chinese	160 (17.2%)	644 (16.4%)	964 (15.8%)	2718 (19.9%)	4486 (18.2%)		
	Indian	74 (7.9%)	327 (8.4%)	553 (9.1%)	952 (7.0%)	1906 (7.7%)		
	Other Bumiputra	66 (7.1%)	352 (9.0%)	562 (9.2%)	1461 (10.7%)	2441 (9.9%)		
	Others	52 (5.6%)	172 (4.4%)	181 (3.0%)	928 (6.8%)	1333 (5.4%)		
	Total	932 (100.0%)	3915 (100.0%)	6095 (100.0%)	13687 (100.0%)	24629 (100.0%)		
Age	< 15 years old	1 (0.1%)	1590 (40.6%)	3115 (51.1%)	31 (0.2%)	4737 (19.2%)	9827.261	<0.001
	15-24 years old	113 (12.1%)	643 (16.4%)	1212 (19.9%)	2587 (18.9%)	4555 (18.5%)		
	25-34 years old	186 (20.0%)	291 (7.4%)	100 (1.6%)	3409 (24.9%)	3986 (16.2%)		
	35-44 years old	192 (20.6%)	372 (9.5%)	256 (4.2%)	2822 (20.6%)	3642 (14.8%)		
	45-54 years old	216 (23.2%)	456 (11.6%)	482 (7.9%)	2328 (17%)	3482 (14.1%)		
	55-64 years old	127 (13.6%)	340 (8.7%)	536 (8.8%)	1457 (10.6%)	2460 (10.0%)		
	>65 years old	97 (10.4%)	223 (5.7%)	394 (6.5%)	1053 (7.7%)	1767 (7.2%)		
	Total	932 (100.0%)	3915 (100.0%)	6095 (100.0%)	13687 (100.0%)	24629 (100.0%)		
Marital Status	Widow/widower or Divorced	67 (7.2%)	165 (4.2%)	275 (4.5%)	963 (7.0%)	1470 (6.0%)	4075.177	<0.001
	Married	692 (74.2%)	1427 (36.6%)	1451 (23.8%)	8967 (65.5%)	12537 (51.0%)		
	Single	173 (18.6%)	2305 (59.1%)	4365(71.7%)	3752 (27.4%)	10595 (43.1%)		
	Total	932 (100.0%)	3915 (100.0%)	6095 (100.0%)	13687 (100.0%)	24602 (100.0%)		
Residential Area	Urban	560 (60.1%)	2226 (56.9%)	3424 (56.2%)	7968 (58.2%)	14178 (57.6%)		
	Rural	372 (39.9%)	1689 (43.1%)	2671 (43.8%)	5719 (41.8%)	10451 (42.4%)		
	Total	932 (100.0%)	3915 (100.0%)	6095 (100.0%)	13687 (100.0%)	24629 (100.0%)		

Table 4.3, continued

Variable(s)	Level(s)	Diabetes Mellitus						
		Impaired Fasting Glucose	Newly Diagnosed DM	Known Diabetes Mellitus	No Diabetes Mellitus	Total N (%)	χ^2	P- value
Gender	Male	450 (48.3%)	2004 (51.2%)	3023 (49.6%)	6325 (46.2%)	11802 (47.9%)	39.681	<0.001
	Female	482 (51.7%)	1911 (48.8%)	3072 (50.4%)	7362 (53.8%)	12827 (52.1%)		
	Total	932 (100.0%)	3915 (100.0%)	6095 (100.0%)	13687 (100.0%)	24629 (100.0%)		
BMI	Obese	177 (19.0%)	1042 (26.6%)	2032(33.4%)	2010 (14.7%)	5261 (21.4%)	1447.948	<0.001
	Overweight	304 (32.6%)	1346 (34.4%)	2099(34.5%)	2894 (28.5%)	7643 (31/0%)		
	Underweight	57 (6.1%)	292 (7.5%)	386 (6.3%)	1261 (9.2%)	1996 (8.1%)		
	Normal weight	394 (42.3%)	1233 (31.5%)	1575 (25.9%)	6517 (47.6%)	9719 (39.5%)		
	Total	932 (100.0%)	3915 (100.0%)	6095 (100.0%)	13687 (100.0%)	24629 (100.0%)		
Education level	Unclassified	6 (0.6%)	507 (13.0%)	946 (15.5%)	202 (1.5%)	1661 (6.7%)	4699.788	<0.001
	No formal education	994 (7.3%)	207 (5.3%)	288 (4.7%)	994 (7.3%)	1559 (6.3%)		
	Primary education	228 (24.5%)	1744 (44.5%)	3105 (50.9%)	2975 (21.7%)	8052 (32.7%)		
	Secondary education	442 (47.4%)	1131 (28.9%)	1541 (25.3%)	6370 (46.5%)	9484 (38.5%)		
	Total	932 (100.0%)	3915 (100.0%)	6095 (100.0%)	13687 (100.0%)	24629 (100.0%)		
Occupation	Retire	96(10.3%)	578 (14.8%)	1579 (25.9%)	1117 (8.2%)	3370 (13.7%)	1625.73	<0.001
	Home maker	168 (18.0%)	920 (23.5%)	1521 (25.0%)	2570 (18.8%)	5179 (21.0%)		
	Self employed	233 (25.0%)	845 (21.6%)	1119 (18.4%)	2913 (21.3%)	5110 (20.7%)		
	Private	308 (33.0%)	1095 (28.0%)	1178 (19.3%)	5276 (38.5%)	7857 (31.9%)		
	Total	932 (100.0%)	3915 (100.0%)	6095 (100.0%)	13687 (100.0%)	24629 (100.0%)		
Household Income	RM0-1500	294 (31.5%)	1358 (34.7%)	2163 (35.5%)	4260 (31.1%)	8075 (32.8%)	53.355	<0.001
	RM1501-3000	239 (25.6%)	1044 (26.7%)	1626 (26.7%)	3796 (27.7%)	6705 (27.2%)		
	RM5001-7000	82 (8.8%)	346 (8.8%)	533 (8.7%)	1253 (9.2%)	2214 (9.0%)		
	RM3001-5000	207 (22.2%)	756 (19.3%)	1196 (19.6%)	2853 (20.8%)	5012 (20.3%)		
	above RM7000	110 (11.8%)	411 (10.5%)	577 (9.5%)	1525 (11.1%)	2623 (10.7%)		
	Total	932 (100.0%)	3915 (100.0%)	6095 (100.0%)	13687 (100.0%)	24629 (100.0%)		

Table 4.3, continued

Variable(s)	Level(s)	Diabetes Mellitus: Impaired Fasting Glucose	Diabetes Mellitus: Newly Diagnosed Diabetes Mellitus	Diabetes Mellitus: Known Diabetes Mellitus	Diabetes Mellitus: No Diabetes Mellitus	Total N (%)	χ^2	P- value
Physical Activity	Inactive	356 (38.2%)	1635 (41.8%)	2529 (41.5%)	4720 (34.5%)	9240 (37.5%)	125.056	<0.001
	Active	576 (61.8%)	2280 (58.2%)	2566 (58.5%)	8967 (65.5%)	15389 (62.5%)		
	Total	932 (100.0%)	3915 (100.0%)	6095 (100.0%)	13687 (100.0%)	24629 (100.0%)		
Fruits and Vegetables consumption	Inadequate	867 (93.0%)	3754 (95.9%)	5645 (92.6%)	12696 (92.8%)	22962 (93.2%)	52.312	<0.001
	Adequate	65 (7.0%)	161 (4.1%)	450 (7.4%)	991 (7.2%)	1667 (6.8%)		
	Total	932 (100.0%)	3915 (100.0%)	6095 (100.0%)	13687 (100.0%)	24629 (100.0%)		
Drinking Status	Unclassified	1 (0.1%)	129 (3.3%)	16 (0.3%)	84 (0.6%)	230 (0.9%)	482.561	<0.001
	Current drinker	68 (7.3%)	183 (4.7%)	378 (6.2%)	1334 (9.7%)	1963 (8.0%)		
	Ex-drinker	55 (5.9%)	129 (3.3%)	225 (3.7%)	740 (5.4%)	1149 (4.7%)		
	Non-drinker	808 (86.7%)	3474 (88.7%)	5476 (89.8%)	11529 (84.2%)	21287 (86.4%)		
	Total	932 (100.0%)	3915 (100.0%)	6095 (100.0%)	13687 (100.0%)	24629 (100.0%)		
Smoking Status	Current smoker	725 (77.8%)	3106 (79.3%)	4401 (72.2%)	10603 (77.5%)	18835 (76.5%)	151.111	<0.001
	Ex-smoker	57 (6.1%)	146 (3.7%)	317 (5.2%)	843 (6.2%)	1363 (5.5%)		
	Non-smoker	150 (16.1%)	663 (16.9%)	1377 (22.6%)	2241 (16.4%)	4431 (18.0%)		
	Total	932 (100.0%)	3915 (100.0%)	6095 (100.0%)	13687 (100.0%)	24629 (100.0%)		

4.4.3 The Fitted Model with all predictors of Diabetes Mellitus

After building the model, it is necessary to determine whether it reasonably approximates the behavior of the selected data.

4.4.3.1 Goodness-of-Fit for model (Diabetes Mellitus)

Table 4.4 presents two tests of the null hypothesis. Results show that the model adequately fits the data. Assuming that the null hypothesis is true, the Pearson and deviance statistics have chi-square distributions with the presented degrees of freedom. If the significance value is small (less than 0.05), then the model does not satisfactorily fit the data. In this instance, however, only Deviance value is larger than 0.05. The Pearson value is found to be less than 0.05. Therefore, this shows that the data is not consistent with the model's assumptions since the Pearson value is not significant.

Table 4.4: Goodness-of-Fit for model (Diabetes Mellitus)

	Chi-Square	df	P value.
Pearson	72733.2	53883	<0.001
Deviance	31093.24	53883	1

4.4.3.2 Model Fitting Information: Likelihood Ratio Test (Diabetes Mellitus)

After determining the validity of the model as shown in **Table 4.4**, the next stage is to check the contribution of each dependent variable's effect to the model as shown in **Table 4.5**. In other words, the next stage of the research is to determine the significance level of selected independent variables in the Multinomial model. For each outcome, the 2 log likelihood is used for the reduced model; that is, a model without effect. The chi-square statistic is the difference between the -2 log- likelihoods of the reduced model and the final model. The value has been stated in the model fitting information table. If the significance of the test is less than 0.05 then the effect contributes to the model.

Table 4.5 indicates the significance of the test for fruit and vegetables consumption, drinking, smoking, Body Mass Index (BMI), physical activity, educational levels, household income, marital status, gender, ethnics, occupation and age groups are smaller than 0.05. On the other hand, according to the results shown in the table, the p-value of residential area is larger than 0.05. As a result, it is statistically proven that there is a positive significant relationship between the likelihood of getting Diabetes Mellitus and drinking, fruit and vegetables consumption, smoking, Body Mass Index (BMI), physical activity, educational levels, household income, marital status, gender, race, occupation and age factors.

The results from the likelihood ratio tests, as presented in **Table 4.5** reveals that the presence of fruit and vegetables consumption, drinking, smoking, Body Mass Index (BMI), physical activity, educational levels, income, marital status, gender, race, occupation and age (except residence) are significant predictors of having Diabetes Mellitus.

Table 4.5: Likelihood Ratio Test (Diabetes Mellitus)

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	χ2	df	P value
Intercept	34364.799	-	-	-
Fruit & vegetables	34429.77	64.966	3	<0.001
Drinking	34561.28	196.476	9	<0.001
Smoking	34437.22	72.416	6	<0.001
Body Mass Index	35047.92	683.116	9	<0.001
Physical Activity	34398.82	34.016	3	<0.001
Education level	34681.39	316.586	12	<0.001
Household Income	34388.23	23.431	12	0.024
Marital status	34420.86	56.061	6	<0.001
Gender	34422.98	58.182	3	<0.001
Residence	34368.13	3.330	3	0.344
Race	34522.00	157.195	12	<0.001
Occupation	34818.79	453.994	12	<0.001
Age	37800.29	3435.494	18	<0.001

The chi-square statistic is the difference in -2 log-likelihoods between the final model and the reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

Table 4.6 indicates the likelihood ratio test of the model (Final) against one in which all the parameter coefficients are 0 (Null). The chi-square statistic is the difference between the -2 log Likelihood of the Null and Final model. Since the significance level of the test is less than 0.05, it can be concluded that the final model is outperforming the Null.

Table 4.6: Model Fitting Information (Diabetes Mellitus)

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	df	P-value
Intercept Only	48473.805			
Final	34364.799	14109.006	108	.000

Table 4.7 explains the validity of our model as a perfect model. Cox and Snell with 0.437 value (which is smaller than 1) satisfies the expectations of the model. The value for Nagelkerke is found to be 0.492 which lies between 0 and 1. Lastly, the value corresponding McFadden, 0.264 also satisfies the expectations of being between 0 and 1. Therefore, it can be concluded that the model used in this research is acceptable as an appropriate model. As a result, the results of the above shown statistics and tests indicates that the selection and use of multinomial model, fits the selected dependent and independent variables appropriately.

Table 4.7: Pseudo R-Square (Diabetes Mellitus)

Cox and Snell	0.437
Nagelkerke	0.492
McFadden	0.264

4.4.3.3 The Model Classification of Diabetes Mellitus

Results from **Table 4.8** given below indicate that from the cases used to create the model, 13,327 out of the 13,677 people are correctly classified as no diabetes. However, nobody from the 932 people suffering from Impaired Diabetes Mellitus has been classified correctly. Results also depicts that, 135 out of the 3,897 who suffered from Newly Diagnosed Diabetes Mellitus are classified correctly. Likewise, 3,855 out of the 6,088 who suffered from Known Diabetes Mellitus are classified correctly. Overall, 70.4% of the cases are classified correctly.

Table 4.8: Classification (Diabetes Mellitus)

Diabetes Mellitus	Predicted				
	No Diabetes	Impaired Fasting Glucose	Newly Diagnosed DM	Known DM	Percent Correct
No Diabetes	13327	0	31	319	97.40%
Impaired Fasting Glucose	903	0	0	29	0.00%
Newly Diagnosed DM	2030	0	135	1730	3.50%
Known DM	2177	0	56	3855	63.30%
Overall Percentage	75.00%	0.00%	0.90%	24.10%	70.40%

4.5 Reporting Results for Modifiable and Non-Modifiable Risk Factors on DM

4.5.1 Reporting Results for Modifiable and Non-Modifiable Risk Factors on Impaired Fasting Glucose

From **Table 4.9,** Parameter Estimates and base category has been chosen from each dependent variable as the comparison group. In this study, the reference category is "No Diabetes." Physical activity has been found to be positively related with the likelihood of having Impaired Fasting Glucose. The results show that physically inactive respondents have higher likelihood (OR=1.199) to have Impaired Fasting Glucose compared to physically active respondents. Body Mass Index (BMI) is a significant (obese: $p<0.001$, overweight: $p<0.05$) variable affecting the likelihood of having Impaired Fasting Glucose. The odds of having Impaired Fasting Glucose for obese and overweight respondents are 1.39 and 1.21 respectively in comparison with normal weight respondents.

The odds ratio for other Bumiputra and Chinese respondents are less than one (0.715 and 0.643 respectively), suggesting that these two ethnic groups are also less likely to have Impaired Fasting Glucose. On the other hand, all smoking status, all drinking status, fruit and vegetables consumption, gender, all age groups, all education levels, residential areas, household income, all types of occupation and marital status are not associated with any likelihood of Impaired Fasting Glucose.

4.5.2 Reporting Results for Modifiable and Non-Modifiable Risk Factors on Newly Diagnosed Diabetes Mellitus

Physical activity significantly (p<0.001) influences the chance of having Newly Diagnosed Diabetes Mellitus on the consequence of being physically inactive. Physically inactive respondents are 1.274 times as likely to have Newly Diagnosed Diabetes Mellitus when compared to physically active respondents. In the case of drinking status, the odds ratio for current-drinkers and ex-drinkers are less than one (0.616 and 0.793 respectively) and hence are less likely to have Newly Diagnosed Diabetes Mellitus compared to non-drinkers. The respondents who consume inadequate fruit and vegetables have significantly (P=0.001) higher likelihood to have Newly Diagnosed Diabetes Mellitus (OR=1.364, CI=1.136-1.639) as compared to respondents who consume adequate fruit and vegetables. Similarly, Body Mass Index (BMI) is significant (p<0.001) variable affecting the likelihood of having Newly Diagnosed Diabetes Mellitus. The odds of having Newly Diagnosed Diabetes Mellitus for obese and overweight respondents are 2.155 and 1.772 respectively, which is higher in comparison to normal weight respondents. In contrast, underweight respondents have significantly (p<0.001) lesser likelihood (OR=0.655, CI=0.549-0.782) of having Newly Diagnosed Diabetes Mellitus than normal weight respondents.

Next, it is found that females have notably (P<0.001) lower chance (OR=0.702, CI=0.639-0.771) of having Newly Diagnosed Diabetes Mellitus as compared to Males. The Indian respondents on the other hand, have significantly (P<0.001) higher odds (OR=1.495) of having Newly Diagnosed Diabetes Mellitus in comparison to Malay respondents. On the contrary, other Bumiputra respondents have significantly (P<0.001) lower odds (OR=0.694) of having Newly Diagnosed Diabetes Mellitus as compared to Malay respondents. In the case of age, all age groups are negatively related with the likelihood of having Newly Diagnosed Diabetes Mellitus. The odds of having Newly Diagnosed 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 and 0.003 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.

Education levels significantly ($P<0.001$) influence the likelihood of having Newly Diagnosed 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 (3.237, 1.647, 1.834 and 1.583 respectively), indicating that those with higher education are also less likely to have Newly Diagnosed Diabetes Mellitus. This study reveals that only respondents with household income above RM7000 are 1.2 times more likely to have Newly Diagnosed Diabetes Mellitus as compared to respondents with household income from RM0 to RM1500. In comparison to government or semi government respondents, retirees have significantly ($P<0.001$) greater likelihood (OR=1.318, CI=1.097-1.585) of having Newly Diagnosed Diabetes Mellitus. On the other hand, the odds ratio for private workers is less than one (0.745); suggesting that private workers are less likely to have Newly Diagnosed Diabetes Mellitus. Moreover, this study shows that only widow/widower or divorced respondents have significantly ($p<0.05$) lower likelihood (OR=0.741, CI=0.575-0.954) of Newly Diagnosed Diabetes Mellitus as compared to single respondents. However, all smoking status and residential areas are not associated with any likelihood of Newly Diagnosed Diabetes Mellitus.

4.5.3 Reporting Results for Modifiable and Non-Modifiable Risk Factors on Known Diabetes Mellitus

The odd of having Known Diabetes Mellitus is 1.146 times greater (with $p<0.001$) among those who are physically inactive compared to the reference category of physically active respondents. However, it is found that only unclassified-drinkers have odds of Known Diabetes Mellitus that are significantly ($P<0.001$) less than 1 (OR=0.09), suggesting that unclassified-drinkers are less likely to have Known Diabetes Mellitus. This study reveals that ex-smokers have significantly ($p<0.05$) greater chance (OR=1.32, CI=1.1-1.583) of having Known Diabetes Mellitus. In contrast to that, it is found that current smokers have significantly ($p<0.05$) lower likelihood of having Known Diabetes Mellitus (OR=0.82) compared to non-smokers. Similarly, it is also found that respondents who consume inadequate fruit and vegetables have significantly ($P<0.001$) lower likelihood of having Known Diabetes Mellitus (OR=0.656) compared to respondents who consume adequate fruit and vegetables. The odds of having Known Diabetes Mellitus for obese and overweight respondents are 3.06 and 2.141 respectively in comparison with normal weight respondents. In contrast, underweight respondents have significantly ($p<0.001$) lower likelihood (OR=0.597, CI=0.501-0.71) to have Known Diabetes Mellitus than normal weight respondents.

Females on the other hand, have odds of Known Diabetes Mellitus that is significantly ($P<0.001$) less than 1 (OR=0.779) indicating females are less likely to have Known Diabetes Mellitus than males. Race significantly ($p<0.001$) influences the likelihood of Known Diabetes Mellitus. For instance, Indians, Chinese, Other Bumiputra and Others are respectively 1.74, 0.813, 0.682 and 0.629 times as likely to have Known Diabetes Mellitus compared to Malays. Results indicate that the odds of having Known Diabetes Mellitus compared to No Diabetes Mellitus are less than 1.

Moreover, it is found to be 0.005, 0.006, 0.005, 0.002, 0.001 and 0.009 times lower (with $p<0.001$) among those above 65, 55-64, 45-54, 35-44, 25-34 and 15-24 years old respectively than the reference category of below 15 years old, suggesting the younger respondents are more likely to have Known Diabetes Mellitus. Education levels significantly ($P<0.001$) affect the likelihood of Known Diabetes Mellitus. The odds ratio for the respondents with unclassified education, no formal education, primary education and secondary education are more than one (5.871, 2.626, 3.432 and 2.908 respectively), indicating those with higher education are also less likely to have Known Diabetes Mellitus.

Household income significantly ($p<0.05$) influences the likelihood of having Known Diabetes Mellitus among the respondents. The odds ratio for the respondents with household income above RM7000 and RM5001-7000 are more than one (1.23 and 1.17 respectively), suggesting that those with higher income level are more likely to have Known Diabetes Mellitus. The odds of having Known Diabetes Mellitus compared to no Diabetes Mellitus were 2.233, and 1.211 times higher (with $p<0.001$) among retirees and home makers respectively than the reference category of government or semi government workers. On the other hand, the odds ratio for private workers are less than one (0.532), suggesting private workers are less likely to have Known Diabetes Mellitus. It has also been found that the odds ratio for marital status among married couples and widow/widower or divorced are less than one (0.554 and 0.498 respectively), suggesting married couples and widow/widower or divorced are less likely to have Known Diabetes Mellitus. However, residential areas are not associated with any likelihood of having Known Diabetes Mellitus.

Table 4.9: Parameter Estimates for Multinomial Logistic Regression on Diabetes Mellitus

Diabetes Mellitus	Predictors	B Coefficient	Std. Error	Wald	Df	P-value	Odds ratio Exp (B)	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
	Intercept	-3.611	1.042	12.012	1	0.001			
Impaired Fasting Glucose	**Fruit & Vegetables Consumption**								
	Inadequate	0.095	0.134	0.498	1	0.48	1.099	0.845	1.43
	Adequate (R)	0b	.	.	0	.	.	.	.
	Drinking status								
	Unclassified	-1.825	1.008	3.28	1	0.07	0.161	0.022	1.162
	Current drinker	-0.127	0.144	0.773	1	0.379	0.881	0.663	1.169
	Ex-drinker	0.124	0.153	0.666	1	0.415	1.133	0.84	1.527
	Non-Drinker (R)	0b	.	.	0	.	.	.	.
	Body Mass Index								
	Obese	0.333	0.096	12.027	1	0.001		1.156	1.685
	Overweight	0.192	0.08	5.751	1	0.016	0.81	1.036	1.418
	Underweight	-0.211	0.147	2.058	1	0.151		0.607	1.08
	Normal weight (R)	0b	.	.	0	.	.	.	.
	Smoking status								
	Current smoker	0.015	0.094	0.026	1	0.872	1.015	0.844	1.222
	Ex-smoker	-0.189	0.168	1.262	1	0.261	0.828	0.595	1.151
	Non-smoker (R)	0b	.	.	0	.	.	.	.

Table 4.9, continued

Diabetes Mellitus	Predictors	B Coefficient	Std. Error	Wald	df	P-Value	Odds ratio Exp (B)	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
Impaired Fasting Glucose	**Physical activity**								
	Inactive	0.181	0.072	6.297	1	0.012	1.199	1.04	1.381
	Active (R)	0^b	.	.	0	.	.	.	.
	Education level								
	Unclassified	-0.521	0.426	1.492	1	0.222	0.594	0.258	1.37
	No formal	0.03	0.178	0.029	1	0.865	1.031	0.727	1.461
	Primary	0.129	0.125	1.066	1	0.302	1.137	0.891	1.452
	Secondary	0.158	0.099	2.557	1	0.11	1.171	0.965	1.42
	Tertiary (R)	0^b	.	.	0	.	.		.
	Household Income								
	Above RM7000	0.105	0.128	0.682	1	0.409	1.111	0.865	1.427
	RM5001-7000	-0.022	0.136	0.026	1	0.871	0.978	0.75	1.276
	RM3001-5000	0.07	0.1	0.499	1	0.48	1.073	0.883	1.304
	RM1501-3000	-0.084	0.093	0.818	1	0.366	0.92	0.767	1.103
	RM0-1501 (R)	0^b	.	.	0	.	.	.	.

Table 4.9, continued

Diabetes Mellitus	Predictors	B Coefficient	Std. Error	Wald	df	P-Value	Odds Ratio Exp(B)	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
Impaired Fasting Glucose	**Marital Status**								
	Widow/widower or Divorced	-0.112	0.19	0.347	1	0.556	0.894	0.616	1.298
	Married	0.176	0.123	2.053	1	.152	1.193	0.937	1.158
	Single (R)	0^b	.	.	0	.	.	.	.
	Gender								
	Female	-0.095	0.081	1.383	1	0.24	0.91	0.777	1.065
	Male (R)	0^b	.	.	0	.	.	.	.
	Residential Area								
	Urban	0.125	0.074	2.828	1	0.093	1.133	0.98	1.31
	Rural (R)	0^b	.	.	0	.	.	.	.
	Race								
	Others	-0.155	0.157	0.967	1	0.325	0.857	0.629	1.166
	Other Bumiputra	-0.441	0.14	9.932	1	0.002	0.643	0.489	0.846
	Indian	0.013	0.134	0.009	1	0.925	1.013	0.779	1.317
	Chinese	-0.335	0.106	9.923	1	0.002	0.715	0.581	0.881
	Malays (R)	0^b	.	.	0	.	.	.	.
	Occupation								
	Retire	0.071	0.17	0.174	1	0.677	1.074	0.769	1.499
	Home maker	-0.06	0.136	0.193	1	0.66	0.942	0.721	1.23
	Self-employed	0.157	0.124	1.597	1	0.206	1.17	0.917	1.493
	Private	-0.019	0.117	0.025	1	0.874	0.982	0.781	1.234
	Gov/Semi Gov (R)	0^b	.	.	0	.		.	

Table 4.9, continued

Diabetes Mellitus	Predictors	B Coefficient	Std. Error	Wald	df	P-Value	Odds Ratio Exp(B)	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
Impaired Fasting Glucose	**Age**								
	>65 years old	0.923	1.034	0.797	1	0.372	2.517	0.332	19.098
	55-64 years old	0.734	1.029	0.508	1	0.476	2.08	0.277	15.657
	45-54 years old	0.762	1.028	0.549	1	0.459	2.142	0.286	16.062
	35-44 years old	0.468	1.029	0.207	1	0.649	1.597	0.213	11.994
	25-34 years old	0.299	1.026	0.085	1	0.771	1.348	0.18	10.08
	15-24 years old	0.124	1.024	0.044	1	0.835	1.238	0.166	9.217
	below 15 years (R)	0^b	.	.	0	.	.	.	.
Newly Diagnosed Diabetes Mellitus	Intercept	2.728	0.236	134.159	1	0			
	Fruit & Vegetables consumption								
	Inadequate	0.311	0.094	11.003	1	0.001	1.364	1.136	1.639
	Adequate (R)	0^b	.	.	0	.	.	.	.
	Drinking status								
	Unclassified	0.116	0.24	0.232	1	0.63	1.123	0.702	1.796
	Current drinker	-0.485	0.094	26.759	1	<0.001	0.616	0.512	0.74
	Ex-drinker	-0.232	0.108	4.616	1	0.032	0.793	0.642	0.98
	Non-Drinker (R)	0^b	.	.	0	.	.	.	.
	Smoking Status								
	Current smoker	0.094	0.057	2.715	1	0.099	1.098	0.982	1.228
	Ex-smoker	-0.072	0.109	0.429	1	0.513	0.931	0.751	1.154
	Non-Smoker (R)	0^b	.	.	0	.	.	.	.

Table 4.9, continued

Diabetes Mellitus	Predictors	B Coefficient	Std. Error	Wald	df	P-Value	Odds Ratio Exp (B)	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
Newly Diagnosed Diabetes Mellitus	**Body Mass Index**								
	Obese	0.768	0.057	180.97	1	<0.001	2.155	1.927	2.41
	Overweight	0.572	0.05	130.167	1	<0.001	1.772	1.606	1.955
	Underweight	-0.423	0.09	21.941	1	<0.001	0.655	0.549	0.782
	Normal weight (R)	0^b	.	.	0	.	.	.	.
	Physical Activity								
	Inactive	0.242	0.044	30.529	1	<0.001	1.274	1.169	1.388
	Active (R)	0^b	.	.	0	<0.001	.	.	.
	Education level								
	Unclassified	1.175	0.132	79.194	1	<0.001	3.237	2.499	4.193
	No formal	0.499	0.118	17.8	1	<0.001	1.647	1.306	2.077
	Primary	0.607	0.085	51.284	1	<0.001	1.834	1.554	2.165
	Secondary	0.459	0.071	41.303	1	<0.001	1.583	1.376	1.821
	Tertiary (R)	0^b	.	.	0	.	.	.	.
	Household Income	0.182	0.078	5.4	1	0.02	1.2	1.029	1.399
	Above RM7000	0.103	0.08	1.657	1	0.198	1.109	0.947	1.298
	RM5001-7000	-0.013	0.061	0.045	1	0.831	0.987	0.876	1.112
	RM3001-5000	-0.076	0.055	1.904	1	0.168	0.927	0.832	1.032
	RM1501-3000	0^b	.	.	0	.	.	.	.
	RM0-1500 (R)								

Table 4.9, continued

Diabetes Mellitus	Predictors	B Coefficient	Std. Error	Wald	df	P-Value	Odds Ratio Exp(B)	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
Newly Diagnosed Diabetes Mellitus	**Marital Status**								
	Widow/widower/ divorced	-0.3	0.129	5.41	1	0.02	0.741	0.575	0.954
	Married	-0.087	0.084	1.075	1	0.3	0.917	0.778	1.08
	Single (R)	0^b	.	.	0	.	.	.	.
	Gender								
	Female	-0.354	0.048	55.333	1	<0.001	0.702	0.639	0.771
	Male (R)	0^b	.	.	0	.	.	.	.
	Residential Area								
	Urban	0.033	0.045	0.555	1	0.456	1.034	0.947	1.128
	Rural (R)	0^b	.	.	0	.	.	.	.
	Race								
	Others	-0.169	0.102	2.762	1	0.097	0.844	0.692	1.031
	Other Bumiputra	-0.365	0.079	21.114	1	<0.001	0.694	0.594	0.811
	Indian	0.402	0.078	26.634	1	<0.001	1.495	1.283	1.742
	Chinese	-0.097	0.062	2.396	1	0.122	0.908	0.803	1.026
	Malays (R)	0^b	.	.	0	.	.	.	.
	Occupation								
	Retire	0.276	0.094	8.65	1	0.003	1.318	1.097	1.585
	Home maker	0.112	0.08	1.94	1	0.164	1.118	0.956	1.308
	Self-employed	-0.036	0.078	0.221	1	0.638	0.964	0.828	1.123
	Private	-0.294	0.073	16.081	1	<0.001	0.745	0.645	0.86
	Gov /Semi Gov (R)	0^b	.	.	0	.	.	.	.

Table 4.9, continued

Diabetes Mellitus	Predictors	B Coefficient	Std. Error	Wald	df	P-Value	Odds Ratio Exp (B)	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
Newly Diagnosed Diabetes Mellitus	**Age**								
	>65 years old	-5.268	0.223	560.534	1	<0.001	0.005	0.003	0.008
	55-64 years old	-5.177	0.211	601.05	1	<0.001	0.006	0.004	0.009
	45-54 years old	-5.238-	0.209	627.481	1	<0.001	0.005	0.004	0.008
	35-44 years old	5.527	0.211	688.446	1	<0.001	0.004	0.003	0.006
	25-34 years old	-5.895	0.207	812.55	1	<0.001	0.003	0.002	0.004
	15-24 years old	-4.901	0.193	643.38	0	<0.001	0.007	0.005	0.011
	below 15 years (R)	0^b	.	.		.	.	.	.
Known Diabetes Mellitus	Intercept	3.522	0.231	232.151	1	0			
	Fruit & Vegetables consumption								
	Inadequate	-0.422	0.078	29.474	1	<0.001	0.656	0.563	0.764
	Adequate (R)	0^b	.	.	0	.	.	.	.
	Drinking Status								
	Unclassified	-2.404	0.342	49.426	1	<0.001	0.09	0.046	0.177
	Current drinker	0.059	0.085	0.484	1	0.487	1.061	0.898	1.254
	Ex-drinker	0.033	0.102	0.104	1	0.747	1.033	0.847	1.261
	Non-Drinker (R)	0^b	.	.	0	.	.	.	.
	Smoking Status								
	Current smoker	-0.198	0.053	13.756	1	<0.001	0.82	0.739	0.911
	Ex-smoker	0.277	0.093	8.944	1	0.003	1.32	1.1	1.583
	Non-Smoker (R)	0^b	.	.	0	<0.001	.	.	.

Table 4.9, continued

Diabetes Mellitus	Predictors	B Coefficient	Std. Error	Wald	df	P-Value	Odds Ratio Exp(B)	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
Known Diabetes Mellitus	**Body Mass Index**								
	Obese	1.118	0.055	410.482	1	<0.001	3.06	2.746	3.409
	Overweight	0.761	0.049	236.797	1	<0.001	2.141	1.943	2.36
	Underweight	-0.516	0.089	33.85	1	<0.001	0.597	0.501	0.71
	Normal weight (R)	0^b	.	.	0	.	.	.	.
	Physical Activity								
	Inactive	0.136	0.043	10.12	1	0.001	1.146	1.054	1.247
	Active (R)	0^b	.	.	0	.	.	.	.
	Education level								
	Unclassified	1.77	0.134	173.739	1	<0.001	5.871	4.513	7.639
	No formal	0.966	0.12	64.407	1	<0.001	2.626	2.075	3.325
	Primary	1.233	0.092	178.257	1	<0.001	3.432	2.864	4.113
	Secondary	1.067	0.082	168.06	1	<0.001	2.908	2.475	3.417
	Tertiary (R)	0^b	.	.	0	.	.	.	.
	Household Income								
	Above RM7000	0.207	0.078	7.048	1	0.008	1.23	1.056	1.433
	RM5001-7000	0.157	0.079	4.005	1	0.045	1.17	1.003	1.365
	RM3001-5000	0.074	0.059	1.58	1	0.209	1.077	0.959	1.208
	RM1501-3000	-0.06	0.053	1.284	1	0.257	0.942	0.848	1.045
	RM0-1501 (R)	0^b	.	.	0	.	.	.	.

Table 4.9, continued

Diabetes Mellitus	Predictors	B Coefficient	Std. Error	Wald	df	P-Value	Odds Ratio Exp(B)	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
Known Diabetes Mellitus	**Marital Status**								
	Widow/widower/divorced	-0.697	0.123	32.334	1	<0.001	0.498	0.391	0.633
	Married	-0.59	0.089	44.284	1	<0.001	0.554	0.466	0.66
	Single (R)	0^b	.	.	0	.	.	.	.
	Gender								
	Female	-0.25	0.047	28.668	1	<0.001	0.779	0.71	0.853
	Male	0^b	.	.	0	.	.	.	.
	Residential Area								
	Urban	0.004	0.043	0.008	1	0.93	1.004	0.922	1.093
	Rural (R)	0^b	.	.	0	.	.	.	.
	Race								
	Others	-0.383	0.11	12.157	1	<0.001	0.682	0.55	0.846
	Other Bumiputra	-0.464	0.077	36.458	1	<0.001	0.629	0.541	0.731
	Indian	0.554	0.074	55.627	1	<0.001	1.74	1.504	2.012
	Chinese	-0.207	0.061	11.705	1	<0.001	0.813	0.722	0.915
	Malays (R)	0^b	.	.	0	.	.	.	.
	Occupation								
	Retire	0.803	0.088	83.071	1	<0.001	2.233	1.879	2.655
	Home maker	0.192	0.079	5.892	1	0.015	1.211	1.038	1.414
	Self-employed	-0.112	0.077	2.092	1	0.148	0.894	0.768	1.041
	Private	-0.632	0.075	70.513	1	<0.001	0.532	0.459	0.616
	Gov/Semi Gov (R)	0^b	.	.	0	.	.	.	.

Table 4.9, continued

Diabetes Mellitus	Predictors	B Coefficient	Std. Error	Wald	df	P-Value	Odds Ratio Exp(B)	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
Known Diabetes Mellitus	**Age**								
	>65 years old	-5.232	0.219	569.264	1	<0.001	0.005	0.003	0.008
	55-64 years old	-5.124	0.21	595.208	1	<0.001	0.006	0.004	0.009
	45-54 years old	-5.371	0.21	656.393	1	<0.001	0.005	0.003	0.007
	35-44 years old	-6.047	0.214	800.384	1	<0.001	.002	0.002	0.004
	25-34 years old	-7.091	0.22	1034.56	1	<0.001	.001	0.001	0.001
	15-24 years old	-4.763	0.19	625.69	1	<0.001	.009	0.009	0.012
	below 15 years old (R)	0[b]	.	.	0	.	.	.	.

4.6 The Full Model Assessment and Model Fitting for Multinomial Logistic Regression on Hypertension

4.6.1 Descriptive Statistics of Hypertension

Out of the total 9376 hypertensive patients involved in this study, almost half: 48.4% (4537 out of 9376) of the patients are found to be "known" cases. Among those whose disease status is not known, more than half: 51.6% (4839 out of 9376) patients are found to be newly diagnosed with hypertension **(Table 4.10)**.

Table 4.10: Frequency of Hypertension

Hypertension	Frequency	Percent
No HP	15256	61.9
Newly HP	4839	19.6
Known HP	4537	18.4
Total	24632	100.0

4.6.2 Results of Univariate Analysis of Hypertension

Table 4.11 shows that all independent variables: gender, education level, occupation, household income, residential area, race, age, marital status, Body mass Index (BMI), drinking, physical activity, fruit and vegetables consumption and smoking have significant statistical evidence with the outcomes of Hypertension because results indicate that $p\text{-value} < 0.05$.

Table 4.11: Univariate Analysis of All Independent Variables with Hypertension

Variable(s)	Level(s)	Hypertension			Total N (%)	Chi-Square	P-Value
		No Hypertension	Newly HP	Known HP			
Smoking Status	Current smoker	11931 (78.2%)	3666 (75.8%)	3240 (71.4%)	18837 (76.5%)	137.977	p<.001
	Ex-smoker	680 (4.5%)	349 (7.2%)	334 (7.4%)	1363 (5.5%)		
	Non-smoker	2645 (17.3%)	824 (17.0%)	963 (21.2%)	4432 (18.0%)		
	Total	15256 (100.0%)	4839 (100.0%)	4537 (100.0%)	24632 (100%)		
Body Mass Index	Obese	2680 (17.6%)	1241 (25.7%)	1341 (29.6%)	5262 (21.4%)	725.035	p<.001
	Overweight	4351 (28.5%)	1688 (34.9%)	1604 (35.4%)	7643 (31.0%)		
	Underweight	1443 (9.5%)	271 (5.6%)	282 (6.2%)	1996 (8.1%)		
	Normal weight	6777 (44.4%)	1637 (33.8%)	1307 (28.8%)	9721 (39.5%)		
	Total	15251(100.0%)	4837 (100.0%)	4524 (100.0%)	24622 (100.0%)		
Drinking Status	Unclassified	106 (0.7%)	36 (0.7%)	88 (1.9%)	230 (0.9%)	117.402	p<.001
	Current drinker	1302 (8.5%)	425 (8.8%)	236 (5.2%)	1963 (8.0%)		
	Ex-drinker	692 (4.5%)	228 (4.7%)	229 (5.0%)	1149 (4.7%)		
	Non-drinker	13156 (86.2%)	4150 (85.8%)	3984 (87.8%)	21290 (86.4%)		
	Total	15256 (100.0%)	4839 (100.0%)	4537 (100.0%)	24632 (100%)		
Physical Activity	Inactive	5654 (37.1%)	1622 (33.5%)	1964 (43.3%)	9240 (37.5%)	98.819	p<.001
	Active	9602 (62.9%)	3217 (66.5%)	2573 (56.7%)	15392 (62.5%)		
	Total	15256 (100.0%)	4839 (100.0%)	4537 (100.0%)	24632 (100%)		
Fruit and Vege	Inadequate	14225 (93.2%)	4485 (92.7%)	4255 (93.8%)	22965 (93.2%)	4.496	p<.001
	Adequate	1031 (6.8%)	354 (7.3%)	282 (6.2%)	1667 (6.8%)		
	Total	15256 (100.0%)	4839 (100.0%)	4537 (100.0%)	24632 (100%)		

Table 4.11, continued

Variable (s)	Level (s)	Hypertension			Total	Chi-Square	P-Value
		No Hypertension	Newly HP	Known HP	N (%)		
Age	< 15 years old	2799 (18.3%)	707 (14.6%)	1232 (27.2%)	4738 (18.5%)	3622.552	p<.001
	15-24 years old	866 (5.7%)	551 (11.4%)	517 (11.4%)	4557 (18.5%)		
	25-34 years old	3279 (21.5%)	943 (19.5%)	156 (3.4%)	3986 (16.2%)		
	35-44 years old	2465 (16.2%)	829 (17.1%)	348 (7.7%)	3642 (14.8%)		
	45-54 years old	1802 (11.8%)	767 (15.9%)	737 (16.2%)	3482 (14.1%)		
	55-64 years old	3571 (23.4%)	469 (9.7%)	827 (18.2%)	2460 (10.0%)		
	>65 years old	474 (3.1%)	573 (11.8%)	720 (15.9%)	1767 (7.2%)		
	Total	15256 (100.0%)	4839 (100.0%)	4537 (100.0%)	24632 (100.0%)		
Marital status	Widow/widower/ divorced	519 (3.4%)	446 (9.2%)	505 (11.2%)	1470 (6.0%)	821.762	P<.001
	Married	7443 (48.8%)	2915 (60.3%)	2179 (48.1%)	12537 (51.0%)		
	single	7281 (47.8%)	1475 (30.5%)	1842 (40.7%)	10598 (43.1%)		
	Total	15243 (100.0%)	4836 (100.0%)	4526 (100.0%)	24605 (100.0%)		
Gender	Female	7939 (52.0%)	2405 (49.7%)	2484 (54.7%)	12828 (52.1%)	23.949	p<.001
	Male	7317 (48.0%)	2434 (50.3%)	2053 (45.3%)	11804 (47.9%)		
	Total	15256 (100.0%)	4839 (100.0%)	4537 (100.0%)	24632 (100.0%)		
Residential area	urban	9076 (59.5%)	2612 (54.0%)	2492 (54.9%)	14180 (57.6%)	61.596	p<.001
	rural	6180 (40.5%)	2227 (46.0%)	2045 (45.1%)	10452 (42.4%)		
	Total	15256 (100.0%)	4839 (100.0%)	4537 (100.0%)	24632 (100.0%)		

Table 4.11, continued

Variable (s)	Level (s)	Hypertension			Total N (%)	Chi-Square	P-Value
		No Hypertension	Newly HP	Known HP			
Occupation	retire	1588 (10.4%)	790 (16.3%)	992 (21.9%)	3370 (13.7%)	799.664	p<.001
	home maker	2963 (19.4%)	1039 (21.5%)	1178 (26.0%)	5180 (21.0%)		
	Self employed	3058 (20.0%)	1143 (23.6%)	909 (20.0%)	5110 (20.7)		
	Private	5574 (36.5%)	1348 (27.9%)	936 (20.6%)	7858 (31.9%)		
	Government/Semi Government	2073 (13.6%)	519 (10.7%)	522 (11.5%)	3114 (12.6%)		
	Total	15256 (100.0%)	4839 (100.0%)	4537 (100.0%)	24632 (100.0%)		
Household income	RM0-1500	4627 (30.3%)	1773 (36.6%)	1676 (36.9%)	8076 (32.8%)	149.449	p<.001
	RM1501-3000	4157 (27.2%)	1355 (28.0%)	1195 (26.3%)	6707 (27.2%)		
	RM3001-5000	3239 (21.2%)	935 (19.3%)	838 (18.5%)	5012 (20.3%)		
	RM5001-7000	1458 (9.6%)	370 (7.6%)	386 (8.5%)	2214 (9.0%)		
	above RM7000	1775 (11.6%)	406 (8.4%)	442 (9.7%)	2623 (10.6%)		
	Total	15256 (100.0%)	4839 (100.0%)	4537 (100.0%)	24632 (100.0%)		
Education level	Unclassified	1026 (6.7%)	227 (4.7%)	408 (9.0%)	1661 (6.7%)	1276.745	p<.001
	No formal educatioı	622 (4.1%)	443 (9.2%)	494 (10.9%)	1559 (6.3%)		
	Primary education	4274 (28.0%)	1781 (36.8%)	2000 (44.1%)	8055 (32.7%)		
	Secondary education	6328 (41.5%)	1838 (38.0%)	1318 (29.1%)	9484 (38.5%)		
	Tertiary education	3006 (19.7%)	550 (11.4%)	317 (7.0%)	3873 (15.7%)		
	Total	15256 (100.0%)	4839 (100.0%)	4537 (100.0%)	24632 (100.0%)		

Table 4.11, continued

Variable (s)		Hypertension			Total N (%)	Chi-Square	P-Value
	Level (s)	No Hypertension	Newly HP	Known HP			
Ethnics (Race)	Malays	8920 (58.5%)	2871 (59.3%)	2674 (58.9%)	14465 (58.7%)		
	Chinese	2734 (17.9%)	861 (17.8%)	891 (19.6%)	4486 (18.2%)	76.159	p<.001
	Indian	1188 (7.8%)	353 (7.3%)	365 (8.0%)	1906 (7.7%)		
	Other Bumiputra	1463 (9.6%)	515 (10.6%)	463 (10.2%)	2441 (9.9%)		
	Others	951 (6.2%)	239 (4.9%)	144 (3.2%)	1334 (5.4%)		
	Total	15256 (100.0%)	4839 (100.0%)	4537 (100.0%)	24632 (100.0%)		

4.6.3 The Fitted Model with all predictors of Hypertension

4.6.3.1 Goodness-of-Fit for model (Hypertension)

Table 4.12 gives two tests of the null hypothesis which displays that the model adequately fits the data. If the significance value is small (less than 0.05), then it can be said that the model does not adequately fit the data. However, in this case, Pearson value is greater than 0.05. At the same time, Deviance value is also greater than 0.05. Since, Pearson value is 0.303, it can be concluded that the data is consistent with the model assumptions.

Table 4.12: Goodness-of-Fit (Hypertension)

	Chi-Square	df	P- value.
Pearson	36065.640	35928	.303
Deviance	31661.564	35928	1.000

4.6.3.2 Model Fitting Information: Likelihood Ratio Test (Hypertension)

The next stage of the research is to determine the significance levels of selected independent variables in the multinomial model. If the significance of the test is less than 0.05 then the effect contributes to the model. **Table 4.13**, indicates that the significance of the test for drinking, smoking, Body Mass Index (BMI), Physical Activity, educational levels, household income, marital status, gender, race, occupation and age groups are smaller than 0.05. On the other hand, for fruit and vegetables consumption and residential area it is larger than 0.05. As a result, it is statistically proven that there is a positive significant relationship between the likelihood of having hypertension and drinking, smoking, Body Mass Index (BMI), physical activity, educational levels, household income, marital status, gender, race, occupation and age factors.

Table 4.13 reveals that drinking, smoking, Body Mass Index (BMI), physical activity, educational levels, income, marital status, gender, race, occupation and age are significant predictors of having Hypertension.

Table 4.13: Likelihood Ratio Tests (Hypertension)

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	χ^2	df	P value
Intercept	35246.276	.000	0	.
Age	36924.860	1678.584	12	.000
Marital status	35269.875	23.599	4	.000
Gender	35264.987	18.711	2	.000
Physical Activity	35288.817	42.541	2	.000
Residence	35251.841	5.566	2	.062
Race	35279.676	33.400	8	.000
Occupation	35288.801	42.526	8	.000
Household Income	35265.719	19.443	8	.013
Fruit & Vegetables consumption	35249.240	2.964	2	.227
Drinking	35296.705	50.430	6	.000
Smoking	35286.686	40.411	4	.000
Education level	35325.531	79.255	8	.000
Body Mass Index	35885.055	638.779	6	.000

The chi-square statistic is the difference in -2 log-likelihoods between the final model and the reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

Table 4.14 presents the likelihood ratio test of the model (Final) against one in which all the parameter coefficients are 0 (Null). The chi-square statistic is the difference between the -2 log-likelihoods of the null and final model. Since the significance level of the test is less than 0.05, it can be concluded the final model is outperforming the Null.

Table 4.14: Model Fitting Information (Hypertension)

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	40166.189			
Final	35246.276	4919.914	72	.000

Table 4.15 demonstrates the outcomes of the goodness of fit test and it exhibits that the model has a good fit. The values of Pseudo R^2 (Cox and Snell=0.181, Nagelkerke=0.215, McFadden=0.108) show the model is equitably acceptable considering the presence of many categorical variables with many levels in the model. There is no serious multicollinearity problem observed for the multinomial regressions **(Appendix B).**

Table 4.15: Pseudo R-Square (Hypertension)

Cox and Snell	0.181
Nagelkerke	0.215
McFadden	0.108

4.6.3.3 The Model Classification of Hypertension

Table 4.16 Classification shows that of the cases used to create the model, 14,408 out of the 21,422 people, who are healthy (No Hypertension) are classified correctly. Similarly, 335 out of the 4834 who suffered from Newly Diagnosed Hypertension are classified correctly. 1025 out of the 4523 who suffered from Known Hypertension are also classified correctly. Overall, 64.1% of the cases are classified correctly.

Table 4.16: Classification (Hypertension)

Observed	Predicted			
	No Hypertension	Newly Diagnosed HP	Known HP	Percent Correct
No Hypertension	14408	251	579	**94.6%**
Newly Diagnosed HP	3806	335	693	**6.9%**
Known Hypertension	3208	290	1025	**22.7%**
Overall Percentage	**87.1%**	**3.6%**	**9.3%**	**64.1%**

4.7 Reporting Results for Modifiable and Non-Modifiable Risk Factors for Hypertension

4.7.1 Reporting Results for Modifiable and Non-Modifiable Risk factors on Newly Diagnosed Hypertension

The results from the estimated multinomial logistic regression are depicted in **Table 4.17**. The first portion of the regression compares respondents who have been Newly Diagnosed Hypertension to those who have no Hypertension and the second part compares those who have Known Hypertension to those who have no Hypertension. Likewise, results show that physical activity significantly ($p<0.001$) influences the chance of having Newly Diagnosed Hypertension on the consequences of being physically inactive. Physically inactive respondents are 0.862 times as less likely to get Newly Diagnosed Hypertension as to physically active respondents. Not all drinking status influences the chance of getting Newly Diagnosed Hypertension. Only current drinkers significantly ($p<0.05$) show higher odds (OR=1.225) of having Newly Diagnosed Hypertension in comparison to non-drinkers. Body Mass Index (BMI) is a significant ($p<0.001$) variable influencing the probability of having Newly Diagnosed Hypertension. The odds of having Newly Diagnosed Hypertension for obese and overweight respondents are 2.112 and 1.513 respectively in comparison with normal weight respondents.

Results also indicate that the females have considerably (p<0.001) lesser likelihood (OR=0.848, CI=0.785-0.916) of having Newly Diagnosed Hypertension than the males. In the case of race, the odds ratio for Chinese and Indians are less than one (0.824 and 0.826 respectively), suggesting Chinese and Indian respondents are less likely to have Newly Diagnosed Hypertension when compared to Malay respondents. Age also significantly (p<0.001) influences the likelihood of having Newly Diagnosed Hypertension among the respondents. The odds ratio in favor of having Newly Diagnosed Hypertension for respondents of age >65, 55-64, 45-54 and 35-44 years are 7.518, 5.264, 3.205 and 2.125 respectively as to the respondents aged below 15 years. However, respondents aged between 15-24 years have odds of having Newly Diagnosed Hypertension that is significantly (p<0.001) less than one (OR=0.695), suggesting that those who are at lower age group are less likely to have Newly Diagnosed Hypertension.

Education level is a significant (p<0.001) variable influencing the chance of having Newly Diagnosed Hypertension. The odd ratios for the respondents with no formal education, primary education and secondary education are more than one (1.426, 1.475 and 1.310 respectively), indicating that those with less education are also more likely to have Newly Diagnosed Hypertension. Next, it is found that the odds of Newly Diagnosed Hypertension is significantly (p<0.001) lower among the urban residents (OR=0.924, CI=0.859-0.994) than those are rural dwellers. Household income significantly (p<0.05) influences the likelihood of having Newly Diagnosed Hypertension among the respondents. The odds ratio for the respondents with household income above RM7000 and RM5001-7000 are less than one (0.806 and 0.871 respectively), suggesting that those with higher income level are less likely to have Newly Diagnosed Hypertension. Married couples on the other hand, have significantly (p<0.001) decreased odds (OR=0.770, CI=0.674-0.879) of Newly

Diagnosed Hypertension when compared to single respondents. Lastly, it has been found that, all smoking status, inadequate fruit and vegetables consumption, ex-drinkers, unclassified drinkers, underweight respondents, other ethnic respondents, unclassified education, all types of occupation and widow/widower are not associated with any likelihood of Newly Diagnosed Hypertension.

4.7.2 Reporting Results for Modifiable and Non-Modifiable Risk Factors on Known Hypertension

From the second part of regression, it is found that the odds of having Known Hypertension is 1.154 times higher (with $p<0.001$) amongst those who are physically inactive compared to the reference category of physically active respondents. The unclassified drinkers have significantly ($p<0.001$) higher likelihood of having Known Hypertension (OR=2.370, CI=1.717-3.271) than the non-drinkers. However, current drinkers have odds of Known Hypertension that is significantly ($p<0.05$) less than 1 (OR=0.836) indicating that the current drinkers are less likely to have Known Hypertension. Smoking status is also positively related to the likelihood of having Known Hypertension. The results show that ex-smokers have higher likelihood (OR=1.220) of having Known Hypertension compared to non-smokers. On the other hand, the current smokers have significantly ($p<0.001$) decreased odds (OR=0.817) of having Known Hypertension. The odds of having Known Hypertension compared to no Hypertension among those who are obese and overweight are 2.608 and 1.847 respectively, when compared to normal weight respondents.

This study shows that only other Bumiputra have considerably ($p<0.05$) higher probability (OR=1.174, CI=1.034-1.333) of having Known Hypertension than Malays. The odds of having Known hypertension compared to no Hypertension are 5.418, 3.417

and 1.501 times greater (with p<0.001) among those above 65, 55-64 and 45-54 years of age respectively than the reference age category of below 15 years. However, respondents who are 35-44, 25-34 and 15-24 years old respectively have odds of Known Hypertension that is significantly (p<0.001) less than 1. The values are 0.558, 0.197 and 0.496 respectively, suggesting that the younger aged groups are less likely to have Known Hypertension. Additionally, education level has also been found to significantly (p<0.001) influence the likelihood of Known Hypertension. For example, respondents who have unclassified education, no formal education, primary education and secondary education are respectively 1.785, 1.786, 1.798 and 1.586 times as more likely to have Known Hypertension compare to respondents who complete tertiary education. Likewise, occupation is found to be a significant variable affecting the likelihood of having Known Hypertension. The odds ratio for respondents who are retirees, self-employed and private workers are less than one (0.829, 0.811 and 0.786 respectively), suggesting private workers are less likely to have Known Hypertension. Married couples on the other hand, are found to have significantly (p<0.05) lower likelihood of having Known Hypertension (OR=0.815) compared to single respondents. In contrast, fruit and vegetables consumption, residential area, household income and gender did not show significant difference in the likelihood of having Known Hypertension among the respondents.

Table 4.17: Parameter Estimates for Multinomial Logistic Regressions on Hypertension

Hypertension	Predictor(s)	B Coefficient	Std. Error	Wald	df	P-value	Exp(B) Odds ratio	95% Confidence Interval for Exp(B) Lower Bound	95% Confidence Interval for Exp(B) Upper Bound
Newly Diagnosed Hypertension	Intercept	-2.007	.126	252.958	1	.000			
	Age								
	>65 years old	2.017	.114	314.178	1	.000	7.518	6.015	9.397
	55-64 years old	1.661	.098	287.266	1	.000	5.264	4.344	6.378
	45-54 years old	1.165	.095	150.687	1	.000	3.205	2.661	3.860
	35-44 years old	.754	.096	61.845	1	.000	2.125	1.761	2.565
	25-34 years old	.081	.090	.811	1	.368	1.085	0.909	1.295
	15-24 years old	-.363	.078	21.967	1	.000	.695	.597	.809
	below 15 yrs old (R)	0[b]	.	.	0	.	.	.	.
	Marital Status								
	Widow/widower or	-.074	.101	.539	1	.463	.928	.761	1.132
	divorced	-.262	.068	15.011	1	.000	.770	.674	.879
	Married	0[b]	.	.	0	.	.	.	.
	Single (R)								
	Gender								
	Female	-.165	.039	17.482	1	.000	.848	.785	.916
	Male (R)	0[b]	.	.	0	.	.	.	.
	Physical Activity								
	Inactive	-.149	.038	15.690	1	.000	.862	.800	.927
	Active (R)	0[b]	.	.	0	.	.	.	.
	Residential Area								
	Urban	-.079	.037	4.511	1	.034	.924	.859	.994
	Rural (R)	0	.	.	0	.	.	.	.

Table 4.17, continued

Hypertension	Predictor(s)	B Coefficient	Std. Error	Wald	df	P-value	Exp(B) Odds ratio	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
Newly Diagnosed Hypertension	**Race**								
	Others	-.055	.082	.456	1	.499	.946	.806	1.111
	Other Bumiputra	.101	.061	2.726	1	.099	1.106	.981	1.247
	Indian	-.191	.070	7.587	1	.006	.826	.721	.946
	Chinese	-.194	.052	13.781	1	.000	.824	.743	.912
	Malays (R)	0[b]	.	.	0	.	.	.	.
	Occupation								
	Retire	.085	.078	1.199	1	.273	1.089	.935	1.268
	Home maker	.131	.068	3.675	1	.055	1.139	.997	1.302
	Self-employed	.073	.066	1.234	1	.267	1.076	.946	1.224
	Private	.055	.063	.786	1	.375	1.057	.935	1.195
	Gov/SemiGov (R)	0[b]	.	.	0	.	.	.	.
	Household Income								
	Above RM7000	-.216	.068	9.931	1	.002	.806	.705	.922
	RM5001-7000	-.138	.070	3.934	1	.047	.871	.760	.998
	RM3001-5000	-.064	.051	1.590	1	.207	.938	.849	1.036
	RM1501-3000	.000	.045	.000	1	.996	1	.916	1.093
	RM0-1500 (R)	0[b]	.	.	0	.	.	.	.
	Fruit & Vege								
	Inadequate	.019	.068	.083	1	.773	1.020	.893	1.164
	Adequate (R)	0[b]	.	.	0	.	.	.	.

Table 4.17, continued

Hypertension	Predictor (s)	B Coefficient	Std. Error	Wald	df	P-value	Exp (B) Odds ratio	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
Newly Diagnosed Hypertension	**Drinking Status**								
	Unclassified	.267	.205	1.708	1	.191	1.307	.875	1.952
	Current drinker	.203	.067	9.080	1	.003	1.225	1.074	1.398
	Ex-drinker	-.069	.085	.658	1	.417	.933	.789	1.103
	Non-Drinker (R)	0^b	.	.	0	.	.	.	.
	Smoking Status								
	Current smoker	-.026	.047	.309	1	.578	.974	.889	1.068
	Ex-smoker	.145	.085	2.887	0	.089	1.156	.978	1.366
	Non-smoker (R)	0^b	.	.	0	.	.	.	.
	Education level								
	Unclassified	.190	.103	3.401	1	.065	1.209	.988	1.479
	No formal	.355	.095	13.876	1	.000	1.426	1.183	1.718
	Primary	.389	.069	32.050	1	.000	1.475	1.289	1.688
	Secondary	.270	.059	21.120	1	.000	1.310	1.167	1.469
	Tertiary (R)	0^b	.	.	0	.	.	.	.
	Body Mass Index								
	Obese	.841	.048	312.600	1	.000	2.318	2.112	2.545
	Overweight	.496	.042	139.495	1	.000	1.642	1.513	1.783
	Underweight	-.106	.076	1.968	1	.161	.899	.775	1.043
	Normal weight (R)	) 0^b	.	.	0	.	.	.	.

Table 4.17, continued

Hypertension Status	Predictor (s)	B Coefficient	Std. Error	Wald	df	P-value	Exp (B) Odds ratio	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
Known Hypertension	Intercept	-1.883	.135	195.125	1	.000			
	Age								
	>65 years old	1.690	.123	187.876	1	.000	5.418	4.255	6.898
	55-64 years old	1.229	.109	126.877	1	.000	3.417	2.759	4.231
	45-54 years old	.406	.108	14.065	1	.000	1.501	1.214	1.856
	35-44 years old	-.583	.115	25.740	1	.000	.558	.445	.699
	25-34 years old	-1.625	.119	185.508	1	.000	.197	.156	.249
	15-24 years ol	-.702	.074	90.415	1	.000	.496	.429	.573
	below 15 yrs (R)	0^b	.	.	0	.	.	.	.
	Marital Status								
	Widow/widower or divorced	-.030	.116	.068	1	.794	.970	.772	1.219
	Married	-.205	.088	5.443	1	.020	.815	.686	.968
	Single (R)	0^b	.	.	0	.	.	.	.
	Gender								
	Female	-.004	.041	.012	1	.914	.996	.919	1.078
	Male (R)	0^b	.	.	0	.	.	.	.
	Physical Activity								
	Inactive	.143	.038	13.891	1	.000	1.154	1.070	1.244
	Active (R)	0^b	.	.	0	.	.	.	.

Table 4.17, continued

Hypertension	Predictor (s)	B Coefficient	Std. Error	Wald	df	P-value	Exp (B) Odds ratio	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
	Residential Area								
Known Hypertension	Urban	-.064	.039	2.614	1	.106	.938	.869	1.014
	Rural (R)	0b	.	.	0	.	.	.	.
	Race								
	Others								
	Other Bumiputra	-.161	.100	2.582	1	.108	.851	.700	1.036
	Indian	.160	.065	6.162	1	.013	1.174	1.034	1.333
	Chinese	.007	.071	.011	1	.918	1.007	.877	1.157
	Malays (R)	-.030	.053	.337	1	.562	.970	.875	1.075
		0b	.	.	0	.	.	.	.
	Occupation								
	Retire	-.187	.075	6.253	1	.012	.829	.716	.960
	Home maker	.043	.068	.405	1	.524	1.044	.914	1.193
	Self-employed	-.209	.069	9.118	1	.003	.811	.708	.929
	Private	-.241	.067	13.067	1	.000	.786	.690	.896
	Gov/Semi Gov (R)	0b	.	.	0	.	.	.	.
	Household Income								
	Above RM7000	.055	.069	.631	1	.427	1.056	.923	1.210
	RM5001-7000	.089	.071	1.568	1	.210	1.093	.951	1.257
	RM3001-5000	.014	.054	.069	1	.793	1.014	.913	1.127
	RM1501-3000	.022	.048	.216	1	.642	1.022	.931	1.123
	RM0-1500 (R)	0b	.	.	0	.	.	.	.

Table 4.17, continued

Hypertension	Predictor (s)	B Coefficient	Std. Error	Wald	df	P-value	Exp (B) Odds ratio	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
Known Hypertension	**Fruit & Vegetables Consumption**								
	Inadequate	.127	.075	2.860	1	.091	1.136	.980	1.316
	Adequate (R)	0b	.	.	0	.	.	.	.
	Drinking status								
	Unclassified	.863	.164	27.537	1	.000	2.370	1.717	3.271
	Current drinker	-.179	.082	4.796	1	.029	.836	.712	.981
	Ex-drinker	.088	.089	.970	1	.325	1.092	.917	1.299
	Non-Drinker (R)	0b	.	.	0	.	.	.	.
	Smoking Status								
	Current smoker	-.202	.046	19.016	1	.000	.817	.746	.895
	Ex-smoker	.199	.089	5.028	1	.025	1.220	1.025	1.452
	Non-smoker (R)	0b	.	.	0	.	.	.	.
	Education level	.580	.102	32.160	1	.000	1.785	1.785	2.181
	Unclassified	.580	.105	30.530	1	.000	1.786	1.786	2.195
	No formal	.587	.081	52.304	1	.000	1.798	1.798	2.108
	Primary	.461	.073	40.151	1	.000	1.586	1.586	1.829
	Secondary	0b	.	.	0	.	.	.	.
	Tertiary (R)								
	Body Mass Index								
	Obese	.959	.050	366.746	1	.000	2.608	2.364	2.877
	Overweight	.614	.046	181.340	1	.000	1.847	1.690	2.020
	Underweight	-.006	.078	.005	1	.942	.994	.853	1.159
	Normal weight (R)	0b	.	.	0	.	.	.	.

. The reference category is: No Hypertension

4.8 The Full Model Assessment and Model Fitting for Multinomial Logistic Regression on Hypercholesterolemia

4.8.1 Frequency of Hypercholesterolemia Status

From the total 13,119 patients involved in this study who suffer from Hypercholesterolemia, more than half: 53.9% (7073 out 13,119) of the patients are "known" cases. Among those whose disease status is not known, almost half: 46.1% (6046 out of 13,119) patients are newly diagnosed with hypercholesterolemia **(Table 4.18).**

Table 4.18: Frequency of Hypercholesterolemia Status

Hypercholesterolemia		Frequency	Percent (%)
	No HC	11513	46.7
	Newly HC	6046	24.5
	Known HC	7073	28.7
	Total	24632	100.0

4.8.2 Results of Univariate Analysis for Hypercholesterolemia

Table 4.19 reveals that all independent variables: gender, education level, occupation, household income, residential area, race, age, marital status, Body mass Index (BMI), drinking, physical activity, fruit and vegetables consumption and smoking have significant statistical evidence with the outcomes of Hypercholesterolemia because results indicate that p-value < 0.05.

Table 4.19: Univariate Analysis of All Independent Variables with Hypercholesterolemia

Variable (s)	Level (s)	Hypercholesterolemia (HC)			Total	Chi-Square	P-value
		Newly Diagnose HC	Known HC	No HC	Total N (%)	Chi-Square (χ^2)	P-value
Gender	Female	3680 (60.9%)	3547 (50.1%)	5601 (48.6%)	12828 (52.1%)	251.906	p<0.001
	Male	2366 (39.1%)	3526 (49.9%)	5912 (51.4%)	11804 (47.9%)		
	Total	6046 (100.0%)	7073 (100.0%)	11513 (100.0%)	24632 (100.0%)		
Education level	Unclassified	215 (3.6%)	1163 (16.4%)	283 (2.5%)	1661 (6.7%)	3953.414	p<0.001
	No formal	552 (9.1%)	260 (3.7%)	747 (6.5%)	1559 (6.3%)		
	Primary	1829 (30.3%)	3588 (50.7%)	2638 (22.9%)	8055 (32.7%)		
	Secondary	2418 (40.0%)	1713 (24.2%)	5353 (46.5%)	9484 (38.5%)		
	Tertiary	1032 (17.1%)	349 (4.9%)	2492 (21.6%)	3873 (15.7%)		
	Total	6046 (100.0%)	7073 (100.0%)	11513 (100.0%)	24632 (100.0%)		
Occupation	Retire	756 (12.5%)	1680 (23.8%)	934 (8.1%)	3370 （13.7%）	1687.408	p<0.001
	Home maker	1520 (25.1%)	1718 (24.3%)	1942 (16.9%)	5180 （21.0%）		
	Self employed	1390 (23.0%)	1268 (17.9%)	2452 (21.3%)	5110 （20.7%）		
	Private	1610 (26.6%)	1463 (20.7%)	4785 (41.6%)	7858 （31.9%）		
	Government/Semi Government	770 (12.7%)	944 (13.3%)	1400 (12.2%)	3114 （12.6%）		
	Total	6046 (100.0%)	7073 (100.0%)	11513 (100.0%)	24632 (100.0%)		
Household income	RM0-1500	2046 (33.8%)	2411 (34.1%)	3619 (31.4%)	8076(32.8%)	28.575	p<0.001
	RM1501-3000	1695 (28.0%)	1862 (26.3%)	3150 (27.4%)	6707 (27.2%)		
	RM3001-5000	1151 (19.0%)	1413 (20.0%)	2448 (21.3%)	5012 (20.3%)		
	RM5001-7000	533 (8.8%)	647 (9.1%)	1034 (9.0%)	2214 (9.0%)		
	above RM7000	621 (10.3%)	740 (10.5%)	1262 (11.0%)	2623 (10.6%)		
	Total	6046 (100.0%)	7073 (100.0%)	11513 (100.0%)	24632 (100.0%)		
Residential Area	Urban	3299 (54.6%)	4090 (57.8%)	6791 (59.0%)	14180 (57.6%)	31.983	p<0.001
	Rural	2747 (45.4%)	2983 (42.2%)	4722 (41.0%)	10452 (42.4%)		
	Tota	6046 (100.0%)	7073 (100.0%)	11513 (100.0%)	24632 (100.0%)		

Table 4.19, continued

Variable (s)	Level (s)	Hypercholesterolemia (HC)				Chi-Square (χ^2)	P-value
		Newly Diagnose HC	Known HC	No HC	Total N (%)		
Age	< 15 years old	524 (8.7%)	3835 (54.2%)	379 (3.3%)	4738 (19.2%)	9674.963	P<0.001
	15-24 years old	601 (9.9%)	1427 (20.2%)	2529 (22.0%)	4557 (18.5%)		
	25-34 years old	966 (16.0%)	150 (2.1%)	2870 (24.9%)	3986 (16.2%)		
	35-44 years old	1167 (19.3%)	271 (3.8%)	2204 (19.15)	3642 (14.8%)		
	45-54 years old	1265 (20.9%)	533 (7.5%)	1684 (14.6%)	3482 (14.1%)		
	55-64 years old	902 (14.9%)	521 (7.4%)	1037 (9.0%)	2460 (10.0%)		
	>65 years old	621 (10.3%)	336 (4.8%)	810 (7.0%)	1767 (7.2%)		
	Total	6046 (100.0%)	7073 (100.0%)	11513 (100.0%)	24632 (100.0%)		
Marital Status	Widow/widower or Divorced	577 (9.5%)	245 (3.5%)	648 (5.6%)	1470 (6.0%)	4457.915	P<0.001
	Married	4042 (66.9%)	1486 (21.1%)	7009 (60.9%)	12537 (51.0%)		
	Single	1426 (23.6%)	5319 (75.4%)	3853 (33.5%)	10598 (43.1%)		
	Total	6045 (100.0%)	7050 (100.0%)	11510 (100.0%)	24605 (100.0%)		
Body Mass Index (BMI)	Obese	1159 (19.2%)	2373 (33.6%)	1730 (15.0%)	5262 (21.4%)	1386.201	P<0.001
	Overweight	2043 (33.8%)	2395 (33.9%)	3205 (27.9%)	7643 (31.0%)		
	Underweight	376 (6.2%)	455 (6.4%)	1165 (10.1%)	1996 (8.1%)		
	Normal weight	2464 (40.8%)	1849 (26.1%)	5408 (47.0)	9721 (39.5%)		
	Total	6042 (100.0%)	7072 (100.0%)	11508 (100.0%)	24622 (100.0%)		
Physical Activity	Inactive	3027 (42.8%)	2161 (35.7%)	4052 (35.2%)	9240 (37.5%)	118.709	P<0.001
	Active	3885 (64.3%)	4046 (57.2%)	7461 (64.8%)	15392 (62.5%)		
	Total	6046 (100.0%)	7073 (100.0%)	11513 (100.0%)	24632 (100.0%)		
Fruit and Vegetables consumption	Inadequate	5577 (92.2%)	6712 (94.9%)	10676 (92.7%)	22965 (93.2%)	45.017	P<0.001
	Adequate	469 (7.8%)	361 (5.1%)	837 (7.3%)	1667 (6.8%)		
	Total	6046 (100.0%)	7073 (100.0%)	11513 (100.0%)	24632 (100.0%)		

Table 4.19, continued

Variable (s)	Level (s)	Hypercholesterolemia (HC)				Chi-Square (χ^2)	P-value
		Newly Diagnose HC	Known HC	No HC	Total N (%)		
Smoking Status	Current smokers	4718 (78.0%)	5167 (73.1%)	8952 (77.8%)	18837 (76.5%)	150.437	p<0.001
	Ex-smokers	338 (5.6%)	315 (4.5%)	710 (6.2%)	1363 (5.5%)		
	Non-smokers	990 (16.4%)	1591 (22.5%)	1851 (16.1%)	4432 (18.0%)		
	Total	6046 (100.0%)	7073 (100.0%)	11513 (100.0%)	24632 (100.0%)		
Race	Malays	3808 (63.0%)	4297 (60.8%)	6360 (55.2%)	14465 (58.7%)	229.613	p<0.001
	Chinese	994 (16.4%)	1267 (17.9%)	2225 (19.3%)	4486 (18.2%)		
	Indian	398 (6.6%)	580 (8.2%)	928 (8.1%)	1906 (7.7%)		
	Other Bumiputra	519 (8.6%)	725 (10.3%)	1197 (10.4%)	2441 (9.9%)		
	Others	327 (5.4%)	204 (2.9%)	803 (7.0%)	1334 (5.4%)		
	Total	6046 (100.0%)	7073 (100.0%)	11513 (100.0%)	24632 (100.0%)		
Drinking Status	Unclassified	27 (0.4%)	169 (2.4%)	34 (0.3%)	230 (0.9%)	393.472	P<0.001
	Current drinkers	370 (6.1%)	457 (6.5%)	1136 (9.9%)	1963 (8.0%)		
	Ex-drinkers	203 (3.4%)	291 (4.1%)	655 (5.7%)	1149 (4.7%)		
	Non-drinker	5446 (90.1%)	6156 (87.0%)	9688 (84.1%)	21290 (86.4%)		
	Total	6046 (100.0%)	7073 (100.0%)	11513 (100.0%)	24632 (100.0%)		

4.8.3 The Fitted Model with all predictors of Hypercholesterolemia

4.8.3.1 Goodness-of-Fit for model (Hypercholesterolemia)

The Goodness-of-Fit table (**Table 4.20**) above shows two tests of the null hypothesis. The tests show that the model adequately fits the data. If the significance value is found to be small, (less than 0.05) then the model is said to be not adequately fitting the data. In this case,. deviance value however, is larger than 0.05. Since, the Pearson value is found to be less than 0.05, it can be concluded that the data is not consistent with the model's assumptions. Here the Pearson value is not significant.

Table 4.20: Goodness-of-Fit foe model (Hypercholesterolemia)

	Chi-Square	df	P value
Pearson	38207.260	35928	.000
Deviance	31203.072	35928	1.000

4.8.3.2 Model Fitting Information: Likelihood Ratio Test (Hypercholesterolemia)

After determining the validity of the model as shown in **Table 4.20,** the next stage is to check the involvement of each dependent variable's effect to the model as shown in **Table 4.21.** If the significance of the test is less than 0.05 then the effect contributes to the model. **Table 4.21**, indicates that the significance of the test for fruit and vegetables consumption, drinking, smoking, Body Mass Index, physical activity, educational levels, income, marital status, gender, ethnics, occupation, residential area and age groups are smaller than 0.05. As a result, it has been statistically proved that there is a positive significant relationship between the likelihood of getting hypercholesterolemia and all the variables.

Table 4.21: Likelihood Ratio Tests (Hypercholesterolemia)

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square χ^2	df	P-value
Intercept	34696.566[a]	.000	0	-
Age	36861.847	2165.281	12	<0.001
Marital status	34781.099	84.533	4	<0.001
Gender	34808.930	112.365	2	<0.001
Residence	34706.419	9.853	2	.007
Race	34779.227	82.662	8	<0.001
Occupation	35183.806	487.240	8	<0.001
Household income	34733.459	36.893	8	<0.001
Education level	34839.156	142.591	8	<0.001
Physical activity	34708.531	11.966	2	.003
Fruit and vegetables consumption	34705.556	8.991	2	.011
Drinking	34838.827	142.261	6	<0.001
Smoking	34753.832	57.266	4	<0.001
Body Mass Index (BMI)	35267.988	571.423	6	<0.001

The chi-square statistic is the difference in -2 log-likelihoods between the final model and the reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

Table 4.22 demonstrates a likelihood ratio test of the model (Final) against one in which all the parameter coefficients are 0 (Null). The chi-square statistic is the difference between the -2 log-likelihoods of the Null and Final model. Since the significance level of the test is less than 0.05, it can be concluded that the Final model is outperforming the Null.

Table 4.22: Model Fitting Information (Hypercholesterolemia)

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	df	Sig.
1ntercept Only	46627.318			
Final	34696.566	11930.752	72	.000

Table 4.23 explains the validity of the model as a perfect model. Cox and Snell with 0.437 value (which is smaller than 1) satisfies the expectations about the model. In

addition, the value for Nagelkerke is found to be 0.492 which is between 0 and 1. Lastly, the value corresponding McFadden, 0.264 also satisfies the expectations of being between 0 and 1. Therefore, it can be concluded that the model used in this research is acceptable as an appropriate model. As a result, the results of the above shown statistics and tests indicates that the selection and use of Multinomial model, fits the selected dependent and independent variables appropriately.

Table 4.23: Pseudo R-Square (Hypercholesterolemia)

Cox and Snell	.384
Nagelkerke	.437
McFadden	.229

4.8.3.3 The Model Classification of Hypercholesterolemia

Table 4.24 Classification given below shows that of the cases used to create the model, 9886 out of the 15,961 people who are healthy (No HC) have been correctly classified. Similarly, 1052 out of the 6041 who suffered from Newly Diagnosed HC are classified correctly. Lastly, 1830 out of the 7049 who suffered from Known Diagnosed HC are also classified correctly. Overall, 63.8% of the cases are classified correctly.

Table 4.24: Classification (Hypercholesterolemia)

Observed	Predicted			
	No HC	Newly Diagnosed HC	Known HC	Percent Correct
No HC	9886	856	763	85.9%
Newly Diagnosed HC	4245	1052	744	17.4%
Known HC	1830	459	4760	67.5%
Overall Percentage	64.9%	9.6%	25.5%	63.8%

4.9 Reporting Results for Modifiable and Non-Modifiable Risk Factors on Hypercholesterolemia

4.9.1 Reporting Results for Modifiable and Non-Modifiable Risk Factors on Newly Diagnosed Hypercholesterolemia

From **Table 4.25,** in respect to drinking, it is observed that ex-drinkers have significantly ($p<0.001$) lower likelihood of having Newly Diagnosed Hypercholesterolemia (OR=0.679) compared to non-drinkers. Similarly, current smokers are more likely (OR=1.116, CI=1.021-1.220) to be diagnosed of having likelihood of Newly Diagnosed Hypercholesterolemia patients compared to non-smokers. Body Mass Index (BMI) has been found as a significant ($p<0.001$) variable affecting the probability of having Newly Diagnosed Hypercholesterolemia. The odds ratio for respondents who are obese and overweight are more than one (1.246 and 1.247 respectively), suggesting that obese and overweight respondents are more likely to have Newly Diagnosed Hypercholesterolemia. On the contrary, it is found underweight respondents have significantly ($p<0.001$) lower likelihood of having Newly Diagnosed Hypercholesterolemia (OR=0.726) compared to normal weight respondents.

Nevertheless, it is observed that females have significantly ($p<0.001$) higher likelihood (OR=1.501, CI=1.392-1.619) of having Newly Diagnosed Hypercholesterolemia than males. The odds of having Newly Diagnosed Hypercholesterolemia compared to no Hypercholesterolemia are 0.771, 0.761 and 0.774 times lower (with $p<0.001$) among respondents who are other Bumiputra, Chinese and Indians respectively than the Malays.

Besides, this study shows respondents who are above 65, 55-64, 45-54, 35-44, 25-34 and 15-24 years of age respectively have odds of Newly Diagnosed Hypercholesterolemia that is significantly ($p<0.001$) less than 1. The values are 0.478, 0.548, 0.498, 0.362, 0.247 and 0.192, respectively, suggesting that the younger aged groups are less likely to have Newly Diagnosed Hypercholesterolemia. In contrast, this study has significantly ($p=0.005$) exhibited decreased odds among urban residents (OR=0.906) of having Newly Diagnosed Hypercholesterolemia compared to other rural dwellers.

The odds of having Newly Diagnosed Hypercholesterolemia compared to no Hypercholesterolemia is 1.106 times higher (with $p<0.001$) among respondents with household income RM1501-3000. The odds ratio for respondents who are home-makers is more than one (OR=1.135) suggesting home makers are more likely to have Newly Diagnosed Hypercholesterolemia. However, private sector workers have significantly ($p<0.05$) revealed decreased odds (OR=0.767) of having Newly Diagnosed Hypercholesterolemia compared to government/semi government workers. Next, it is found that widow/widower/divorced respondents have significantly ($p<0.05$) higher likelihood (OR=1.231) of having Newly Diagnosed Hypercholesterolemia in comparison to single respondents. Lastly, physical activity, fruit and vegetables consumption and all education levels are found to be insignificant in showing likelihood of having Newly Diagnosed Hypercholesterolemia.

4.9.2 Reporting Results for Modifiable and Non-Modifiable Risk Factors on Known Hypercholesterolemia

Physically inactive respondents are more likely (OR=1.133; 95% CI 1.045-1.227) to be diagnosed as Known Hypercholesterolemia patients than physically active respondents. The odds of having Known Hypercholesterolemia compared to no Hypercholesterolemia are 7.021, 1.351 and 1.296 times higher (with $p<0.001$, $p=0.001$) among those who are unclassified drinkers, ex-drinkers and current drinkers respectively than the reference category of non-drinkers. The ex-smokers have higher likelihood (OR=1.287, 95% CI 1.075-1.541) of having Known Hypercholesterolemia. Nevertheless, the odds of having Known Hypercholesterolemia compared to no Hypercholesterolemia is 0.285 times lower (with $p<0.001$) among current smokers than the reference category of non-smokers. Inadequate fruit and vegetables consumption hare more likely (OR=1.274, 95% CI 1.083-1.499) to have Known Hypercholesterolemia than the respondents with adequate fruit and vegetables consumptions. The odds of having Known Hypercholesterolemia compared to no Hypercholesterolemia are 2.656 and 1.907 respectively among those who are obese and overweight respectively than the reference category of normal weight respondents. However, the odds ratio for underweight respondents is less than one (0.616), suggesting that the underweight respondents are less likely to have Known Hypercholesterolemia.

Females have significantly ($p<0.05$) shown increased odds (OR=1.134, 95% CI 1.042-1.234) of Known Hypercholesterolemia in comparison to males. The odds ratio for Indians is more than one (OR=1.218), suggesting Indian respondents are more likely to have Known Hypercholesterolemia when compared to Malay respondents. In contrast, other race have odds of Known Hypercholesterolemia that is significantly ($p<0.001$) less than 1. The value 0.702 suggests other race respondents are less likely to have Known Hypercholesterolemia. Respondents who are above 65, 55-64, 45-54, 35-44, 25-34 and 15-24 years of age respectively have odds of Newly Diagnosed Hypercholesterolemia that is significantly ($p<0.001$) less than 1. The values are 0.068, 0.092, 0.072, 0.031, 0.013 and 0.092 respectively, suggesting that the respondents aged 15-24 and 55-64 years old are more likely to have Known Hypercholesterolemia.

Meanwhile, the odds ratio for the unclassified educated respondents, no formal education, primary education and secondary education are more than one (2.589, 1.339, 2.058 and 1.920 respectively), indicating those with less education are also more likely to have Known Hypercholesterolemia. Moreover, the odds ratio for the respondents with household income levels: above RM7000.00, RM5001-7000 and RM3001-5000 are more than one (1.348, 1.304 and 1.127 respectively), suggesting those with higher income level are more likely to have Known Hypercholesterolemia. In the case of occupation, the odds of having Known Hypercholesterolemia compared to no Hypercholesterolemia are 1.427 times higher (with $p<0.001$) among retirees than the reference category of government/ semi government workers. However, respondents who are home makers, self-employed and private sector workers respectively have odds of Known Hypercholesterolemia that are significantly ($p<0.05$, $p<0.001$ and $p<0.001$) less than 1. The values are 0.803, 0.591 and 0.393 respectively, suggesting that the home makers, self-employed and private sector workers are less likely to have Known Hypercholesterolemia. On the other hand, married couples and widow/widower/divorced have significantly ($p<0.001$) lower likelihood (OR=0.508 and OR=0.502 respectively) to have Known Hypercholesterolemia. However, results suggest that residential area is not associated with the likelihood of having Known Hypercholesterolemia.

Table 4.25: Parameter Estimates for Multinomial Logistic Regressions on Hypercholesterolemia

HC	Predictor(s)	B Coefficient	Std. Error	Wald	df	P-value	Exp(B) Odds ratio	95% Confidence Interval for Exp(B) Lower Bound	Upper Bound
Newly Diagnosed HC	Intercept	.042	.129	.108	1	.742			
	Age	-.738	.117	39.550		.000	.478	.380	.602
	>65 years old	-.601	.105	32.647	1	.000	.548	.446	.674
	55-64 years old	-.698	.103	46.196	1	.000	.498	.407	.609
	45-54 years old	-1.016	.103	96.623	1	.000	.362	.296	.443
	35-44 years old	-1.399	.099	200.569	1	.000	.247	.203	.300
	25-34 years old	-1.649	.091	327.803	1	.000	.192	.161	.230
	15-24 years old	0[b]	.	.	0	.	.	.	.
	below 15 years old (R)								
	Marital Status								
	Widow/widow/divorced	.208	.090	5.270	1	.022	1.231	1.031	1.469
	Married	.117	.060	3.776	1	.052	1.124	.999	1.265
	Single (R)	0[b]	.	.	0	.	.	.	.
	Gender	.406	.039	111.048	1	.000	1.501	1.392	1.619
	Female	0[b]	.	.	0	.	.	.	.
	Male (R)								
	Residential Area	-.099	.035	7.778	1	.005	.906	.845	.971
	Urban	0[b]	.	.	0	.	.	.	.
	Rural								
	Race								
	Others	-.120	.075	2.571	1	.109	.887	.766	1.027
	Other Bumiputra	-.260	.061	17.977	1	.000	.771	.684	.870
	Indian	-.273	.067	16.386	1	.000	.761	.667	.869
	Chinese	-.256	.050	25.713	1	.000	.774	.701	.855
	Malays (R)	0	.	.	0	.	.	.	.

Table 4.25, continued

HC	Predictor(s)	B Coefficient	Std. Error	Wald	df	P-value	Exp(B) Odds ratio	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
Newly Diagnosed HC	**Occupation**								
	Retire	.129	.080	2.563	1	.109	1.137	.9721	1.332
	Home maker	.127	.064	3.919	1	.048	1.135	1.001	1.288
	Self-employed	.027	.062	.193	1	.660	1.028	.910	1.160
	Private	-.266	.058	21.141	1	.000	.767	.684	.859
	Gov/Semi Gov (R)	0^b	.	.	0	.	.	.	.
	Household Income								
	0=AboveRM7000	.100	.063	2.525	1	.112	1.106	.977	1.252
	RM5001-7000	.108	.065	2.757	1	.097	1.114	.981	1.266
	RM3001-5000	.005	.049	.010	1	.919	1.005	.913	1.106
	RM1501-3000	.101	.043	5.400	1	.020	1.106	1.016	1.205
	RM0-1501 (R)	0^b	.	.	0	.	.	.	.
	Education level								
	Unclassified	.162	.112	2.089	1	.148	1.176	.944	1.464
	No formal	-.068	.085	.630	1	.427	.935	.791	1.105
	Primary	-.012	.061	.036	1	.850	.988	.876	1.115
	Secondary	-.024	.050	.234	1	.629	.976	.885	1.076
	Tertiary (R)	0^b	.	.	0	.	.	.	.
	Physical Activity								
	Inactive	-.019	.035	.277	1	.599	.982	.916	1.052
	Active	0^b	.	.	0	.	.	.	.
	Fruit & Vege Consumption	.028	.062	.206	1	.650	1.029	.910	1.163
	Inadequate	0^b	.	.	0	.	.	.	.
	Adequate								

Table 4.25, continued

HC	Predictor(s)	B Coefficient	Std. Error	Wald	df	P-value	Exp (B) Odds ratio	95% Confidence Interval for Exp (B) Lower Bound	95% Confidence Interval for Exp (B) Upper Bound
Newly Diagnosed HC	**Drinking Status**								
	Unclassified	.299	.265	1.277	1	.258	1.349	.803	2.268
	Current drinker	-.122	.070	3.050	1	.081	.885	.772	1.015
	Ex-drinker	-.387	.087	19.934	1	.000	.679	.573	.805
	Non-Drinker (R)	0^b	.	.	0	.	.	.	.
	Smoking Status								
	Current smoker	.110	.045	5.893	1	.015	1.116	1.021	1.220
	Ex-smoker	.102	.083	1.537	1	.215	1.108	.942	1.302
	Non-smoker (R)	0^b	.	.	0	.	.	.	.
	Body Mass Index								
	Obese	.220	.047	21.663	1	.000	1.246	1.136	1.366
	Overweight	.221	.039	32.329	1	.000	1.247	1.156	1.345
	Underweight	-.321	.067	22.822	1	.000	.726	.636	.828
	Normal weight (R)	0^b	.	.	0	.	.	.	.
Known HC	Intercept	1.142	.147	60.541	1	.000			
	Age								
	0=> 65 years old	-2.688	.133	409.951	1	.000	.068	.052	.088
	55-64 years old	-2.389	.116	427.214	1	.000	.092	.073	.115
	45-54 years old	-2.635	.114	535.800	1	.000	.072	.057	.090
	35-44 years old	-3.476	.121	827.007	1	.000	.031	.024	.039
	25-34 years old	-4.376	.123	1265.665	1	.000	.013	.010	.016
	15-24 years old	-2.391	.079	923.688	1	.000	.092	.078	.107
	below 15 years old (R)	0^b	.	.	0	.	.	.	.

Table 4.25, continued

HC	Predictor(s)	B Coefficient	Std. Error	Wald	df	P-value	Exp (B) Odds ratio	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
Known HC	**Marital Status**								
	widow/widower/divorced	-.690	.122	32.001	1	.000	.502	.395	.637
	Married	-.677	.082	68.087	1	.000	.508	.433	.597
	Single (R)	0^b	.	.	1	.000	.	.	.
					0	.			
	Gender								
	Female	.126	.043	8.414	1	.004	1.134	1.042	1.234
	Male	0^b	.	.	0	.	.	.	.
	Residential Area								
	Urban	.017	.042	.170	1	.680	1.017	.937	1.104
	Rural (R)	0^b	.	.	0	.	.	.	.
	Race								
	Others	-.354	.106	11.111	1	.001	.702	.570	.864
	Other Bumiputra	-.082	.070	1.391	1	.238	.921	.803	1.056
	Indian	.197	.074	7.143	1	.008	1.218	1.054	1.407
	Chinese	.074	.057	1.703	1	.192	1.077	.963	1.205
	Malays (R)	0^b	.	.	0	.	.	.	.
	Occupation								
	Retire	.355	.083	18.175	1	.000	1.427	1.212	1.680
	Home maker	-.220	.074	8.799	1	.003	.803	.695	.928
	Self-employed	-.526	.073	52.089	1	.000	.591	.512	.682
	Private	-.933	.069	182.754	1	.000	.393	.343	.450
	Gov/Semi Gov (R)	0^b	.	.	0	.	.	.	.

Table 4.25, continued

HC	Predictor(s)	B Coefficient	Std. Error	Wald	df	P-value	Exp (B) Odds ratio	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
	Household Income								
	Above RM7000	.299	.073	16.604	1	.000	1.348	1.168	1.557
Known HC	RM5001-7000	.266	.075	12.598	1	.000	1.304	1.126	1.510
	RM3001-5000	.120	.057	4.471	1	.034	1.127	1.009	1.259
	RM1501-3000	.010	.052	.034	1	.854	1.010	.912	1.117
	RM0-1501 (R)	0^b	.	.	0	.	.	.	.
	Education level								
	Unclassified	.951	.110	74.784	1	.000	2.589	2.087	3.211
	No formal	.292	.116	6.297	1	.012	1.339	1.066	1.683
	Primary	.722	.082	78.116	1	.000	2.058	1.753	2.415
	Secondary	.652	.070	86.558	1	.000	1.920	1.673	2.203
	Tertiary (R)	0^b	.	.	0	.	.	.	.
	Physical Activity								
	Inactive	.124	.041	9.208	1	.002	1.133	1.045	1.227
	Active	0^b	.	.	0	.	.	.	.
	Fruit & Vegetables								
	Consumption	.242	.083	8.539	1	.003	1.274	1.083	1.499
	Inadequate	0^b	.	.	0	.	.	.	.
	Adequate								
	Drinking Status								
	Unclassified	1.949	.236	68.129	1	.000	7.021	4.420	11.153
	Current drinker	.259	.078	11.154	1	.001	1.296	1.113	1.509
	Ex-drinker	.301	.092	10.583	1	.001	1.351	1.127	1.620
	Non-Drinker (R)	0^b	.	.	0	.	.	.	.

Table 4.25, continued

HC	Predictor(s)	B Coefficient	Std. Error	Wald	df	P-value	Exp (B) Odds ratio	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
Known HC	**Smoking status**								
	Current smoker	-.192	.051	14.282	1	.000	.825	.747	.912
	Ex-smoker	.252	.092	7.552	1	.006	1.287	1.075	1.541
	Non-smoker (R)	0[b]	.	.	0	.	.	.	.
	Body Mass Index								
	Obese	.977	.053	341.063	1	.000	2.656	2.395	2.947
	Overweight	.646	.048	182.852	1	.000	1.907	1.737	2.094
	Underweight	-.485	.079	38.042	1	.000	.616	.528	.718
	Normal weight (R)	0[b]	.	.	0	.	.	.	.

The reference category is: No Hypercholesterolemia.

4.10 Summary of Results

This section presents the findings of the estimated odds ratio generated through the multinomial logistic regression, in order to model categorical response variables. From this modelling approach, modifiable and non-modifiable risk factors which are associated with different outcome levels of NCDs have been determined simultaneously. The summary of this research demonstrate that different NCDs outcome levels are associated with different modifiable and non-modifiable risk factors in this study as shown in **Table 4.3 and 4.4.** Through this study, it has been found that non-modifiable risk factors for instance socio-demographics factors also play a role for the control of NCDs.

The findings of this study suggest that the Government needs to look into the significant predictors of newly diagnosed NCDs, such as, overweight and obese, current drinkers, current smokers and inadequate fruit and vegetables consumption, in order to implement health promotion strategies and appropriate intervention programmes. These initiatives will be targeted to reduce NCD prevalence in our country by educating people and by creating preventive measures for newly diagnosed NCDs. Since Malaysia is a multi-ethnic country, the results of this study are important for policy makers to address targeted group of Malaysians for intervention programmes.

Table 4.26: Summary of Results for Modifiable Risk Factors for DM, HP and HC

Modifiable Risk factors		Impaired Fasting Glucose	Newly Diagnosed DM	Known DM	Newly Diagnosed HP	Known HP	Newly Diagnosed HC	Known HC
Physical Activity	Inactive	**1.199**** More likely	**1.274**** More likely	**1.146**** More likely	0.862** Less likely	**1.154**** More likely	0.982 Not sig.	**1.133**** More likely
	Active	(reference)						
Body Mass Index (BMI)	Obese	**1.396**** More likely	**2.155**** More likely	3.06 Not sig.	**2.318**** More likely	**2.608**** More likely	**1.246**** More likely	**2.656**** More likely
	Overweight	**1.212*** More likely	**1.772**** More likely	2.141 Not sig.	**1.642**** More likely	**1.847**** More likely	**1.247**** More likely	**1.907**** More likely
	Underweight	0.81 Not sig.	0.655** Less likely	0.597 Not sig.	0.899 Not sig.	0.994 Not sig.	0.726** Less likely	0.616** Less likely
	Normal weight	(reference)						
Fruit & vegetable Consumption	Inadequate	1.099 Not sig.	**1.364**** More likely	0.656** Less likely	1.020 Not sig.	1.136 Not sig.	1.029 Not sig.	**1.274*** More likely
	adequate	(reference)						
Smoking status	Current smoker	1.015 Not sig.	1.098 Not sig.	0.82** Less likely	0.974 Not sig.	0.817** Less likely	**1.116*** More likely	0.825** Less likely
	Ex-smoker	0.828 Not sig.	0.931 Not sig.	**1.32*** More likely	1.156 Not sig.	**1.220*** More likely	1.108 Not sig.	**1.287*** More likely
	Non-smoker	(reference)						
Drinking status	Unclassified	0.161 Not sig.	1.123 Not sig.	0.09** Less likely	1.307 Not sig.	**2.370**** More likely	1.349 Not sig.	**7.021**** More likely
	Current drinker	0.881 Not sig.	0.616** Less likely	1.061 Not sig.	**1.225*** More likely	0.836*	0.885 Not sig.	**1.296*** More likely
	Ex-drinker	1.133 Not sig.	0.793* Less likely	1.033 Not sig.	0.933 Not sig.	1.092 Not sig.	0.679** Less likely	**1.351*** More likely
	Non-drinker	(reference)						

Table 4.27: Summary of Findings: Non-Modifiable Risk Factors for DM, HP and HC

Non-Modifiable Risk factors		Impaired Fasting Glucose	Newly Diagnosed DM	Known DM	Newly Diagnosed HP	Known HP	Newly Diagnosed HC	Known HC
Age	>65 years old	2.517 Not sig.	0.005** Less likely	0.005** Less likely	**7.518**** More likely	**5.418**** More likely	0.478** Less likely	0.068** Less likely
	55-64 years old	2.083 Not sig.	0.006** Less likely	0.006** Less likely	**5.264**** More likely	**3.417**** More likely	0.548** Less likely	0.092** Less likely
	45-54 years old	2.142 Not sig.	0.005** Less likely	0.005** Less likely	**3.205**** More likely	**1.501**** More likely	0.498** Less likely	0.072** Less likely
	35-44 years old	1.597 Not sig.	0.004** Less likely	0.002** Less likely	**2.125**** More likely	0.558** Less likely	0.362** Less likely	0.031** Less likely
	25-34 years old	1.348 Not sig.	0.003** Less likely	0.001** Less likely	1.085 Not sig.	0.197** Less likely	0.247** Less likely	0.013** Less likely
	15-24 years old	1.238 Not sig.	0.007** Less likely	0.009** Less likely	0.695** Less likely	0.496** Less likely	0.192** Less likely	0.092** Less likely
	0-15 years old	Reference						
Gender	Female	0.91 Not sig.	0.702** Less likely	0.779** Less likely	0.848 Not sig.	0.996 Not sig.	0.848 Not sig.	1.134* Less likely
	Male	Reference						
Race	Others	0.857 Not sig.	0.844 Not sig.	0.682** Less likely	0.946 Not sig.	0.851 Not sig.	0.887 Not sig.	0.702* Less likely
	Other Bumiputra	0.643* Less likely	0.694** Less likely	0.629** Less likely	1.106 Not sig.	1.174* More likely	0.771 Not sig.	0.921 Not sig.
	Indian	1.013 Not sig.	1.495** More likely	1.74** More likely	0.826** Less likely	1.007 Not sig.	0.761 Not sig.	1.218* Less likely
	Chinese	0.715* Not sig.	0.908 Not sig.	0.813* Not sig.	0.824** Less likely	0.970 Not sig.	0.774 Not sig.	1.077 Not sig.
	Malays	Reference						

Table 4.27, continued

Non-Modifiable Risk factors		Impaired Fasting Glucose	Newly Diagnosed DM	Known DM	Newly Diagnosed HP	Known HP	Newly Diagnosed HC	Known HC
Occupation	Retiree	1.074 Not sig.	1.318* More likely	2.233** More likely	1.089 Not sig.	0.829* Less likely	1.137 Not sig.	1.427** More likely
	Home maker	0.942 Not sig.	1.118 Not sig.	1.211* More likely	1.139 Not sig.	1.044 Not sig.	1.135* More likely	0.803* Less likely
	Self-employed	1.17 Not sig.	0.964 Not sig.	0.894 Not sig.	1.076 Not sig.	0.811* Less likely	1.028 Not sig.	0.591** Less likely
	Private	0.982 Not sig.	0.745 Not sig.	0.532** Less likely	1.057 Not sig.	0.786** Less likely	0.767** Less likely	0.393** Less likely
	Government/ Semi Gov	Reference						
Household Income	Above RM7000.00	1.111 Not sig.	1.2* More likely	1.23* More likely	0.806* Less likely	1.056 Not sig.	1.106 Not sig.	1.348** More likely
	RM5001-7000	0.978 Not sig.	1.109 Not sig.	1.17* More likely	0.871* Less likely	1.093 Not sig.	1.114 Not sig.	1.304** More likely
	RM3001-5000	1.073 Not sig.	0.987 Not sig.	0.959 Not sig.	0.938 Not sig.	1.014 Not sig.	1.005 Not sig.	1.127* More likely
	RM1501-5000	0.92 Not sig.	0.927 Not sig.	0.848 Not sig.	1.00 Not sig.	1.022 Not sig.	1.106* More likely	1.010 Not sig.
	RM0-1500	Reference						
Education level	Unclassified	0.594 Not sig.	3.237** More likely	5.871** More likely	1.209 Not sig.	1.785** More likely	1.176 Not sig.	2.589** More likely
	No formal	1.031 Not sig.	1.647** More likely	2.626** More likely	1.426** More likely	1.786** More likely	0.935 Not sig.	1.339* More likely
	Primary	1.137 Not sig.	1.834** More likely	3.432** More likely	1.475** More likely	1.798** More likely	0.988 Not sig.	2.058** More likely
	Secondary	1.171 Not sig.	1.583** More likely	2.908** More likely	1.310** More likely	1.586** More likely	0.976 Not sig.	1.920** More likely
	Tertiary	Reference						

Table 4.27, continued

Non-Modifiable Risk factors		Impaired Fasting Glucose	Newly Diagnosed DM	Known DM	Newly Diagnosed HP	Known HP	Newly Diagnosed HC	Known HC
Marital Status	Widow/ widower or divorced	0.894 Not sig.	0.741* Less likely	0.498 Not sig.	0.928 Not sig.	0.970 Not sig.	**1.231*** More likely	0.502** More likely
	Married	1.193 Not sig.	0.917 Not sig.	0.554 Not sig.	0.770** Less likely	0.815* Less likely	1.124 Not sig.	0.508** Less likely
	Single	Reference						
Residential area	Urban	1.133 Not sig.	1.034 Not sig.	1.004 Not sig.	0.924* Less likely	0.938 Not sig.	0.906* Less likely	1.017 Not sig.
	Rural	Reference						

CHAPTER 5: DISCUSSION

5.1 Results Discussion for Modifiable and Non-Modifiable Risk Factors on Diabetes Mellitus

5.1.1 Results Discussion for Modifiable and Non-Modifiable Risk Factors on Impaired Fasting Glucose

The present study corroborates the findings of Wei et al. (1999), and claims that physical activity has positive impact on the likelihood of having Impaired Fasting Glucose. Men who were in the low-fitness group have been found to have a 1.9-fold risk (95% CI, 1.5- to 2.4-fold) of having impaired fasting glucose compared with those in the high-fitness group. Additionally, doing exercise during their free time at least once a week was not significantly associated with the odds of Impaired Fasting Glucose in Spain (Soriguer et al., 2012).

This finding supports the conclusion drawn by Pandev (2014) that primary prevention sought to prevent the onset of specific diseases via risk reduction, by changing behaviors or exposures which could lead to the disease, or by enhancing resistance to the effects of exposure to a disease agent. Therefore, health behaviors will be promoted such as physical activities among citizens in Malaysia.

On the other hand, the findings of this study are also consistent with a previous research based in Spain which indicated that smoking had no significant difference on the likelihood of Impaired Fasting Glucose (Soriguer et al., 2012).

The findings on Body Mass Index (BMI) lend support to (Rathmann et al., 2003) who reported that obesity could be a predictor for the high prevalence of Impaired

Glucose Tolerance (IFG) in Germany. Similarly, it was revealed that overweight (24 $kg/m^2 \leq BMI < 28\ kg/m^2$) and obesity (BMI ≥ 28 kg/m2) were 2.32 times higher and 4.63 times more likely to suffer from IFG than normal weight respondents in China (Qian et al., 2010). Hence, the maintenance of normal body weight (less than BMI 18-20) is essential to prevent Impaired Fasting Glucose. Besides, Body Mass Index (BMI) was found associated with IFG which significantly showed 1.482 times more likely to be IFG (OR=1.482; 95% CI=1.288–1.705) (Kim et al., 2006).

The finding of this study is consistent with the previous researches conducted by Baker (2006), Bouffard (2007) and Friedman & Hechter (1998) which stated that according to the rational choice theory, individuals were recognized as rational, utility-maximizing and self-interested agents who allocated limited resources based on their personal preferences and values, opportunities, costs and institutional constraints. Hence, an individual may assign his/her expected utility score to the possible choices (Cha, Crowe, Braxter, & Jennings, 2016). Hence, it is implied that individuals should make the right choice about their lifestyles such as heathy behavior: adequate fruit and vegetables consumption, maintain normal body weight, physically active, quit excess alcohol consumption and smoking.

Next, the findings of this study on race lend support to that of (Letchuman et al., 2010), who reported that the Indians (5.2%, 95% CI: 4.3– 6.1) and the Chinese (5.1%, 95% CI: 4.5–5.7%) respondents were found to have significantly higher prevalence of Impaired Fasting Glucose (IFG) compared to Malays (4.0%, 95% CI: 3.6–4.3%). It is suggested that it may be due to the difference in lifestyles and culture among the Indians, which could consequently impact the likelihood of having Diabetes Mellitus in Malaysia. The lipid toxicity of unsaturated fats has been used as a cooking medium among Indians has become the cause of a sharp rise in the prevalence of Diabetes Mellitus in Malaysia (Raheja, 1999).

In the perspective of residential area, all urban respondents are not found to be significant on the likelihood of having Impaired Fasting Glucose compared to rural respondents. This is consistent with a previous research which noted that the age-standardized prevalence of impaired fasting glucose was not significant (7.7% vs 7.4%; p=0.48) among urban and rural residence (Gu et al., 2003).

5.1.2 Results Discussion for Modifiable and Non-Modifiable Risk Factors on Newly Diagnosed Diabetes Mellitus

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 inactive with 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).

However, this study demonstrates that current-drinkers and ex-drinkers have significantly lower odds of Newly Diagnosed Diabetes Mellitus which 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 have different impact on the likelihood of different stages of NCDs such as Newly Diagnosed Diabetes Mellitus.

Next, 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 Newly Diagnosed Diabetes Mellitus (Soriguer et al., 2012). On the other hand, current and former smokers were found to be associated with a higher prevalence of diabetes (Choi & Shi, 2001). It is suggested it may be probably different context show different outcomes of research based on varied levels of smoking.

Hence, the findings of this study implies that based on the rational choice theory, any choice which has been made will incur a tradeoff. This is because individuals make trade-off between alternatives. Individuals make choices to achieve his/her objective, assuming all relevant factors that are beyond his/her control (Onwujekwe, 2006). However, it has been revealed that most people will make choices to develop their lifestyles for the purpose to minimize their cost or from which will gain more of what they use in tangible and/ or intangible terms (Milio, 1976). Therefore, each individual is assumed to make their best informed decision making in choosing the prevention strategy by practicing healthy lifestyles to maximize their social welfare and to prevent NCDs.

Besides, the prevalence of Newly Diagnosed Diabetes Mellitus is greatly influenced by obesity. The findings of this study are agreeable to the previous findings which reported that significant associations were found among the obese respondents on the likelihood of having Newly Diagnosed Diabetes Mellitus (Ismail et al., 2016; Rathmann et al., 2003). Similarly, obese increased the risk of prevalence of non-communicable diseases such as cardiovascular diseases and diabetes (Fontaine, Redden, Wang, Westfall, & Allison, 2003; Hill, Wyatt, Reed, & Peters, 2003; Solomon & Manson, 1997).

This finding implies that the application of rational choice theory, to address obesity, understanding the problem within a rational utility maximization framework is necessary (Asfaw, 2007). This was because the satisfaction obtained from eating more and exercising less could be higher than the costs related to maintaining a lower body weight and the future (discounted) health costs which is related to obesity (Philipson & Posner, 1999; Suranovic, Goldfarb, & Leonard, 2003).

Next, the findings of this study are in line with the previous researches which reported that the odds ratio of diabetes was in the top quintile when fruit and vegetable consumption was 0.78 (95% confidence interval, 0.60-1.00). Thus, these findings indicated the benefits of a diet rich in fruits and vegetables (Harding et al., 2008). It is important for the nation to be aware of the importance of adequate consumption of fruits and vegetables is essential to decrease the likelihood of having Newly Diagnosed Diabetes Mellitus and this applies to the rational choice theory that each individual makes their choice based on their own preferences and the constraints they face. These preferences are based on the axioms relating to customer preferences (Kreps, 1990; Mas-Colell et al., 1995).

Based on the prevention model of this study which emphasizes on primary prevention perspective, the surveillance of the major risk factors known to predict disease is an appropriate starting point (Labarthe, 1999). Moreover, previous researches indicated that primary prevention of NCDs, such as, diabetes was possible by modifying risk factors such as obesity and insulin resistance (Group, 2002; Pratley & Matfin, 2007). Hence, lifestyle intervention that had been identified could have a sustained a 43% reduction in the occurrence of diabetes over a 20-year period (Li et al., 2008).

This study has found that female respondents have lower odds of Newly Diagnosed Diabetes Mellitus compared to male respondents. These results are consistent with the previous findings which reported that males have significantly exhibited a higher association on the likelihood of having Newly Diagnosed Diabetes Mellitus compared to females (Ismail et al., 2016; Regitz-Zagrosek et al., 2006). It is suggested that females are more health conscious than their male counterparts. This health consciousness is achieved by practicing a healthier lifestyle with less sugar intake and regular health screening among females.

It is found that Indian respondents on the other hand, have significantly higher odds of having Newly Diagnosed Diabetes Mellitus in comparison to Malay respondents and this finding is supported by (Tan, Dunn, & Yen, 2011) Tan, Dunn & Yen (2011) revealed that Indians Indians were more likely to exhibit central obesity, elevated fasting blood glucose, and low high-density lipoprotein cholesterol because it was found that Indians tend to engage in less fruits and vegetables consumption and less participation in physical activity.

The findings of this study are consistent with those of Ismail et al. which reported that other Bumiputra have significantly ($p<0.001$) lower likelihood (adjusted OR=0.70) of having Newly Diagnosed Diabetes Mellitus than the Malays in Malaysia. The probable reasons behind this observation may be the differences in dietary intake, lifestyle and genetic inheritance among the races in Malaysia (Ismail et al., 2016).

The findings of this study which state that older aged group is less likely to have Newly Diagnosed Diabetes Mellitus are in alignment with a previous research conducted in India which observed that older subjects were less likely to have Newly Diagnosed Diabetes Mellitus compared to younger groups (Kanungo et al., 2016).

Findings of this present study also suggest that respondents with lower education levels are more likely to have Newly Diagnosed Diabetes Mellitus and this has been supported by a previous study based on Korean women which reported that there was a significant inverse correlation between educational level and the Newly Diagnosed Diabetes Mellitus (Rathmann et al., 2005). These findings support the the concept of Rational Choice Theory which implies that there may be an absence of information for consumers to make rational and proficient choices, often compounded by hesitation or miscommunication on the health benefits and harms of different lifestyle choices. Hence, education level has been identified as a significant predictor of Newly Diagnosed Diabetes Mellitus.

The results of this study which demonstrate that higher income earners are less likely to have Newly Diagnosed Diabetes Mellitus is consistent with the research which reported that the odds ratio decreased with higher income among women (adjusted OR: 0.7; 95% CI 0.5–1.03) for Newly Diagnosed Diabetes Mellitus (Kanjilal et al., 2006; Rathmann et al., 2005). It may be due to the fact that respondents with higher household income have more access to health screening and practice healthy diet, which consequently reduces the likelihood of having Newly Diagnosed Diabetes Mellitus.

In this study, when retirees have been found to be more likely to have Newly Diagnosed Diabetes Mellitus is supported by the research which found that the proportions of population affected by Diabetes Mellitus were rising in the countries, which have higher proportion of ageing societies (McDonald, Hertz, Unger, & Lustik, 2009; Porapakkham, Pattaraarchachai, & Aekplakorn, 2008).

However, results indicate respondents who work in private sector demonstrate lower odds of Known Diabetes Mellitus. The probable reason is private sector especially corporate offers better private medical benefits to the workers and they will have health screening which provides the opportunity to prevent NCDs.

Findings for marital status is consistent with a study based on India which revealed divorced/separated/widowed/widowers had lower odds of having uncontrolled (Known) diabetes (Kanungo et al., 2016).

5.1.3 Results Discussion for Modifiable and Non-Modifiable Risk Factors on Known Diabetes Mellitus

This research shows that physically inactive respondents are more likely to have Known Diabetes Mellitus and the results are consistent with a previous study. It was found the risk of suffering from chronic diseases and mental health problems could be reduced through regular engagement in physical activity (Batty & Lee, 2004). Next, it had been stressed that the women with high income tended to become less physically active compared to men of the same income group which explained the higher risk of having Known Diabetes Mellitus (Oli et al., 2013). Hence, it is important that government intervention strategies to promote physical activities among the Known Diabetes Mellitus patients by building more sports-oriented facilities in the housing areas and work places as well as to provide affordable treatment facilities.

In the previous studies, it indicated that alcoholics were at higher risk of diabetes (Balkau et al., 2008). However, the results in this study which show that unclassified-drinkers have significantly ($P<0.001$) lower odds of Known Diabetes Mellitus compared to non-drinkers, disagree with the previous studies. The probable reason may be that the amount of alcohol consumption by unclassified drinkers was indecisive/unconcluded which is resulted in lower likelihood of having Known Diabetes Mellitus.

The present results of this study have exhibited that ex-smokers are more likely to be diagnosed as Known Diabetes Mellitus patients. This observation is consistent with a previous research which reported that ex-smoking habit was found positively associated to Known Diabetes Mellitus when compared to current smoking behavior (Akhtar & Dhillon, 2017). Next, smoking habit was identified as one of the major contributors for Diabetes Mellitus (Bener et al., 2009).

However, the results of this study which show that current smokers reveal lower odds of Known Diabetes Mellitus is disagreeable with a previous research that indicated current smokers were found to be associated with a higher prevalence of diabetes (Choi & Shi, 2001). It may be because the current smokers have already suffered from Known Diabetes Mellitus. As a result, the habit of current smoking does not have much impact on the odds of Known Diabetes Mellitus. Nevertheless, based on the results, continuous and more comprehensive anti-smoking policy measures are needed in order to further prevent the increasing trend of Known Diabetes Mellitus among individuals in Malaysia.

Another finding of this study suggests that respondents with inadequate fruit and vegetables consumption have significantly ($P<0.001$) lower odds of Known Diabetes

Mellitus compared to respondents with adequate fruit and vegetables consumption. This is inconsistent with a previous research based on Finland which revealed that rich fruit and vegetables intake reduced the risk suffering type-2 Diabetes Mellitus (Mursu et al., 2013). It is suggested that some other factors may also contribute to this subject besides inadequate fruit and vegetables consumption, affecting the odds of Known Diabetes Mellitus.

In terms of Body Mass Index, results of this study indicate that obese and overweight respondents are found to have significantly higher likelihood to have Known Diabetes Mellitus. This is consistent with a previous study which reported that the prevalence of diabetes was significantly higher in men, older groups, married, subject of low educational, past smokers and subject with obesity (Dajani et al., 2012). Also, it has been found that BMI greater than 30 was recognized as obese, consequently such BMI greatly increased the risk of prevalence of non-communicable diseases such as cardiovascular diseases and diabetes (Fontaine et al., 2003; Hill et al., 2003; Solomon & Manson, 1997). Next, the risks for Diabetes Mellitus were found to be greatly increased in subjects with BMI above 29 kg/m^2 (Ishikawa-Takata et al., 2002; Willett et al., 1999). Additionally, another previous study also reported that overweight and obesity had significantly higher risk towards diabetes (Ahmad et al., 2011; Ather Ali, 2009).

From the application of Levels of Prevention Model, primary prevention has been identified and was necessary to implement in national strategies and previous researches have indicated primary prevention of NCDs, for example, diabetes was possible by modifying risk factors such as obesity and insulin resistance (Group, 2002; Pratley & Matfin, 2007). Hence, government intervention programs should focus on maintaining normal weight among Malaysians by having health promotion of active lifestyle and healthy eating habits prevent the prevalence of different stages of Diabetes Mellitus.

In the case of gender, the outcomes of this study indicate that females are less likely to have Known Diabetes Mellitus. This is consistent with a previous research based on Jordan which reported that females were less likely to be diabetic than males (Ajlouni et al., 1998). It was also reported that male Canadian patients have a higher proportion of diabetes (46% females, males 54%) (Choi & Shi, 2001). It is suggested that males lack health awareness and frequently engage in fast-food intake and practice unhealthy lifestyle such as excess alcohol consumption which consequently leads to higher likelihood of having Known Diabetes Mellitus.

Likewise, the results of this study also demonstrate that race shows a significant function in predicting the likelihood of having Known Diabetes Mellitus. This lends support to the work of Jan Mohamed et al. (2015) based on a systematic review in Malaysia. It was found that Indians have 1.54 times the odds of having diabetes (adjusted OR = 1.54; 95% CI = 1.20, 1.98) compared to Malays. However, the Chinese have been found to have 29% lesser odds (adjusted OR = 0.71; 95% CI = 0.56, 0.91). It can be concluded that cultural, religious and socioeconomic backgrounds have influence on the likelihood of having Known Diabetes Mellitus.

Based on the age groups, this study shows that the odds of Diabetes Mellitus have become higher among younger respondents. This is in complete alignment with a previous research which reported that the occurrence of Diabetes Mellitus was not limited to elderly but was also incurred among younger age group (Agborsangaya et al., 2012; Barnett et al., 2012).

In this present study, it has been found that respondents possessing lower education level have significantly higher odds of Known Diabetes Mellitus. A previous research also revealed the same, that low educational level may lead to inadequate diet quality, unhealthy behaviors and physical inactivity which consequently would resulted into higher risk of Diabetes Mellitus (Drewnowski et al., 2004). Moreover, this was also supported by another study based on Iran, which identified that low education groups lead to high prevalence of Diabetes Mellitus (Rahmanian et al., 2013).

Besides, this study reports that respondents with higher household income are more likely to have Known Diabetes Mellitus. This outcome tallies with the research that reported the women with high income tended to become less physically active compared to men of the same income group; this explains the higher risk of having Known Diabetes Mellitus (Oli et al., 2013). Similarly, research by Dinca-Panaitescu et al. also claimed that the income and the prevalence of diabetes had a negative relationship because lower-income groups exhibited higher likelihood of Diabetes Mellitus (Dinca-Panaitescu et al., 2011).

Similarly, the outcomes of this study tallies with a previous study which found that retirees are more likely to have Known Diabetes Mellitus compared to other related categories (Azimi-Nezhad et al., 2008). Moreover, this study demonstrates that married respondents have significantly ($P<0.001$) lower odds (OR=0.554, CI=0.466-0.66) of Known Diabetes Mellitus as compared to single respondents. It is suggested that married respondents have higher responsibility towards their family, so they will be more health conscious and have greater access to health care in order to stay healthy to take care of their families.

5.2 Results Discussion for Modifiable and Non-Modifiable Risk Factors on Hypertension

The present study finds that among the modifiable risk factors, significant predictors consisting of obese and overweight respondents together with current drinkers, are more likely to lead to Newly Diagnosed Hypertension. However, physically inactive respondents exhibit lower odds of Newly Diagnosed Hypertension. In addition to that, significant predictors which also include older respondents (above 65 years old) and respondents with primary education are respectively found more likely to have Newly Diagnosed Hypertension.

This has highlighted that less educated people are less aware of the importance of healthy lifestyle because according to the rational choice theory, expected utility score would be different from individual to individual. As cited by Cha, Crowe, Braxter & Jennings (2016), expected utility scores would be estimated incorrectly when an individual has inadequate personal competence and incorrect information. This theory tallies with the finding of this study which explains vary socioeconomic background contributes to different decision making in choosing appropriate lifestyles in the prevention of NCDs.

Next, female respondents, youngest age group (15-24 years old), urban dwellers, Chinese and Indian respondents, the higher income earners and retirees are found to possess statistically significant lower odds of Newly Diagnosed Hypertension. Likewise, this study found that among the modifiable risk factors, significant predictors (respondents who are obese and overweight, physically inactive, unclassified drinkers, ex-smokers) increased the chance of exposure to Known Hypertension. However, results indicate that current smokers are less likely to have Known Hypertension. Besides that, other significant predictors such as older respondents (above 65 years old), other Bumiputra and respondents with primary education are found more likely to have Known Hypertension. In contrast to that, retirees, self-employed, private employees and married couples have significantly lower odds of having Known Hypertension.

5.2.1 Results Discussion for Modifiable and Non-Modifiable Risk Factors on Newly Diagnosed Hypertension

With regard to physical activity, this study shows that physically inactive respondents are found less likely to have Newly Diagnosed Hypertension. This is **inconsistent** with a previous research which revealed that physical inactivity was found significantly associated with increased odds of Newly Diagnosed Hypertension among urban Chinese adults (Zhang et al., 2017). This contradiction may due to fact that the researches have been based on different context. Some other factors, for example excess alcohol consumption may contribute to higher odds of Newly Diagnosed Hypertension.

This study exhibits that only current drinkers have significantly higher odds of Newly Diagnosed Hypertension and this is agreeable with a previous research based on China which revealed that alcohol drinking was found to be significantly associated with increased odds of Newly Diagnosed hypertension (Zhang et al., 2017). As a result, it is essential for the government to conduct health awareness campaign among Malaysians to monitor the prevalence of Newly Diagnosed Hypertension. Another finding of this study indicates that there is a significant difference between the obese as well as overweight respondents and the likelihood of Newly Diagnosed Hypertension. This lends support to the work of Bushara, Noor, Elmadhoun, Sulaiman, & Ahmed (2015) which found that increased weight led to increased prevalence of Newly Diagnosed Hypertension.

Next, female respondents are found to have statistically significant lower likelihood of Newly Diagnosed Hypertension. This is inconsistent with the arguments presented by Cuschieri et al. (2017) which stated that females had 39.3% prevalence which was slightly higher than males 36.7% for Newly Diagnosed Hypertension.

However, male respondents among Chinese urban adults, were found related to increased odds of Newly Diagnosed Hypertension (Zhang et al., 2017). Similarly, it was found the Maltee males tend to be more likely (64.01% CI 95%: 58.56–69.13) to have Newly Diagnosed Hypertension (Cuschieri et al., 2017). Likewise, the results of this study show that both Indians and Chinese exhibited lower odds of having Newly Diagnosed Hypertension.

However, with respect to the age group, this study demonstrates that higher aged group respondents have significantly higher odds of Newly Diagnosed Hypertension. This is consistent with a previous research which reported that highest prevalence was recorded for participants above 65 years and therefore there was significant association between undiagnosed hypertension and increasing age ($p < 0.05$) (Bushara et al., 2015). Furthermore, the findings also tally with another study which stated that older age was found to be associated with higher odds of Newly Diagnosed Hypertension in China (Zhang et al., 2017).

The results of this study demonstrate that lower education level has significantly higher odds of Newly Diagnosed Hypertension and hence it tallies with the study conducted by El Fadil et al. (2007) which reported that lower educational status, illiteracy led to higher prevalence (34.9%) of Newly Diagnosed Hypertension.

This study reveals that the likelihood of Newly Diagnosed Hypertension decreased among the urban residents (odds ratio, OR=0.924) when compared to other rural dwellers. Consequently, it shows that rural respondents are more likely to have Newly Diagnosed Hypertension. This is inconsistent with a previous finding which demonstrated that Newly Diagnosed Hypertension rate was significantly higher in countryside than in city (Hou, 2008). The probable reason behind this result may be that the rural population was older which led to higher likelihood of Newly Diagnosed Hypertension (Cheah et al., 2011). Interventions targeting rural adults should promote the awareness of hypertension among Malaysians.

From this study, the findings demonstrate that the higher income group has significantly lower odds of Newly Diagnosed Hypertension. This lends support to the research done by Zhang et al. (2017) which also reported that respondents with higher income had lower odds of Newly Diagnosed Hypertension. It is suggested that higher income group respondents would have better access to medical facilities, for example health screening to monitor blood pressure, and thus prevent the likelihood of having Newly Diagnosed Hypertension.

On the contrary, the results of this study are disagreeable to previous researches which reported that having variety sources of income positively increased the likelihood of hypertension (Teh et al., 2014).

The results of this study reveal that married couples will tend to have statistically significant lower odds of Newly Diagnosed Hypertension as compared to single respondents. This outcome is consistent with a previous research that reported married adults were less likely to have high blood pressure objectively in United States of America, but not in Ireland (Mosca & Kenny, 2014). It was found that married individuals have potentially greater financial resources available for health care and for promoting a healthier lifestyle (Lipowicz & Lopuszanska, 2005). Overall, occupation does not show any significant difference on the likelihood of having Newly Diagnosed Hypertension.

5.2.2 Results Discussion for Modifiable and Non-Modifiable Risk Factors on Known Hypertension

Evidently, this study is consistent with that of Olack et al. which found higher odds for Known Hypertension among individuals with moderate level of physical activity in Kenya. As a result, government intervention on active lifestyle should be emphasized in public as well in private sector by promoting more sports activities among Malaysians.

The findings of this study show that current drinkers and unclassified drinkers are more likely to have Known Hypertension. This is inconsistent with a previous research which revealed that there was a significant association between drinking ($p<0.001$) and Hypertension where respondents who were hypertensive and consumed alcohol were 33.1% (39/118), compared to 66.9% (79/118) of those who did not consume alcohol (Ibekwe, 2015). Similarly, it was found that frequent alcohol consumption also increased the probability of Hypertension in China (Hou, 2008).

Smoking has been found to be significantly associated with the likelihood of having Known Hypertension in this study. Ex-smokers have significantly higher odds of Known Hypertension compared to non-smokers and this is in complete alignment with the previous researches which reported that regular and long cigarette smoking was associated with hypertension (Abdulsalam et al., 2014; Alikor et al., 2013; Onwuchekwa et al., 2012). Similarly, it was found that the prevalence of hypertension was higher (33.3%) among those who were in the habit of chewing tobacco for more than 5 years as compared to (31.6%) those who had this habit for less than 5 years (Kannan & Satyamoorthy, 2009). However, this study shows that current smokers exhibit lower likelihood of having Known Hypertension. Hence, it is essential to promote awareness through campaigns to stop smoking among individuals to prevent the likelihood of having Known Hypertension. This is because smoking-related diseases such as cancer and cardiovascular disease are the main cause of premature death globally (Bonita et al., 2013).

This study has identified that obese respondents have significantly higher odds of Known Hypertension when compared to normal weight respondents. This finding agrees with that of the previous researches which reported that overweight and obesity, high sodium intake, physical inactivity, heavy alcohol intake, low potassium intake, and a Western-style diet make up the major modifiable risk factors for hypertension (Chobanian et al., 2003; Forman et al., 2009). Obesity has also been identified as a well-established risk factor for cardiovascular disease in the general population as stated by Rampal et. al. (2007). It has also been agreed by Flack et al., 2003 that obesity has been linked to raised blood pressure, salt-sensitivity, as well as glucose intolerance, and dyslipidemia. Additionally, overweight and obese participants were approximately 2.0 times more likely to be hypertensive than their counterparts with normal Body Mass Index (BMI) (Mbochi et al., 2012). The risks for Hypertension in subjects with BMI above 27 kg/m^2 were also greatly increased and had a two-fold higher relative risk than subjects with BMI<18.5 kg/m^2 (Ishikawa-Takata et al., 2002).

Socio-demographics factors play an important role as determinants of daily activities among individuals. The exploration of socio-demographic factors (non-modifiable risk factors) differences in patterns of health-related lifestyle behaviours would provide an impact on the prevention strategies of NCDs in the nation. Prevention strategies applied early in life provide the greatest long-term potential for avoiding the precursors that lead to different stages of NCDs for reducing the overall burden of economic burden and treatment costs in the community.

From this research, the findings demonstrate that age, education levels, marital status, gender, residential area, races, household income and occupation are discovered to be statistically significant in regulating individuals' chance of getting varied Hypertensive stages. In contrast to the findings of Azimi-Nezhad et al. (2008), this study exhibits that gender is not significantly associated with the likelihood of Known Hypertension in Malaysia. Similarly, the results of this study are comparable with the findings of a previous study which indicated that there was no significant difference of gender on the likelihood of Known Hypertension (Bharati et al., 2012). Other factors/predictors may contribute to the likelihood of Known Hypertension.

This study shows that only other Bumiputra have significantly higher odds of Known Hypertension and this has been by supported by the study of Omar et al., (2016) which reported that Other Bumiputera were 1.55 times more likely to have hypertension compared to Malays. This disparity may be due to the difference in genetic or socio-environmental factors.

Similarly, the finding of this study is consistent with those of Cheah, Lee, Khatijah, & Rasidah (2011), El Fadil, Suleiman, & Alzubair (2007) and Gao et al. (2013), which revealed that higher aged group was more likely to have Known Hypertension. For example, it was found that prevalence of hypertension increased in relation to higher aged group with 13.0%, 36.7%, and 56.5% among respondents aged 20 to 44 years (young people), 45 to 64 years (middle-aged people), and ≥65 years (elderly people), respectively (Gao et al., 2013).

The findings of this study closely follow the studies done by the previous researchers who identified that the lower education level was more likely to cause Known hypertension (Bushara et al., 2015; Chun et al., 2016; Naing et al., 2016; Shapo et al., 2003). However, there may be an absence of information for consumers to make rational and proficient choices, often compounded by hesitation or miscommunication on the health benefits and harms of different lifestyle choices. Hence, it is important for the application of rational choice theory which needs information to make a rational decision, for example participating in healthy lifestyle to promote health awareness among lower educated group to prevent the occurrence of Hypertension.

The results of this study reveal that retirees, self-employed and private sector respondents are found less likely to have Known Hypertension. This has been consistent with a previous research based on China which demonstrated that the retirees were found to have statistically significant lower likelihood of Known Hypertension because retirement may be beneficial for blood pressure, in the Chinese context (Xue et al., 2017).

Notably from a previous research based on United States of America, it was demonstrated that married adults were less likely to have high blood pressure (Mosca & Kenny, 2014). This supports the finding of this research which exhibits that married couples have statistically significant lower odds of Known Hypertension as compared to single respondents. The probable reason may be that married couples bear greater responsibility to take care of their families, as a result they are more aware in terms of monitoring blood pressure and health status through health screening programs. Thus, this study will provide valuable information to relevant authorities and help in the implementation of Government intervention programs to focus and control the prevalence of Newly Diagnosed and Known Hypertension among targeted older age group. However, this study does not show any significant difference between residential area, as well as household income level and the likelihood of having Known Hypertension.

5.3 Results Discussion for Modifiable and Non-Modifiable Risk Factors on Hypercholesterolemia

From this research, it is observed that current smokers, obese and overweight respondents are more likely to have Newly Diagnosed Hypercholesterolemia. However, ex-drinkers and underweight respondents are identified as significant predictors which show decreased odds of Newly Diagnosed Hypercholesterolemia. Furthermore, physically inactive respondents, all drinking status (unclassified drinkers, ex-drinkers and current drinkers), respondents who consume inadequate fruit and vegetables consumption, obese and overweight respondents are more likely to have Known Hypercholesterolemia.

With regard to the non-modifiable risk factors, this study reveals that females, higher income group (RM5001.00 - RM7000.00), home makers and widows/widowers/divorced are more likely to have Newly Diagnosed Hypercholesterolemia. On the other hand, other Bumiputras, Indians and Chinese, older aged group, urban residents and private employees have significantly lower odds of

Newly Diagnosed Hypercholesterolemia. Likewise, it is found that females, Indians, respondents with lower education level, higher income group and retirees are more likely to have Known Hypercholesterolemia. However, other race, older aged group, home makers, self-employed, private employees, married respondents and widows/widowers/divorced are found to have significantly lower odds of Known Hypercholesterolemia.

5.3.1 Results Discussion for Modifiable and Non-Modifiable Risk Factors on Newly Diagnosed Hypercholesterolemia

The results of this study exhibit that ex-drinkers have significantly lower odds of Newly Diagnosed Hypercholesterolemia and this has lent support to a research which stated that alcohol drinking was positively associated with Hypercholesterolemia (Song et al., 2017).

The present findings of this study indicate that current smokers have significantly higher odds of Newly Diagnosed Hypercholesterolemia. This is inconsistent with the previous empirical findings which reported that there were no significant associations between respondents with unknown diabetes or hypercholesterolemia and smoking (Lim et al., 2016).

With regard to Body Mass Index (BMI), it is found that overweight and obese respondents have significantly higher odds of Newly Diagnosed Hypercholesterolemia. Another study was found which reported the same result that obesity and overweight had significant higher odds of Hypercholesterolemia (Ahmed et al., 2014). As a result, it is essential that the government intervention programs to focus on maintaining healthy body weight by promoting more physical activities in order to prevent the occurrence of Newly Diagnosed Hypercholesterolemia.

Next, this study tallies with the research which revealed that female respondents were positively associated with hypercholesterolemia (Song et al., 2017). Results for race indicate that, other Bumiputra, Indian and Chinese respondents have significantly lower odds of Newly Diagnosed Hypercholesterolemia. This is inconsistent with a research which revealed that the Indian population was more likely (OR = 1.41, CI 1.05–1.89) to exhibit low high-density lipoprotein cholesterol (HDL) (Tan et al., 2011).

The respondents from all age groups has been found to be significant for having Newly Diagnosed Hypercholesterolemia. However, the odds ratio values for all age groups are below 1 which consequently depicts lower likelihood of having Newly Diagnosed Hypercholesterolemia. However, the older respondents still demonstrate higher likelihood of Newly Diagnosed Hypercholesterolemia. Apparently, this study is contradictory with the findings from a previous research which reported that the younger aged had significantly higher odds of Newly Diagnosed Hypercholesterolemia (Cooper et al., 2000).

On the other hand, it is found that urban respondents are less likely to have Newly Diagnosed Hypercholesterolemia in comparison to rural respondents. Hence, this study lends support to the study conducted by Chun et al. who found that rural dwellers were less likely to be aware of Hypercholesterolemia. Hence, rural dwellers were more prone to Hypercholesterolemia. When compared to elderly urban dwellers, it was assumed that the rural dwellers may suffer from a scarcity of information, knowledge, or accessibility to health care services (Chun et al., 2016).

This study reveals that lower income group (RM1501-3000) has significantly higher odds of Newly Diagnosed Hypercholesterolemia. This observation is in line with a research which demonstrated that lower income was associated with a higher risk of hypercholesterolemia in Malaysia (Amiri et al., 2014). Hence, it is suggested that government and non-government intervention programs should be designed and collaborate in order to focus on health promotion and create awareness of health literacy in private and government sector especially among low skilled working adults to prevent and monitor the prevalence of Newly Diagnosed Hypercholesterolemia in Malaysia.

Moreover, the findings of this study demonstrate that home makers have significantly higher odds of Newly Diagnosed hypercholesterolemia. This tallies with a previous study which showed that housewives are at a greater risk of suffering from multiple cardiovascular risk factors, including diabetes, hypercholesterolemia and being overweight (Ghazali et al., 2015). Home makers are commonly associated with being housewives in Malaysian traditional. Hence, housewives play a major role in managing their family, rearing and raising children (Hossain, 2017). With the daily household chores that needs to be taken care of, the assumption was that these home makers or housewives would have higher odds for metabolic diseases (Hossain, 2017; Jan Mohamed et al., 2013).

Besides that, it has been observed in this study that widow/widower/divorced respondents have significantly higher odds of Newly Diagnosed Hypercholesterolemia. However, this contradicts with a previous study which states that married people were more likely to have Hypercholesterolemia (Ghazali et al., 2015; Karunaratne & Perera, 2015). Education level on the other hand, has been found not significantly related to the likelihood of having Newly Diagnosed Hypercholesterolemia.

5.3.2 Results Discussion for Modifiable and Non-Modifiable Risk Factors on Known Hypercholesterolemia

In this study, respondents who are physically inactive are found higher probability to be diagnosed as Known Hypercholesterolemia patients. This finding is consistent with some studies which showed that physical activities prevented hyperlipidemia and improved the lipid profile (Gordon et al., 2014; Kodama et al., 2013; Mann et al., 2014).

Consistent with other reports, the results of this study exhibit that unclassified drinkers have the highest odds of Known Hypercholesterolemia, followed by ex-drinkers and then current drinkers in comparison to non-drinkers. In addition to that, this study also agrees with the research done by Lee et al. (2012) which revealed that a positive association was noted between alcohol consumption and serum low high-density lipoprotein cholesterol (HDL-C) concentrations in both genders.

The findings of this study also reveal that ex-smokers have increased odds (OR=1.287) of Known Hypercholesterolemia. However, this is inconsistent with the previous findings by Chun, Kim, & Min (2016) which reported that the sensitivity on Hypercholesterolemia was lower among ex-smokers than those who have never smoked.

On the other hand, the finding of this study demonstrates that current smokers have significantly lower odds of Known Hypercholesterolemia. Overall, smoking and its association with the likelihood of having Known Hypercholesterolemia should be addressed tactfully and early screening should be prompted among Malaysians to ensure early prevention.

However, this study reveals that respondents with inadequate fruit and vegetables consumption are significantly 1.274 times more likely to have Known hypercholesterolemia and this may due to the fact that fruit and vegetables consumption pattern was distinctive across different country (Song et al., 2017). On the other hand, the results of this study are inconsistent with a previous study where respondents who were eating ≥ 2 servings of fruits and vegetables per day, had lower odds (OR 0.72, 95% CI 0.56 to 0.94) than others of hypertriglyceridemia (Kjøllesdal et al., 2016).

This study is however, consistent with the research done by Ahmed, Rhmtallah and Eledum (2014), who found that obesity and overweight had significant higher odds of Hypercholesterolemia. At the same time, the findings of this study reveal that obesity is related to higher likelihood of having hypercholesterolemia than the normal weight respondents. Similarly, this has been agreed by Song et al. (2017) who claimed that overweight/obesity was positively associated with hypercholesterolemia.

The findings of this study support a previous research which revealed that female respondents were found to have statistically significant higher likelihood of having Hypercholesterolemia in the age range of 50-59 years (Ahmed et al., 2014). A previous finding also observed a greater proportion of females suffered from hypercholesterolemia (Amiri et al., 2014).

Following the previous finding, it was found that Indians had the most prevalence for Hypercholesterolemia (Khor, 1994). This consequently, supports the study which indicates that Indians are more likely to have Known Hypercholesterolemia. On the other hand, this study also shows that others ethnic groups are less likely to have Known Hypercholesterolemia.

The findings of this study are inconsistent with those of the previous researches which found that respondents who were in their 40's had the highest prevalence of hypercholesterolemia (Amiri et al., 2014). In this study, it is observed that two age groups (55-64 years old & 15-24 years old) are significantly at lesser odds (OR=0.092, CI=0.073-0.115; OR=0.092, CI=0.078-0.107) of Known Hypercholesterolemia as compared to respondents who are below 15 years of age. It is suggested the older aged groups that suffer from Known Hypercholesterolemia may suffer from additional risk factors other than age factors.

Moreover, the findings of this study also show that respondents who possess unclassified education (other than formal education) have significantly higher odds (OR=2.589) of Known Hypercholesterolemia in comparison to others with tertiary education level. This is inconsistent with the research done by Song et al. who mentioned that education was not associated with Hypercholesterolemia. This research indicates that perhaps because of the higher level of awareness of screening for Hypercholesterolemia, resulted from higher level of education, lower likelihood of having Hypercholesterolemia is observed. However, it may also be because the association between socio-economic status among countries vary (Ahmed et al., 2014). At the same time, these findings have been supported by a research by Chun et al. which revealed that highly educated group was more aware and showed less likelihood of Hypercholesterolemia.

Evidently, the results of this study demonstrate that the higher income group has significantly higher odds of Known Hypercholesterolemia. A previous research which revealed that the higher annual household income per capita was identified as a risk factor associated with hypercholesterolemia and as a result increased the likelihood of hypercholesterolemia ($P<0.05$)(Zhang et al., 2018) is in complete alignment with the results of this study. The explanation of this outcome may be that higher income earners have more opportunities and access to unhealthy lifestyles, such as, sedentary behaviour and unhealthy diet and inadequate fruit and vegetables intake. These may make them obese and thus increase the likelihood of having hypercholesterolemia. Based on the rational choice theory which stated that the choice process involves constraints. The presence of constraints which would lead to the trade-offs between alternative choices has become explicit (Oladepo et al., 2008). This implies that behavioral interventions are essential to target higher income group to develop skills to enhance health literacy. This will consequently help them to make better choice with healthy behavior in order to control and monitor the prevalence of Known Hypercholesterolemia in Malaysia.

With regard to occupation, retirees are found to have statistically significant (higher) odds of Known Hypercholesterolemia. This could be because the retirees had no access to workplace health and wellness programs, such as screening for hypercholesterolemia and other CVD risk factors (Hossain, 2017).

On the other hand, this study has found that married respondents are less likely to have Known Hypercholesterolemia compared to single respondents. This may be because married respondents have to bear higher responsibilities. Thus, they are more aware about health monitoring and health screening programs in monitoring the prevalence NCDs. However, this result is inconsistent with a previous study which indicated that Malaysian adults mentioned that married people were more likely to have Hypercholesterolemia (Ghazali et al., 2015).

Lastly, community intervention is needed to combat Hypercholesterolemia through expanding existing screening and awareness programmes, such as KOSPEN (Strenthening communities, empowering the Nation) which was recommended by the Ministry of Health Malaysia in October 2013.

5.4 Conclusions

This study has contributed to the theoretical development of knowledge in the relevant economic theories with reference to the NCDs risk factors status in Malaysia. From the findings of this study, it is observed that there would be shared modifiable risk factors on different outcome levels of NCDs and the modifiable risk factors are preventable.

The findings of this study have shown that modifiable risk factors which include obesity and overweight respondents are more likely to lead to Impaired Fasting Glucose, Newly Diagnosed Diabetes Mellitus, Known Diabetes Mellitus, Known Hypertension, Newly Diagnosed Hypercholesterolemia and Known Hypercholesterolemia. Hence, government intervention programs should focus on maintaining normal weight among Malaysians. To address the high prevalence of stated NCDs, active lifestyle and healthy diet must be practiced.

Physically inactive respondents are more likely to have Impaired Fasting Glucose, Newly Diagnosed Diabetes Mellitus, Known Diabetes Mellitus, Known Hypertension, Newly Diagnosed Hypercholesterolemia and Known Hypercholesterolemia. It is found that the magnitude of odds ratio for Newly Diagnosed Diabetes Mellitus is higher than Known Diabetes Mellitus among physically inactive respondents. Both government and non-government agencies should carry out intensive efforts to further promote active lifestyle and intervention on physical inactivity among Malaysian population, particularly the youngsters to gauge their physical activity pattern. Hence, it is important that government intervention strategies promote physical activities within the nation by building more sports-oriented facilities in the housing areas and work places.

With respect to drinking status, the findings of this study demonstrates that current-drinkers and ex-drinkers have significantly lower odds of Newly Diagnosed Diabetes Mellitus which 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). This has contributed to the existing literature in the context of Malaysia and the government intervention strategy needs to focus on other lifestyles intervention, for example, quit smoking, improve adequate fruits and vegetables consumption and promoting active lifestyle and maintain ideal body weight among Malaysians to prevent NCDs in Malaysia. Awareness campaigns on the dangers and adverse effect of alcohol can be initiated at an early age, especially at lower and upper secondary school level, colleges and universities. Furthermore, parents also play a significant role in guiding and showing good role models for the younger generation which would prevent young adults involve in irresponsible drinking habits.

On the other hand, unclassified drinkers have been found to have increased chance of Known Hypertension as well as Known Hypercholesterolemia. Current drinkers have been found to be more likely to have Newly Diagnosed Hypertension and Known Hypercholesterolemia. However, ex-drinkers have been found to be more prone to Known Hypercholesterolemia.

Ex-smokers reveal higher odds of Known Diabetes Mellitus and Known Hypertension. Current smokers on the other hand, are found to be more likely to have Newly Diagnosed Hypercholesterolemia.

Furthermore, current smokers have exhibited higher likelihood of Newly Diagnosed Hypercholesterolemia than Known Hypercholesterolemia. Next, the magnitude of odds ratio for Newly Diagnosed Hypertension is higher than Known Hypertension among current drinkers. Hence, it is evident that the findings have demonstrated that the prevalence of newly diagnosed NCDs has added on the total prevalence of NCDs in Malaysia. Therefore, it is an urgent need to have lifestyle modification through behavioral intervention by the policy makers to prevent NCDs in Malaysia. Continuous and more comprehensive anti-smoking policy measures are needed in order to further prevent the increasing trend of Known Diabetes Mellitus among individuals in Malaysia.

Next, inadequate fruit and vegetables consumption respondents have demonstrated higher likelihood of having Newly Diagnosed Diabetes Mellitus and Known Hypercholesterolemia. Likewise, inadequate fruit and vegetables consumption respondents have demonstrated higher likelihood of Newly Diagnosed Diabetes Mellitus. Therefore, it is an urgent need to have long term solution to solve nutrition issues in Malaysia. As highlighted in the National Plan of Action for Nutrition Malaysia (NPANM), collaborative effort from multi-sectors are needed for more comprehensive policies and intervention strategies to address behavioural changes towards healthier eating practices among Malaysians. The availability of cheaper local fruits and vegetables could be included in the national agenda to inculcate healthy eating habits among Malaysians.

With respect to age, elderly have demonstrated higher likelihood of Newly Diagnosed Hypercholesterolemia, Newly Diagnosed Diabetes Mellitus than Known Hypercholesterolemia and Known Diabetes Mellitus respectively. However, all age groups except those aged between 25-34 years have shown higher odds of Newly Diagnosed Hypertension than Known Hypertension. Hence, government intervention strategies should be focused on the establishment of sports facilities in the township, primary schools and secondary schools and also public universities to encourage the participation of adolescents in physical activity in Malaysia.

However, the occurrence of Known Diabetes Mellitus, Newly Diagnosed Hypertension, Known Hypertension, Known Hypercholesterolemia among the elderly would surely reduce welfare as well as quality of life among them. Therefore, it is an urgent need to reallocate resources for more holistic public health interventions to address this group with health screening services to monitor and reduce the prevalence and unawareness of the stated NCDs among the elderly.

In the case of gender, the outcomes of this study indicate that females are less likely to have Known Diabetes Mellitus. The occurrence of Known Diabetes Mellitus, Newly Diagnosed Hypertension, Known Hypertension, Known Hypercholesterolemia among the retirees, would surely lead to deadweight loss, reduced welfare and utility and also reduced quality of life. This would eventually increase the burden on healthcare cost for Malaysia in the future. Hence, the findings of this study can serve as a good benchmark for the Malaysian Government to allocate resources more efficiently especially among the elderly and the retirees. It is suggested affordable health screening services and recreation facilities should be offered to the retirees in order to monitor the prevalence of NCDs among the retirees.

The magnitude of odds ratio for Newly Diagnosed Diabetes Mellitus and Newly Diagnosed Hypercholesterolemia is higher than Known Diabetes Mellitus and Known Hypercholesterolemia among private employees. It is essential for the non-Government body to have appropriate interventions to create awareness and improve health literacy among Malaysian private employees to monitor health behaviors, for example, cultivate good eating habits by providing menus of the cafeteria with appropriate nutrition label and providing affordable health screening services among Malaysian private employees in order to prevent and monitor the prevalence of Newly Diagnosed Diabetes Mellitus and Newly Diagnosed Hypercholesterolemia in Malaysia.

With respect to the education level, one of the findings of this research indicate that lower educated respondents are more possible to be diagnosed as Newly Diagnosed Hypertension, Known Hypertension and Known Hypercholesterolemia patients. Hence, it is recommended that both government and private sectors should collaborate to conduct health promotion programmes to provide health education for employed individuals especially low skilled workers.

Higher income group (RM5001.00 - RM7000.00) is more likely to have Newly Diagnosed and Known Diabetes Mellitus and Known Hypercholesterolemia. On the other hand, lowest income earners (RM1501-RM3000) have revealed higher likelihood of Newly Diagnosed Hypercholesterolemia than Known Hypercholesterolemia. As a result, it is essential that intervention strategies incorporate poverty as a major risk factor for Newly Diagnosed and Known Diabetes Mellitus and Known Hypercholesterolemia and develop health policies to decrease socioeconomic disparities, in particular income inequities, along with individual-level risk factors in order to effectively prevent, manage and reduce the overall burden of diabetes.

Additionally, other Bumiputra are found more likely to have Known Hypertension. However, Indians have shown higher likelihood of Newly Diagnosed and Known Diabetes Mellitus as well as Known Hypercholesterolemia. This implies that race/ethnicity distinction which serves as a constraint in the process of choosing and as a result may generate difficulty in opting for healthy behavior, for example food preparation may vary according to different cultural background because of eating habits and lifestyle. Hence, government intervention strategies should take into consideration of different cultural background from multi-racial community in Malaysia for effective prevention of stated NCDs. Awareness should be addressed to particularly certain ethnic group and provision of nutrition and calories labels in restaurants should be practiced because differences in diet was suggested as one of the primary contributors of diabetes amongst patients of different ethnics (Termizy & Mafauzy, 2009).

Hence, the findings could be an excellent benchmark for policy makers to specifically address certain targeted group for instance lower income earners, widow/widowers/divorced, elderly, etc. in order to implement appropriate policy intervention to prevent and monitor the prevalence of NCDs in Malaysia.

CHAPTER 6: CONCLUSION

6.1 Contribution of Study

6.1.1 Policy Implications

The preceding analysis has revealed a few important aspects of policy implications based on the research objectives of this study related to the modifiable and non-modifiable risk factors on different stages of Non-Communicable Diseases which includes Diabetes Mellitus: Impaired Fasting Glucose, Newly Diagnosed Diabetes Mellitus and Known Diabetes Mellitus; Hypertension: Newly Diagnosed Hypertension and Known Hypertension; and Hypercholesterolemia: Newly Diagnosed Hypercholesterolemia and Known Hypercholesterolemia.

Besides, the benefit of using multinomial modeling approach is, it enables to investigate on how the association between the outcomes for the stated NCDs, for instance, Diabetes Mellitus (Impaired Fasting Glucose, Newly Diagnosed Diabetes Mellitus and Known Diabetes Mellitus); Hypertension (Newly Diagnosed Hypertension and Known Hypertension); Hypercholesterolemia (Newly Diagnosed Hypercholesterolemia and Known Hypercholesterolemia) and potential predictors vary at different level of outcomes.

Based on this study, it has been significantly proven that modifiable risk factors which are related to lifestyle, for example overweight and obesity, physically inactive are associated with newly diagnosed NCDs which will eventually put an impact on the total prevalence of known NCDs because of the progression of NCDs. Prevention is always better than cure. By identifying the modifiable risk factors, lifestyle could be change and improve in order to prevent NCDs. In terms of policy implications, early detection of NCDs are necessary to control and reduce the occurrence and prevalence of NCDs. Awareness campaigns or programs could be addressed amongst all Malaysians, particular attention should be paid to the promotion of healthy behaviours, for example, quit smoking and drinking, adequate consumption of fruits and vegetables, maintain normal body weight and being physically active o prevent the development of NCDs among Malaysians. As a result, the insightful findings and evidence provides a platform for early detection and prevention of NCDs especially for Newly Diagnosed NCDs and these needs to be established in order to monitor and control the increasing prevalence of different stages of NCDs (Diabetes Mellitus, Hypertension and Hypercholesterolemia) in Malaysia. As a result, the prevention of future mortalities and morbidities of different stages of Diabetes Mellitus, Hypertension and Hypercholesterolemia in Malaysia would effectively reduce the economic burden on the allocation of resources especially on the treatment cost of the NCDs of the country.

More importantly, policy implementation should address based on the chances of getting different outcome levels of Diabetes Mellitus, Hypertension and Hypercholesterolemia are different among the ethnic groups in Malaysia from the results of this study. Separate intervention policies are needed to tackle the future risk of Newly Diagnosed and Known Diabetes Mellitus as well as Known Hypercholesterolemia among Indians because they have increased chances of having the stated NCDs according to this study. Government intervention strategies should be focus on particular ethnic group and the programs could be in the form of various language-based media (e.g. television programs, newspapers, popular magazines, radio channels), including using celebrities or spokespersons as role model to promote awareness of dangers of developing NCDs such as Newly Diagnosed and Known Diabetes Mellitus as well as

Known Hypercholesterolemia and increase physical activity among Indian Malaysians.

Government intervention measures involving physical activity promotion for example, walking briskly, general gardening and sports should be encouraged among people to highlight the importance of being physically active in preventing the likelihood of Impaired Fasting Glucose. One of the the important implication is that government intervention on active lifestyle should be directed to the all nations to promote participation in physical activity for example, I love Putrajaya Run, Natura Run for Hope 2019 and Earth Hour Night Run Malaysia 2019 in the country. Moreover, government also could consider to build more sport facilities in the recreational parks, public schools and public universities.

Next, obesity and overweight have been identified as important predictors on the likelihood of having all status of NCDs (Impaired Fasting Glucose, Newly Diagnosed Diabetes Mellitus, Newly Diagnosed Hypertension, Known Hypertension, Newly Diagnosed Hypercholesterolemia and Known Hypercholesterolemia). Hence, maintaining normal weight is essential for Malaysians in order to prevent the risk of having NCDs. As a result, implementation of active lifestyle and proper diet should be conducted in private and public sectors among Malaysians as mentioned by Mustapha (2014), Harris (1996) and Association (2010) who reported body weight maintenance would decrease the risk for developing diabetes and cardiovascular disease. Appropriate and healthy diet and being physically active are necessary to address overweight and obese issues to prevent the above mentioned NCDs.

Cultivating healthy lifestyle among Malaysian is important and particularly in promoting healthy eating habits among multi-racial community in Malaysian.

Consumption of nutritious and balanced diet for breakfast together with the adequate consumption of fruits and vegetables should be encouraged among Malaysians. It is suggested that government intervention programs to raise awareness about rich diet and high intake of fruits and vegetables consumption should be emphasized among the Malaysians especially starting from the adolescent group to inculcate a good eating habit since young.

Based on the results of this study, continuous and more comprehensive anti-smoking policy measures are needed in order to further prevent the increasing trend of Known Diabetes Mellitus among individuals in Malaysia. This implies that government may implement media campaigns to develop and evaluate clear messages about harmful health effects of tobacco products rather than focusing communication campaigns on a single tobacco product like cigarettes among Malaysians.

Besides, drinking is one of the modifiable risk factors which can be prevented. From the findings of this study, it is observed that different drinking behavior has vary impact on the likelihood of different stages of NCDs. Hence, it is essential for policy makers to promote healthy lifestyle by creating awareness through mass communication to deliver important messages about different drinking status which may impact on varied NCDs status among Malaysian. For example, current drinkers exert higher likelihood to have Newly Diagnosed and Known Hypertension in this study. This is because it has been identified that lifestyle intervention could have 43% reduction in the incidence of diabetes, sustained over a 20-year period (Li et al., 2008). Appropriate intervention is essential to be implemented to modify the drinking behavior among Malaysians.

From the findings of this study, it is an urgent need to address the age as a predictor of NCDs. As stated in this study (Diabetes Mellitus, Hypertension and Hypercholesterolemia), it is essential by referring to the findings which exhibit older aged group has significantly higher odds of Newly Diagnosed and Known Hypertension. In contrast, it is observed younger aged group (15-24 years old) are more likely to have Newly Diagnosed Diabetes Mellitus and Known Hypercholesterolemia. Middle aged group (45-54 years old) has demonstrated higher odds of Newly Diagnosed Hypercholesterolemia among other age groups. Hence, policy makers should apply different intervention to different aged group of citizens to address different outcome levels of NCDs. Focus on younger aged group should be by promoting physical activities to prevent Newly Diagnosed Diabetes Mellitus and Hypercholesterolemia. However, old aged group should be targeted to promote healthy diet by reducing salt intake to prevent and monitor the occurrence of Newly and Known Hypertension.

Since education level has been found to significantly affect the likelihood of having different outcome levels of NCDs, it should be focused on more countrywide health related courses, forums, seminars and workshops, reading materials and newspapers. Besides, population-based policies should be addressed to lower educated group because lower education level has exhibited higher odds of Newly Diagnosed and Known Hypertension as well as Newly Diagnosed and Known Diabetes Mellitus in this study. Awareness campaigns should be addressed among low skilled workers. On the other hand, higher education group exhibits higher likelihood to have Known Hypercholesterolemia in this study. Hence, health promotion should especially focus on how to be physically active among white-collar workers.

Finally, household income also significantly predicts the likelihood of having Newly and Known Diabetes Mellitus, and Known Hypercholesterolemia. Higher income group

(RM5001.00 - RM7000.00) is more likely to have Newly Diagnosed and Known Diabetes Mellitus, and Known Hypercholesterolemia. This implies that behavioral interventions are essential to target higher income group to develop skills to enhance health literacy and informed decision making. This will consequently help them to make better choice on healthy behavior in order to control and monitor the prevalence of Newly Diagnosed and Known Diabetes Mellitus and Known Hypercholesterolemia in Malaysia.

Hence, public health policies are required to concentrate more among higher income group which focus on disseminating information on healthy lifestyles, reduce alcohol consumption and smoking, adequate fruit and vegetables intake and being physically active in order to prevent the occurrence the stated NCDs.

As a result, it is essential that intervention strategies incorporate poverty as a major risk factor for diabetes and develop health policies to decrease socioeconomic disparities, in particular income inequalities, along with individual-level risk factors in order to successfully prevent, manage and reduce the overall burden of diabetes (Okwechime & Roberson, 2015).

From the findings of this study, it is noted that there is ethnic-based disparities in the prevalence of NCDs in Malaysia. This implies that how different stages of Non-Communicable Diseases may vary by sociodemographic factors such as race. This will provide a better understanding to the policy makers with the baseline information needed to monitor and finally to reduce disparities in the prevalence of NCDs in Malaysia.

6.2 Limitations of study

A number of limitations have been identified in this study. To begin with, using secondary data is complicated as in any other studies because it is necessary to find out the details of the secondary data. Nevertheless, it was tackled in satisfactory level to give a better understanding of the survey based on few available materials, information gathered during actual data management and published articles of researchers involved in data collection.

Secondly, our 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.

Thirdly, sedentary behavior should be included in this study as it contributes a significant influence on physical activities among Malaysians.

6.3 Suggestions for Future Research

For future studies, sedentary behavior should be included as one of the variables in the analysis. Next, it is encouraged to increase the number of attributed variables related to relevant risk factors, for example, family history which will enable us to understand the characteristics of family history of the NCDs patients and to predict the likelihood of having the different outcome levels of NCDs.

Besides, longitudinal studies are encouraged to follow up among the respondents from several panel data for more robust and detailed analysis.

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LIST OF PUBLICATIONS AND PAPERS PRESENTED

Journal publications

Lim, O. W., & Yong, C. C. (2017). The Analysis of Risk Factors Among Diagnosed Hypertension Individuals in Malaysia: A Population Study. *Advanced Science Letters,* 23(9), 9220-9223 (Scopus-indexed)

Lim, O. W. and Yong C. C. (2018). Analysis of Risk Factors on Undiagnosed Diabetes Mellitus among individuals : Evidence from Malaysia. *The Turkish Online Journal of Design Art and Communication* (8), 2991-3005 (Non-ISI/Non-Scopus)

Lim, O. W. and Yong C. C. (2018). Risk Factors of Newly Diagnosed Hypertension among individuals in Malaysia. *Malaysian Journal of Public Health Medicine*, Vol. 18 (2): 57-69 (Scopus-indexed)

Conference papers / proceedings

Lim, O. W., & Yong, C. C. (2017). Hazard Ratios among Diagnosed Hypertension Individuals in Malaysia : A population study. Paper presented at the *5th Global Conference on Business and Social Sciences 2017.* Kuala Lumpur.

Lim, O. W., & Yong, C. C. (2018). Analysis of Risk Factors of Undiagnosed Diabetes Mellitus among Individuals: Evidence from Malaysia. Paper presented at the *1st International Conference of Social Science, Humanities & Art 2018*. Port Dickson, Malaysia.

Submission to Journals

1. Submitted paper titled : 'Risk Factors of Known Hypercholesterolemia among individuals in Malaysia' to BMC Public Health Journal (ISI cited) on 13 April 2018.

2. Submitted paper titled : 'A study of risk factors of Undiagnosed and Known Hypertension among Malaysians' to Health Promotion Practice (ISI cited) on 13 October 2018.