YOUNG-ONSET HYPERTENSION IN MALAYSIA: A MIXED-METHODS STUDY

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FACULTY OF MEDICINE
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YOUNG-ONSET HYPERTENSION IN MALAYSIA: A MIXED-METHODS STUDY

ABSTRACT

The continuous cumulative presence of raised blood pressure (BP) when young is a strong predictor of future cardiovascular risk. This study, which was conducted between June 2018 and December 2019, aimed to elucidate the epidemiology of young-onset hypertension (YOH) in Malaysia during the period 2006–2015, and to explore the underlying experiences and perspectives of young adults living with hypertension. Phase I involved a systematic review to identify variables for the secondary data analysis. In Phase II, data on respondents aged 18–39 diagnosed with YOH according to the 7th Joint National Committee Report (United States) were extracted from three National Health and Morbidity Surveys (2006, 2011, and 2015). Univariate analysis was used to examine associations between YOH and baseline characteristics; Chi-square test for categorical variables and analysis of variance for continuous variables. All potential confounding factors were adjusted for using multiple logistic regression analyses. In Phase III, an interpretive phenomenological approach was adopted to conduct in-depth interviews among hypertensive young adults recruited from the Department of Primary Care Medicine, University of Malaya Medical Centre. Interviews were conducted until saturation point, transcribed verbatim, followed by content analysis and thematic coding. In Phase I, twenty studies showed considerable variability in YOH epidemiology and trends worldwide. Phase II analysis revealed that the prevalence of YOH in Malaysia remained stable during 2006–2015: 17.7%, 95% CI [17.0, 18.3] in 2006, 17.0%, 95% CI [16.0, 17.9] in 2011, and 18.4%, 95% CI [17.4, 19.4] in 2015. Awareness, treatment, and control rates were suboptimal: 15% were aware of their diagnosis, of which less than 50% were on treatment and less than 40% of those on treatment had their BP controlled.

Significant positive associations were found with sociodemographic (male, increasing age, primary education, lower income group, positive family history) and cardiovascular risk factors. The Phase III analysis revealed that young Malaysian adults were concerned about self-stigma associated with YOH and displayed a lack of insight regarding the factors involved in developing YOH. Moreover, there was cognitive dissonance between knowledge and practice. Barriers to treatment adherence were attributed to personal (time), treatment (side effects), and disease (being asymptomatic) factors. Facilitators included social support, high self-efficacy, perceived threat and severity of disease, experiencing symptomatic relief, and role-modelling. Unmet needs included shared decision-making with healthcare professionals, having long-term expectations of treatment addressed, and the usage of social media and hypertension education materials to intensify awareness of YOH among peers. The results of this study narrow the knowledge gap on YOH epidemiology in Malaysia by providing crucial information on the pervasiveness of hypertension among young adults. They also indicate that an understanding of young adults' lived illness experiences is critical to improving treatment adherence and BP control. Additionally, they highlight the need to treat young adulthood as a separate entity in research planning, programming, and policymaking. Thus, this study provides a basis upon which health policymakers and relevant stakeholders can build non-communicable disease policies and health promotion strategies specially targeted at young adults who are in the prime of life.

Keywords: Cardiovascular disease, epidemiology, Malaysia, young-onset hypertension, young adults

HIPERTENSI DI KALANGAN ORANG DEWASA MUDA DI MALAYSIA: KAJIAN KAEDAH CAMPURAN

ABSTRAK

Kesan kumulatif berterusan tekanan darah tinggi ketika muda adalah ramalan kuat bagi risiko kardiovaskular pada masa depan. Kajian ini yang dijalankan antara Jun 2018 hingga Disember 2019, bertujuan untuk menerangkan epidemiologi hipertensi di kalangan orang dewasa muda (YOH) dan memahami tingkah laku yang mempengaruhi kesedaran, rawatan dan kawalan YOH di Malaysia. Fasa I terdiri daripada tinjauan sistematik untuk mengenalpasti pembolehubah yang diggunakan dalam analisis data sekunder. Dalam Fasa II, data responden berumur 18 hingga 39 tahun yang dikelaskan sebagai YOH mengikut Laporan Ketujuh Jawatankuasa Bersama Kebangsaan (Amerika Syarikat) diekstrak dari tiga Tinjauan Kebangsaan Kesihatan dan Morbiditi (2006, 2011 dan 2015). Analisis univariat digunakan untuk menilai faktor risiko yang berkaitan dengan YOH dan ciri-ciri asas; ujian Chi-square untuk pembolehubah kategorikal dan analisis varians untuk pembolehubah berterusan. Kesemua faktor pengungkapan yang berpotensi diselaraskan dengan regresi logistik berganda. Fasa III melibatkan pendekatan fenomenologi tafsiran dengan menjalankan temubual di kalangan pesakit YOH dari Klinik Rawatan Utama, Pusat Perubatan Universiti Malaya. Temubual dijalankan sehingga ketepuan tercapai dan diterjemahkan secara verbatim. Seterusnya, analisis kandungan dan pengekodan tematik telah dilakukan. Dalam Fasa I, terdapat dua puluh kajian yang menunjukkan kebolehubahan dalam epidemiologi dan trend YOH di seluruh dunia. Prevalens YOH di Malaysia adalah stabil dalam tempoh 2006-2015: 17.7%, 95% CI [17.0, 18.3] pada tahun 2006, 17.0%, 95% CI [16.0, 17.9] pada tahun 2011 dan 18.4%, 95% CI [17.4, 19.4] pada tahun 2015. Kadar kesedaran, rawatan dan kawalan adalah suboptima: 15% sedar tentang diagnosis mereka, di mana kurang daripada 50% sedang menjalani rawatan dan kurang

daripada 40% yang sedang menjalani rawatan mempunyai tekanan darah yang terkawal. Dalam Fasa III, faktor risiko YOH yang signifikan ditemui dengan sosiodemografi (jantina lelaki, umur meningkat, pendidikan rendah, golongan berpendapatan rendah, sejarah keluarga yang positif) dan mempunyai faktor risiko kardiovaskular. Dalam Fasa III, majoriti bimbang tentang stigma diri negatif yang berkaitan dengan diagnosis YOH. Lebih lagi, terdapat disonansi kognitif antara pengetahuan dan amalan. Halangan untuk kepatuhan rawatan termasuk masa, kesan sampingan ubat, dan ketiadaan simptom Fasilitator termasuk sokongan sosial, keberkesanan diri yang tinggi, ancaman penyakit, mengalami kelegaan gejala dan mempunyai contoh ikutan. Keperluan yang tidak dipenuhi termasuk perkongsian dalam mengambil keputusan bersama-sama pegawai perubatan, menangani isu berkaitan rawatan jangka panjang, penggunaan media sosial dan bahan pendidikan hipertensi untuk meningkatkan kesedaran dan pencegahan hipertensi di kalangan orang muda. Kajian ini meningkatkan pengetahuan mengenai epidemiologi YOH di Malaysia dengan membentangkan maklumat penting mengenai penyakit ini. Pengalaman dan persepsi orang dewasa muda yang unik tentang kehidupan dengan hipertensi menekankan betapa pentingnya golongan ini dalam penyelidikan, perancangan, pengaturcaraan dan pembuatan dasar. Keputusan kajian ini boleh digunakan sebagai asas bagi penggubal dasar kesihatan. Pihak berkepentingan yang berkaitan juga boleh menggunakan hasil kajian ini untuk membangunkan dasar promosi penyakit tidak berjangkit dan strategi promosi kesihatan yang berkesan di kalangan orang dewasa muda.

Kata kunci: Penyakit kardiovascular, epidemiologi, hipertensi, orang dewasa muda, Malaysia

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LIST OF SYMBOLS AND ABBREVIATIONS

ABPM	:	Ambulatory blood pressure monitoring
AI	:	Artificial intelligence
aOR	:	Adjusted odds ratio
AUDIT	:	Alcohol Use Disorder Identification Test
AYA	:	Adolescents and young adults
BMI	:	Body mass index
BP	:	Blood pressure
CAD	:	Coronary artery disease
CARDIA	:	Coronary Artery Risk Development in Young Adults
CPG	:	Clinical practice guidelines
CVD	:	Cardiovascular disease
DALY	:	Disability-adjusted life year
DASH	:	Dietary Approaches to Stop Hypertension
DBP	:	Diastolic blood pressure
DG	:	Director General
DM	:	Diabetes mellitus
DOSM	:	Department of Statistics Malaysia
DrPH	:	Doctor of Public Health
EB	:	Enumeration block
EBM	:	Evidence-based medicine
EM	:	Explanatory model
ESC	:	European Society of Cardiology
ESH	:	European Society of Hypertension
GATS	:	Global Adult Tobacco Survey

GBD	:	Global burden of disease
HIV	:	Human immunodeficiency virus
IDF	:	International Diabetes Foundation
ID	:	Identification
IDI	:	In-depth interview
IPA	:	Interpretive phenomenological analysis
IPH	:	Institute for Public Health
JBI	:	Joanna Briggs Institute
JNC 7	:	The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure
JSH	:	Japan Society of Hypertension
LQ	:	Living quarters
MAR	:	Missing at random
MCAR	:	Missing completely at random
MCH	:	Maternal and child health
MeSH	:	Medical Subject Headings
MNAR	:	Missing not at random
MoH	:	Ministry of Health
MREC	:	Medical Research and Ethics Committee
NCD	:	Non-communicable disease
NCEP-ATP III	:	National Cholesterol Education Program – Third Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults
NHANES	:	National Health and Nutrition Examination Survey
NHMS	:	National Health and Morbidity Survey
NMRR	:	National Medical Research Register

NSP-NCD	:	National Strategic Plan for Non-Communicable Diseases
OR	:	Odds ratio
OSA	:	Obstructive sleep apnoea
PI	:	Principal investigator
PRISMA	:	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SBP	:	Systolic blood pressure
SES	:	Socioeconomic status
T&CM	:	Traditional and Complementary Medicine
UMMC	:	University of Malaya Medical Centre
WC	:	Waist circumference
WHR	:	Waist-to-hip ratio
WHtR	:	Waist-to-height ratio
YOH	:	Young-onset hypertension

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

In this chapter, first some background on the problem addressed in this thesis, namely, young-onset hypertension (YOH) is presented, and the magnitude of this problem both internationally and nationally is highlighted. Next, a situational analysis is presented – both in the global and the local Malaysian context. Then, the main implications of YOH are explained as well as how they affect not only the individual, but populations and countries at large. These implications provide the impetus for this study, which is justified in this chapter; and leads to the research objectives, both general and specific. Following on from this, an overview of the study design and an explanation of the researcher's role in the conduct of the study are provided. A description of the organization of this thesis is given and, finally, the chapter concludes with a summary of its contents.

1.1 Background

Hypertension is a critical public health issue not least because it is the most widely recognized modifiable risk factor for cardiovascular diseases (CVDs), which include myocardial infarction, congestive heart failure, stroke, end-stage renal disease, and peripheral vascular disease (World Health Organization, 2013). It is an insidious disease, rarely causing any symptoms in the early stages. In addition to being a major cause of morbidity and mortality, hypertension places a heavy burden on healthcare systems, families, and society as a whole (Falkner, Lurbe, & Schaefer, 2010).

Globally, over a period of almost four decades from the 1980s as agrarian-based societies transition towards industrialization, high systolic blood pressure (SBP) still remains the leading risk factor for attributable disease burden, accounting for 10.4 million deaths and 218 million disability-adjusted life years (DALYs) (Roth et al., 2018). In terms

of complications as a result of hypertension, the leading cause of mortality from non-communicable diseases (NCDs) were due to CVDs that accounted for 17.8 million deaths; of which ischaemic heart disease and stroke together comprised 84.9% or 15.1 million of those deaths in 2017 (Roth et al., 2018). A similar picture can be seen in Malaysia, whereby high SBP is the principle risk factor in terms of DALYs in both genders (Forouzanfar et al., 2016). Notably, the main causes of premature mortality in Malaysia are ischaemic heart disease and stroke, coming in first and third place, respectively (Murray et al., 2015). Therefore, from both an international and national perspective, high or raised blood pressure (BP) is a major public health issue (World Health Organization, 2013).

1.1.1 Situational Analysis

Many prospective epidemiological studies have shown that BP has a continuous, graded, adverse effect on the risk of developing future cardiovascular events (Adler et al., 2015; Vasan et al., 2002). Pathophysiological changes such as left ventricular hypertrophy, increased left ventricular mass, and carotid stenosis typically remain unchanged following exposure to prolonged periods of high BP even despite pharmacological treatment (Vasan et al., 2002). This adds strength to the theory that the continuous existence of hypertension risk factors when young may act as a precursor to the development of incipient left ventricular systolic and diastolic function in middle age. In short, the earlier the onset of hypertension, the longer its duration, and the greater the risk of future cardiovascular events (Buck, Baker, Bass, & Donner, 1987).

Nonetheless, over the years, research on hypertension globally has focused either on middle-aged and elderly populations, two groups in which hypertension is more common, or on all age groups collectively (S.-W. Choi et al., 2014; Lloyd-Sherlock, Beard, Minicuci, Ebrahim, & Chatterji, 2014; Murphy et al., 2016; Sarki, Nduka, Stranges,

Kandala, & Uthman, 2015). These research directions have been pursued despite increasing insurmountable evidence that cumulative years of prehypertension in early adulthood is associated with later life coronary artery calcification (Allen et al., 2014; M. J. Pletcher et al., 2008). Inevitably, this calcification leads to subclinical atherosclerosis, which has been shown to be significantly associated with future cardiovascular risk (Detrano et al., 2008).

Similarly, in Malaysia, research has focused largely on hypertension among the general population, with no particular emphasis on young adults (Akter et al., 2010; Chang, Lee, & Cheah, 2012; Naidu et al., 2019; Naing et al., 2016; Rampal, Rampal, Azhar, & Rahman, 2008). Furthermore, Malaysia's current healthcare system is still very much focused on curative rather than preventive care, with 70% of service expenditure allocated to therapeutic care and only 5% to public health services (which include health promotion and prevention programmes) (Malaysia National Health Accounts Section, 2019).

Healthcare in Malaysia is supported by a hybrid network of private and public providers, and hypertension treatment and screening are carried out in both domains, more often than not by primary care providers (Lim, Sivasampu, Khoo, & Noh, 2017). However, this well-established primary care system favours provision of services for infectious diseases and maternal and child health (MCH). Hence, it may no longer be adequate for the healthcare needs of Malaysia today because it does not target medical conditions (e.g., hypertension) that are increasing the disease burden as the country undergoes a shift towards rapid urbanization from a traditional agricultural society (Ng et al., 2017). The organized provision of MCH services (such as antenatal services for pregnant mothers and childhood vaccinations for infants) as well as contact tracing for infectious diseases (such as tuberculosis) is in stark contrast to the lack of any form of

systematic community-wide health screening for hypertension. In 2007, streamlining of screening facilities provided by primary care clinics was performed to signify the point at which health personnel would respond with respect to impaired glucose status, borderline hypertension, and status of overweight or obesity (Mustapha, Omar, et al., 2014). Nonetheless, due to the insidious nature of hypertension, it is a challenge to ensure sufficient uptake of screening services for this disease by people who otherwise feel healthy.

1.1.2 Implications of Young-onset Hypertension

There exists an antithesis regarding the health of young adults in which it is supposed that young adults should be at the peak of physical health because they have overcome the trials of adolescence and are yet to experience the ravages of older age (Irwin, 2010; L. S. Neinstein & Irwin, 2013). However, an analysis of the data on respondents who participated in the 2003 Behavioural Risk Factor Surveillance System survey revealed that individuals aged 18–24 years had the highest prevalence of smoking, high levels of sedentary behaviour, and low levels of fruit and vegetable intake compared to other age groups (Winkleby & Cubbin, 2004). Moreover, according to another analysis performed on the same survey, the responses of > 18,000 male and female individuals aged 18–24 years indicated that < 22% consumed five or more fruit and vegetable servings per day, > 40% reported that they performed less than the recommended physical activity levels, and close to 40% were overweight or obese (McCracken, Jiles, & Blanck, 2007).

Thus, in contrast to conventional wisdom, there is an emerging recognition that young adults aged approximately 18–26 years from all backgrounds are less healthy compared to adolescents and those in their late 20s and 30s (Irwin, 2010; L. S. Neinstein & Irwin, 2013). Additionally, according to the results of an examination of the health indicators designated in *Healthy People 2010* for related health statuses of adolescents and the basic

health behaviours as they transition into young adulthood, the dominant pattern was found to be one of declining health (Harris, Gordon-Larsen, Chantala, & Udry, 2006). As adolescents evolve into young adults, they are more likely to consume unhealthy diets, which include fast food and convenience food, to smoke, use drugs, and binge drink. At the same time, they are less prone to perform physical activity, get regular dental and medical check-ups, and consume breakfast (Irwin, 2010).

Previous studies have shown that an escalation in multiple cardiovascular risk factors can commence at a relatively young age (Dhruv, Iyer, & Bhatt, 2012; Vikram et al., 2003). Recently, the United States National Health and Nutrition Examination Survey (NHANES) published in 2012 reported a significant decline in the proportion of older adults > 60 years with uncontrolled risk factors (BP, low-density lipoprotein (LDL), and current smoking) from 1999 to 2010, but no change in the proportion of younger adults with the same uncontrolled risk factors over the same period. This finding could explain why the incidence of acute myocardial infarction and stroke in young adults has not improved (Fryar, Chen, & Li, 2012).

It is therefore of concern that, on the one hand, hypertension is the leading risk factor for stroke and, on the other, that approximately 10% of all strokes occur in individuals who are 18–50 years of age (Bejot et al., 2014; Lewington, Clarke, Qizilbash, Peto, & Collins, 2002; Nedeltchev et al., 2005). From 2003 to 2012 in the United States, the hospitalization rate for acute ischaemic stroke rose at a significant rate in young adults < 45 years of age (George, Tong, & Bowman, 2017). Moreover, a country-specific study reported that the incidence rates of first-time hospitalization for ischaemic stroke and for transient ischaemic attacks in young Danish adults aged 15–30 years increased substantially from the mid-1990s to 2012 (Tibaek et al., 2016). Furthermore, examination of NHANES data during the period 1999–2006 showed that two thirds of young adults

that were aged between 20 and 45 years of age had at least one risk factor for CVD (Oikonen et al., 2013). Thus, from the above, it is apparent that CVDs now occur at a younger age than traditionally expected, and this may have a consequent significant impact on national productivity (Gersh, Sliwa, Mayosi, & Yusuf, 2010; Roth et al., 2018).

Young adulthood is a critical developmental period in a person's life, bridging the periods of adolescence and independent adulthood. This is the time when individuals face significant challenges and are expected to assume new responsibilities and obligations. Although the normal course of physiological and biological development of young adults probably has not changed for many generations, the world in which young adults live today has changed greatly from that experienced by their earlier counterparts. In the 21st century, young adults reside in an increasingly dynamic and networked environment, characterized by increasing connectivity and technology sharing, growing challenges and greater economic disparity (National Research Council and Institute of Medicine, 2015).

While circumnavigating these extensive challenges, young adults also play an important role in society. They are a valuable asset to their country and investing in them brings tremendous social and economic benefits (Sukarieh & Tannock, 2014). During 2018, in Malaysia, the age-dependency ratio (percentage of working-age population in the total population) was 44.23% (The World Bank, 2019), and it has been predicted that this ratio will increase to 49.5% by 2040 due to the anticipated growth in the ageing population (Department of Statistics Malaysia, 2016a). Furthermore, the Malaysian government's latest estimates show that the majority of the population is aged 20–39 years (Figure 1.1). This means that Malaysia relies on a workforce that includes a large proportion of young adults. Hence, looking after the well-being of these young adults as a valuable socioeconomic 'asset' by reducing their health vulnerabilities and risks will in turn produce resilient, productive, and active young adults, which will not only be of

benefit to this subpopulation, but to all members of Malaysian society and the country as a whole.

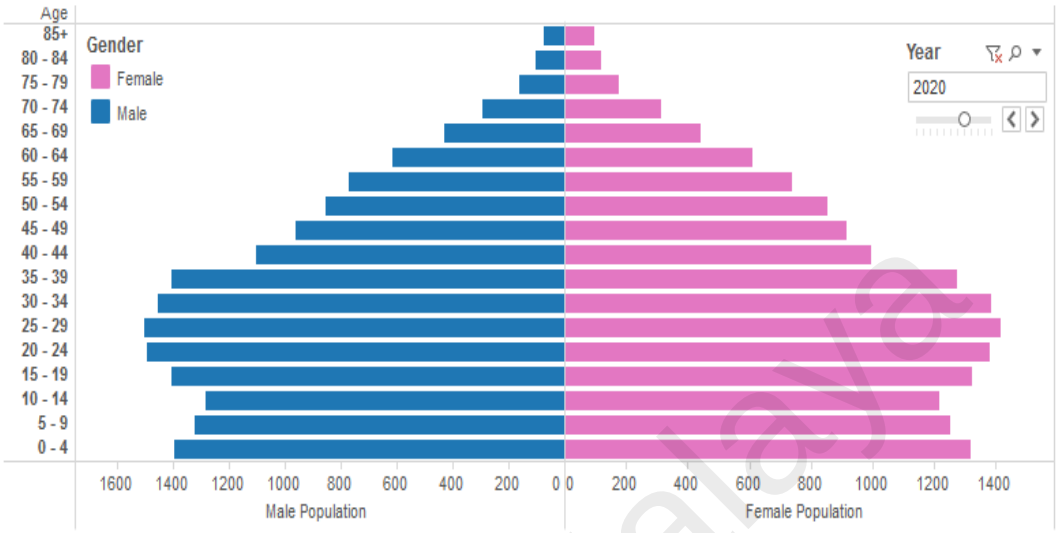

Figure 1.1: The population pyramid 2020

Source: Department of Statistics Malaysia (2020)

Young adults are essentially dissimilar to adolescents and older adults both physically and mentally, and this is reflected in the way in which they respond to health prevention and treatment measures. Nonetheless, they are still consistently combined with one group or the other in research, health policymaking, and intervention programmes. Young adults are an important subpopulation because they are resilient and adaptable, display an extraordinary ability for innovation, and hence are capable of achieving remarkable accomplishments. Increased rates of poor health during young adulthood will inadvertently have a negative impact on the economic well-being, educational attainment, and future health of this subpopulation. The fast pace of technological transitions and financial pressures seem to be causative factors to young adults' health issues (due to stress and sedentary lifestyles), while decreasing their engagement in job and family activities that usually act as protective factors over risk-taking (National Research

Council and Institute of Medicine, 2015). Concomitantly, many young adults are besieged with health problems which are left undetected or untreated due to problems associated with unemployment and financial insecurity (Harris et al., 2006). Therefore, it is imperative to prioritize the health and well-being of young adults because healthy, active, and productive young adults will be able to make a positive contribution to their country.

1.2 Justification of the Study

The incidence of future cardiovascular events can be forecasted by the levels of BP during young adulthood (Lewington et al., 2002; Vasan et al., 2002). As research has shown that management and prevention of hypertension in young people is correlated with greater risk reductions compared to elderly people, initiatives to enhance the detection of hypertension should emphasize on the identification of younger patients with or at risk for hypertension (Gooding, McGinty, Richmond, Gillman, & Field, 2014; Lewington et al., 2002). Prospective data from the Coronary Artery Risk Development in Young Adults (CARDIA) Study also indicates that the cardiovascular health score in young adulthood and maintenance of better cardiovascular health into middle age are both associated with better self-reported quality of life 25 years later at a mean age of 50 years (Fonarow et al., 2015). Moreover, young adults are ideal targets for prevention efforts because they are in the process of establishing lifestyle habits, which track forward into adulthood (Arts, Fernandez, & Lofgren, 2014).

Notwithstanding the importance of early diagnosis and treatment of hypertension for CVD prevention, young adults aged 18–39 years relative to older adults have lower awareness and treatment rates; 59% vs 84% and 40% vs 77%, respectively. (Yoon, Burt, Louis, & Carroll, 2012). In the United States, awareness, treatment, and control of hypertension appears worse in young adults compared to their older counterparts (Egan,

Zhao, & Axon, 2010; Guo, He, Zhang, & Walton, 2012; Hajjar & Kotchen, 2003; Yoon, Carroll, & Fryar, 2015; Yoon, Ostchega, & Louis, 2010; Y. Zhang & Moran, 2017).

Recognizing the importance of the health of young adults in relation to hypertension, some communities and countries have already started to investigate YOH in order to determine the pervasiveness of this problem in their local setting. In the United States alone, it has been found that nearly one in five young adults has hypertension (Nguyen et al., 2011) and measures are already underway to expound and address this finding (Johnson et al., 2014b; Johnson, Warner, LaMantia, & Bowers, 2016). Elsewhere, other countries have progressed as far as conducting genetic studies on young hypertensives (L. P. Wang et al., 2015). A growing number of scientists are focusing on young adults because the early stages of atherosclerotic plaque formation can already be found in this subpopulation (McGill Jr et al., 2000). In Malaysia however, young adults as a population group have largely been overlooked by researchers perhaps because the approach to addressing hypertension seems to be one that focuses on treating the later consequences of CVDs (Mustapha, Omar, et al., 2014).

Currently in Malaysia, there is a reliance on opportunistic health screening in order to identify individuals with or at risk of hypertension. Moreover, young adults may not be using screening services specifically for hypertension because it is often a silent disease with no apparent symptoms. Due to its largely asymptomatic presentation, young adults typically are not exposed to routine screening systems or may not see a healthcare provider regularly, leaving them unaware and uninformed about the permanent and ongoing damage caused by chronic diseases (National Research Council and Institute of Medicine, 2015). Furthermore, in general, young adults may have the impression that they are endowed with good health and, consequently, they do not readily seek services provided by the healthcare system. Often described as ‘young invincibles’ (Bibbins-

Domingo & Burroughs Peña, 2010), this subpopulation may not contemplate themselves to be at risk for chronic conditions, e.g. hypertension and CVD. It is therefore imperative to understand the knowledge, attitudes, and practices of young adults in regard to their management of CVD risk factors (which include hypertension) in order to initiate preventive efforts (Baig et al., 2015).

Malaysia's *National Strategic Plan for Non-Communicable Disease* (NSP-NCD) 2016–2025 emphasizes the importance of adopting a life course approach in the management of NCDs. In the life course approach, it is posited opportunities to prevent and control NCDs occur at multiple stages of life, with interventions in early life often offering the best chance for primary prevention (Ministry of Health Malaysia, 2016). However, this proposition does not hold true when programmes, regardless of whether they focus on health promotion or disease prevention, do not include young adults as a separate subpopulation and, instead, efforts to manage NCDs are consolidated for all age groups.

The latest clinical practice guidelines (CPGs) produced by the Malaysian Society of Hypertension (2018) propose several suggested areas of research. As such, the output of the current study will help to increase knowledge on several burgeoning topics in the Malaysian context. These research areas and topics are listed in Table 1.1.

Table 1.1: Suggested areas for research

Source: Malaysian Society of Hypertension (2018)

Research area	**Topic**
Risk Factors	Risk factors of hypertension in the younger age group
Monitoring	Methods of assessing cardiovascular risk in people aged under 40 years with hypertension
	Barriers to good blood pressure control in the community
Treatment	Patient empowerment in blood pressure management

Within the life course, young adulthood is a critical period and as such should be explored in its own right, rather than in combination with older adult age groups, or as an adjunct to adolescence. The paucity of evidence on YOH leads to a lack of depth and breadth of knowledge with regard to the best way to identify and treat younger patients. The burden of hypertension among young adults will continue to grow unless it is given the attention it deserves by policy makers, healthcare providers, and society alike. The most effective strategy to tackle this growing public health epidemic is that of prevention, which can be achieved by addressing the upstream determinants and risk factors of YOH as early as possible in the life course (Choukem et al., 2017). Therefore, it is crucial to elucidate the epidemiology of YOH and its risk determinants in Malaysia as well as to explore the unique experiences of young adults who are living with this disease. Early appropriate treatment and lifestyle changes may reduce target organ damage and attenuate long-term cardiovascular risks (Gan, Loh, & Seet, 2003). Hence, it is envisaged that the findings of this study may serve as a prelude to the development of targeted health promotion strategies, interventions, and disease prevention programmes for this subpopulation.

1.3 Objectives of the Study

1.3.1 General Objective

To determine the epidemiology of YOH in Malaysia over a ten-year period from 2006 to 2015 and explore underlying experiences and perspectives that influence awareness, treatment, and control of YOH.

1.3.2 Specific Objectives

i. To systematically review the prevalence of YOH worldwide;

ii. To describe the prevalence, awareness, treatment, and control of YOH in Malaysia from 2006 to 2015;

iii. To measure the association of YOH with sociodemographic (gender, age, locality, ethnicity, education, income, family history), lifestyle (alcohol intake, smoking, physical activity) and cardiovascular risk factors (diabetes, hypercholesterolaemia, obesity, abdominal obesity);

iv. To understand the underlying experiences and perspectives of young Malaysian adults' living with hypertension that influence the awareness, treatment, and control rates of YOH in Malaysia.

1.4 Overview of Study Design and Role of the Researcher

This study comprised three phases:

i. Phase I: A systematic literature review of the epidemiology of YOH worldwide

ii. Phase II: A quantitative study involving an analysis of secondary data derived from the 2006, 2011, and 2015 National Health and Morbidity Surveys (NHMSs)

iii. Phase III: A qualitative study involving in-depth interviews (IDIs) of young adults living with hypertension to explore the underlying experiences and perspectives of young adults living with hypertension that influence the awareness, treatment, and control rates measured in Phase II.

The researcher was the principal investigator (PI) in all three phases of the study and was involved in all aspects of data collection, data analysis, interpretation, and writing. In Phase I, the systematic literature review, the researcher determined the Boolean search terms, spearheaded the database search, constructed a modified form to extract the data,

assessed methodological quality, and then analysed and interpreted the information obtained. This systematic review of the prevalence data on YOH was important because it assisted the researcher to determine the hypertension burden among the young adult population globally (Joanna Briggs Institute Reviewers' Manual, 2014) and to identify the variables required for the data analysis in Phase II of the study.

A research study is categorized as sequential when one data collection phase occurs before the next. A study is classified as explanatory when the intent is to conduct a qualitative research phase in order to help explain the results of a previous quantitative phase (Creswell & Clark, 2017). In this study, Phase II (quantitative phase) occurred first and helped to identify the appropriate questions for Phase III (qualitative phase). Prior to the start of Phase II, the quantitative study, the researcher obtained approval and consent from the Director General (DG) of Health, Malaysia and the Director of the Institute for Public Health (IPH) to utilize secondary data from the NHMSs. The obtained data was cleaned, addressed for missingness using the multiple imputation method, age-adjusted using 2010 census data, and reweighted. A descriptive diagnostic analysis as well as univariate and multivariate logistic regression analyses were then performed on the data to determine the epidemiology of YOH in Malaysia over the period of one decade (2006–2015). It should be noted that the researcher was also a member of the NHMS 2015 research team and was directly involved in the development of the Individual Questionnaire for that survey, specifically Section D: Hypertension. The researcher was also a research member of the Central Coordinating Team for Data Management and Processing. This role involved participating in weekly meetings with the Director of the IPH to review the activities of the field/data collection teams, response rates, and logistical challenges, as well as ascertaining whether the quality and quantity of the collected data were appropriate. The results from Phase II that elucidated the decade-long rates of YOH prevalence, awareness, treatment, and control in Malaysia laid the

foundation for the study, shedding a light on the pervasiveness of this disease among young adults in the country.

The determination of the factors associated with a disease enables identification of the young adults who are most at risk of developing that disease. This goal underpinned the design and implementation of Phase III, the qualitative study. The results of Phase II informed the approach adopted in Phase III in two ways. First, it allowed the researcher to determine that the sampling method in the qualitative study should include participants from all backgrounds. Second, it enabled the researcher to develop questions that would elicit information from the respondents allowing an in-depth understanding of the experiences and perspectives of young hypertensive adults underlying the results produced in Phase II, especially with regard to the awareness, treatment, and control rates of YOH in Malaysia. The researcher obtained prior ethical approval from University of Malaya Medical Centre Medical Research and Ethics Committee (UMMC MREC) to conduct Phase III, constructed the interview topic guide based on the literature review, interviewed all the participants, analysed the interview transcriptions using NVivo 9 software (QSR International, Australia), and then interpreted the results.

1.5 Organization of the Thesis

This thesis is organized into six chapters. The following paragraphs briefly outline the content of each chapter and Figure 1.2 depicts the overall organization of the thesis.

This first chapter, Chapter One: Introduction, presents an overview of the study, including the background to and justification for the study as well as its aim, objectives (both general and specific) and design.

Chapter Two reviews the literature on areas of research that are pertinent to this study. The chapter begins with a comprehensive systematic review of the worldwide epidemiology of YOH, thus highlighting the global nature of the disease and its variations

across countries. This systematic review constituted Phase I of the study and was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Guidelines (Moher, Liberati, Tetzlaff, & Altman, 2009) and the Joanna Briggs Institute Reviewers' Manual (2014) for the systematic review of prevalence and incidence data. The literature on the epidemiology of YOH (which includes trends in awareness, treatment, and control of this disease) and on the experiences of those affected was also reviewed. Additionally, in order to understand this paradigm of health, the study utilized a conceptual framework adapted from the multilevel eco-epidemiological life course framework for the health, disease and mortality cross-continuum in human populations (Kuate Defo, 2014) and the explanatory model (EM) of illness framework (Kleinman, Eisenberg, & Good, 1978; M. Weiss, 1997). The combination of these two frameworks encompasses the principles of the evidence-based medicine (EBM) triad so as to be able to deliver results that can be used to guide both individual and population-based clinical decision making.

Chapter Three outlines the study design and the methods underpinning Phases II and III of the study. The quantitative study (Phase II) involved the analysis of secondary data obtained from three consecutive NHMSs covering the decade 2006–2015. The qualitative study (Phase III) portrayed the rich voices of the participants and explored their experiences of living with hypertension. The data collection and analysis techniques employed in both of these phases are described in this chapter.

Chapter Four presents the overall results of the mixed-methods data. In Phase II, the prevalence, awareness, treatment, and control rates of YOH from 2006–2015 are revealed, in addition to its associated risk factors. In Phase III, analysis of in-depth interviews revealed four major themes, that is, young adults' understanding of hypertension, their personal experiences, the factors influencing treatment adherence and their unmet needs.

Chapter Five discusses the study findings and comprehensively integrates the results of each phase by employing a process of data triangulation. The chapter also highlights the strengths and limitations of the study.

Chapter Six concludes the thesis. It provides a clear insight into the significance of the study findings which have both public health and clinical implications. It also presents some recommendations for policy and practice as well as directions for future research.

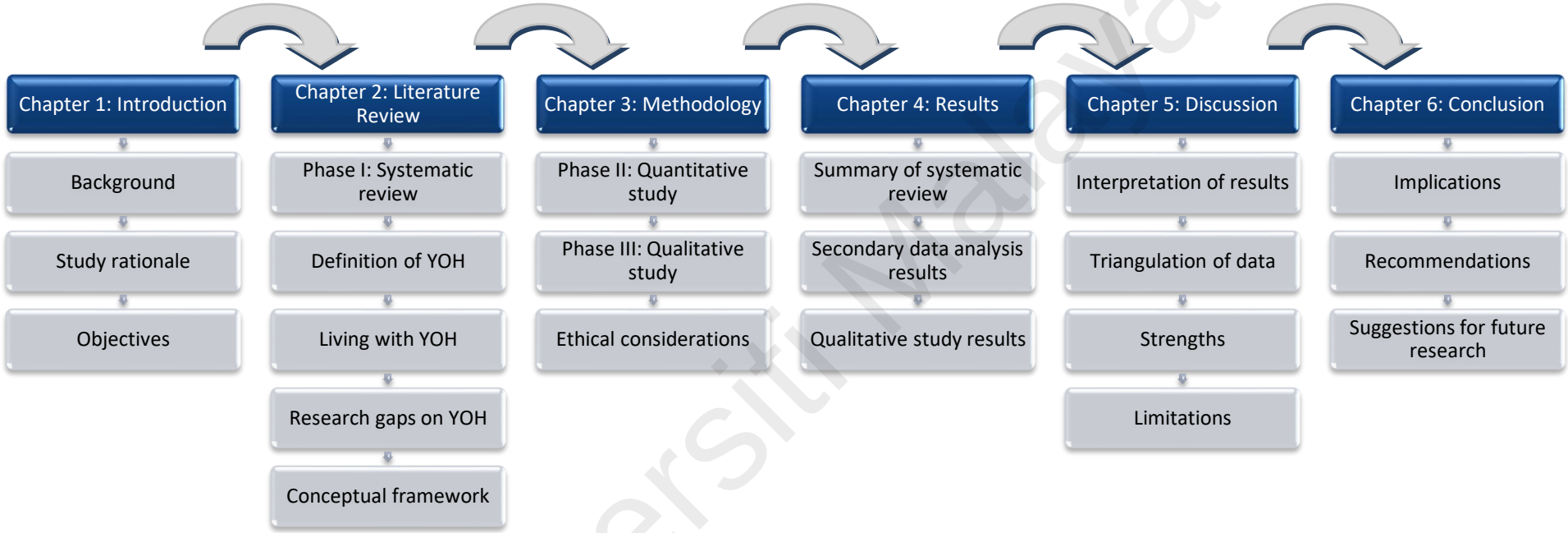

Figure 1.2: Organization of the thesis

1.6 Summary of the Chapter

Despite the wealth of evidence that exists on the relationship between hypertension and age, research on YOH only started to gain momentum in the early years of the 21st century. Furthermore, most young adults remain unaware of their CVD risk as they are not screened for this condition (Arts et al., 2014). Risk identification and mitigation strategies are still inadequate for the young adult population. Thus, if proactive measures are not taken, the implications of YOH will be both far reaching and devastating because this disease affects not only the individual, but has major adverse consequences for families, communities, and populations at large.

To address the large and rapidly growing number of individuals affected by YOH worldwide, prevention is critical as is effective, up-to-date management of the condition. However, there are major challenges that stand in the way of achieving primary and secondary prevention, including lack of data, limited national resources, and lack of prediction models for certain populations (Gersh et al., 2010). In order to formulate effective health policies for the prevention and management of this disease, updated and reliable information on the prevalence of YOH is crucial (J. Wang, Zhang, Wang, Liu, & Wang, 2014). Moreover, different populations may have their own specific determinants or combination of determinants of hypertension. Therefore, it is necessary to gather and analyse empirical data for a specific country in order to provide a baseline for formulating and monitoring effective interventions that are tailored to the local context for the effective control and prevention of hypertension (Naing et al., 2016).

Currently, the epidemiology of YOH in Malaysia is, as yet, unknown and there is also a lack of information on the experiences and perspectives of Malaysian young adults living with this disease. Thus, this body of research contributes to the limited but growing literature surrounding the epidemiology of YOH generally and in Malaysia. and provides

a platform for the voices of young adults with hypertension to be heard from which healthcare providers and others can learn how best to help them manage this chronic disease. This study is a nationally representative, population-based study that focuses on hypertension among young adults, and is the first of its kind in Malaysia.

CHAPTER 2: LITERATURE REVIEW

This first two subsections of this chapter describe the global epidemic that is hypertension and presents its underlying pathophysiology. Articles from the latest Global Burden of Disease Study (Forouzanfar et al., 2017; Institute for Health Metrics and Evaluation, 2018) as well as clinical medicine and physiology textbooks (Hall et al., 2012; Kumar & Clark, 2012; Mangena, Saban, Hlabyago, & Rayner, 2016) were reviewed to obtain the required information.

The third subsection of this chapter details the epidemiology of YOH, encompassing the prevalence, awareness, treatment, and control of YOH, the recent trends in this phenomenon as well as its associated risk factors. To obtain the information utilized in this review, a comprehensive literature search was performed on three large databases (Scopus^{TM}, CINAHL® and PubMed) using a systematic approach in accordance with PRISMA guidelines (Moher et al., 2009) and the Joanna Briggs Institute Reviewers' Manual (2014). Retrieved articles were evaluated for methodological quality using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Studies Reporting Prevalence Data (Munn, Moola, Lisy, Riitano, & Tufanaru, 2015). Following the review of the relevant literature on YOH, the definition of young adults employed in this study is then determined. Then, some previous studies on the insights of young adults on living with hypertension are reviewed. This is followed by a subsection that highlights research gaps on YOH to further underscore the importance of this body of research.

The penultimate subsection of this chapter presents the conceptual framework adopted by this study. This framework holistically combines the quantitative and qualitative literature components identified in this review by applying the principles of the EBM triad (Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996). The rationale for utilizing

this particular conceptual framework is also elaborated in this subsection. The last subsection summarizes the chapter.

2.1 Global Burden of Hypertension

Hypertension bears an independent continuous relationship with cardiovascular and renal complications across all ages (Mancia et al., 2013). Moreover, in previous studies it was projected that the global burden of hypertension would rise from roughly 0.9 billion in 2000 to more than 1.6 billion in 2025 (Kearney et al., 2005; Mills et al., 2016). In 2015 alone, an estimated 874 million adults had hypertension as defined by a SBP level of 140 mmHg or higher (Forouzanfar et al., 2017). Furthermore, mortality from CVDs has been increasing since 2007 worldwide (Institute for Health Metrics and Evaluation, 2018). Hypertension can thus be seen as a global epidemic. However, despite efforts to lower BP, hypertension continues to be a prevailing problem due to unfavourable behavioural risk factors such as unhealthy diet, excessive intake of alcohol, lack of exercise, stress, and obesity (Booth, Roberts, & Laye, 2012; Buttar, Li, & Ravi, 2005; Husain, Ansari, & Ferder, 2014; Matsuda & Shimomura, 2013; World Health Organization, 2014a).

2.2 Pathophysiology of Hypertension

Hypertension is defined as the persistent elevation of SBP of 140 mmHg or greater and/or diastolic blood pressure (DBP) of 90 mmHg or greater, based on measurements taken at least twice on two separate occasions. According to the seventh version of the Joint National Committee guidelines (JNC 7) published in 2003, BP is considered normal when SBP is less than 120 mmHg and DBP is less than 80 mmHg (Chobanian et al., 2003). The JNC 7 guidelines also include a prehypertension category (systolic 120–139

mmHg or diastolic 80–89 mmHg), which was added to reflect the continuum between normal and abnormal BP. In addition, Stage 1 hypertension was categorized as systolic 140–159 mmHg or diastolic 90–99 mmHg and Stage 2 hypertension was categorized as SBP greater than 160 mmHg or DBP greater than 100 mmHg (Chobanian et al., 2003).

There are two types of hypertension: primary (essential) and secondary. Primary hypertension refers to cases without any secondary identifiable cause. Secondary hypertension has an identifiable cause, such as renal artery stenosis or pheochromocytoma, and is managed as part of the treatment provided for the primary condition (Kumar & Clark, 2012).

2.2.1 Primary Hypertension

Over 90% of young people with hypertension have primary elevation of BP (Mangena et al., 2016), that is, essential hypertension due to an unknown cause. The pathogenesis of essential hypertension remains unclear. In some young hypertensive patients, there is an early increase in cardiac output, in association with increased pulse rate and circulating catecholamines. This phenomenon could result in changes in baroreceptor sensitivity, which would then operate at a higher BP level (Hall et al., 2012).

Essential hypertension has a multifactorial aetiology. It is often associated with environmental (obesity, alcohol intake, sodium intake, and stress) and genetic factors (family history). Foetal factors such as low birth weight have also been associated with subsequent high BP. This relationship, also known as the Barker–Brenner hypothesis, may be due to foetal adaptation to intrauterine undernutrition that then leads to long-term changes in blood vessel structure or in the function of crucial hormonal systems (Keijzer-Veen et al., 2005; Kumar & Clark, 2012; Luyckx & Brenner, 2015). Other mechanisms implicated in the pathogenesis of essential hypertension include hyperuricaemia (Gaffo et al., 2013; Rule et al., 2009).

2.2.2 Secondary Hypertension

Secondary hypertension is present when BP elevation is the result of a specific and potentially treatable cause such as Cushing's syndrome, Conn's syndrome, phaeochromocytoma, renovascular disease, obstructive sleep apnoea (OSA) and aortic coarctation, among others (Kumar & Clark, 2012; Puar et al., 2016). This form of hypertension affects approximately 10% of young hypertensives (Mangena et al., 2016). The importance of identifying the presence and cause of secondary hypertension lies in the potential to cure the patient with the appropriate treatment.

2.3 Phase I – Systematic Review of the Epidemiology of Young-onset Hypertension

There is growing interest in the study of hypertension among the young adult population (De Venecia, Lu, & Figueredo, 2016; Mancia et al., 2013). The estimation of hypertension epidemiology and its associated risk factors among young adults is of great importance to public health practitioners (Sharabi, Grotto, Huerta, Eldad, & Green, 2001) for the following reasons:

i. It enables timely planning of appropriate intervention programmes, and leaves open a wide window of opportunity to adjust them as needed in order to attain maximal success.
ii. The data is essential for targeting at-risk subpopulations with specially tailored intervention programmes.
iii. The analysis of a progressive database which describes the health profile of a large population enables the tracking of trends in the characteristics of health status, and may assist in explaining temporal changes in mortality and morbidity related to CVDs.

Additionally, long-term CVD risk can be predicted by examining risk factor profiles that exist during young adulthood (Arts et al., 2014). An important element in the development of tailored therapies for young adults is the recognition of the magnitude and types of risk factors of hypertension that exist among this subpopulation (Sabra, Taha, Al-Sebiany, Al-Kurashi, & Al-Zubier, 2007).

A preliminary search of PROSPERO, CINAHL®, PubMed, the JBI Database of Systematic Reviews and Implementation Reports, and the Cochrane Database of Systematic Reviews, yielded no ongoing or published systematic reviews on this topic. Therefore, it was imperative that the results of related work were collated and synthesized to identify evidence on the prevalence of YOH as well as to appraise the limitations and strengths of such studies. To ensure that the literature review on the subject would be comprehensive, a thorough search strategy was formulated. The search for relevant information was conducted in a systematic manner, in accordance with PRISMA guidelines (Moher et al., 2009).

The purpose of this systematic review was to answer the first specific objective of the study, that is, to systematically review the prevalence of YOH worldwide. The rationale behind the review was fourfold:

i. To highlight the global nature of YOH;
ii. To collate and synthesize the information and data required to decide on the operational definitions and variables to include in the secondary data analysis (Phase II);
iii. To determine the comprehensiveness of the risk factor variables employed in Phase II; and
iv. To determine the appropriate definition for the age range of the young adults included in this study.

2.3.1 Eligibility Criteria

2.3.1.1 Inclusion Criteria

i. Cross-sectional or cohort studies that reported the prevalence of hypertension (or information to compute the prevalence) in young adults
ii. Studies conducted from 1 January 1999 to 1 January 2019 (20 years)
iii. Studies published in English or with English translation
iv. Studies conducted on human subjects
v. Relevant unpublished papers, theses, conference proceedings.

2.3.1.2 Exclusion Criteria

i. Studies on restricted populations, e.g., hospitalized patients, institutionalized for mental illness, residing in prisons
ii. Studies on pregnant women
iii. Studies that were not community-based; case series; case studies; letters; reviews; commentaries; editorials
iv. Studies on non-systemic hypertension, e.g., intracranial hypertension, pulmonary hypertension
v. Studies from which it was not possible to extract data on young adults, e.g., those including older adult and paediatric populations
vi. Studies whose full data was not accessible even after submitting a request to the authors.

2.3.2 Information Sources

Three electronic databases were utilized to search for publications, namely, PubMed, Scopus™, and CINAHL®. Grey literature sources included the WorldCat catalogue, The Grey Literature Report (American focus), Open Grey (European focus), and the Cochrane Handbook Grey Literature Database. In addition, manual hand-searching and reviewing

of the reference lists of all eligible articles was conducted to obtain additional studies of relevance to the research topic.

2.3.3 Search Strategy

A Boolean search with pre-identified medical subject headings (MeSH) terms was performed on each selected database using the index terms 'prevalence', 'young-onset' and 'hypertension' (Table 2.1).

Table 2.1: Boolean Search with Pre-identified MeSH Terms

Criterion 1		**Criterion 2**		**Criterion 3**
Prevalence	AND	'young-onset'	AND	Hypertension
OR		OR		OR
Epidemiolog*		'young adult'		Hypertens*
OR		OR		OR
Survey*		'early onset'		'blood pressure'
OR				OR
"population-based"				'systolic blood pressure'
				OR
				'diastolic blood pressure'

2.3.4 Study Records

2.3.4.1 Selection Process

The selection process was performed in accordance with the PRISMA 2009 Flow Diagram (Moher et al., 2009). First, two independent reviewers (the PI and a research team member) screened the titles and/or abstracts for eligibility against the inclusion and exclusion criteria and all obviously irrelevant studies was removed. Next, all the potentially eligible studies were exported into EndNote X7 citation management software and duplicates were removed. Then, the full texts of the remaining potentially eligible studies were retrieved and independently reviewed by the same two review team members. Any disagreements or uncertainties between the two reviewers at any stage in the selection process were resolved by discussion with a third reviewer, and if necessary, a majority decision mechanism was utilized.

2.3.4.2 Record Management

Two mechanisms were used to manage records and data throughout the review:

i. EndNote X7 software to manage and organize citations, e.g., to remove duplicates, to employ the 'cite while you write' function, and to enable the whole team access to one reference library;

ii. Microsoft Excel to extract data using a data extraction form as explained in the following section.

2.3.5 Data Collection

2.3.5.1 Data Extraction

Data was extracted with a standardized, pre-piloted extraction form using Microsoft Excel. Where information on the disease prevalence or the data for calculating this was lacking, the corresponding authors were directly contacted to request access to this information. If no feedback was received from said authors after a maximum of eight weeks, the studies were excluded.

2.3.5.2 Quality Assessment

Articles were evaluated for methodological quality using the JBI standardized critical appraisal instrument for prevalence studies (i.e., the Critical Appraisal Checklist for Studies Reporting Prevalence Data) (Munn et al., 2015). Studies that scored five or more 'yes' ratings out of nine were included in the review. The checklist is reproduced in Appendix A.

2.3.6 Data Items

The information captured for each identified article included details of publication (first author, year published), study location (World Health Organization (WHO) region, country, setting), study population, study objective(s), study period (survey year and length of study), study design, sample size, sampling methods, characteristics of study

participants (age range, gender, ethnicity), BP measurement methods (auscultatory/oscillometric, preparation time, number of measurements, ascertainment of final reading, number of visits), diagnostic criteria for hypertension, risk or associated factors assessed, and prevalence of hypertension. Where available, details on the prevalence of hypertension by age group and gender, as well as the awareness, treatment, and control of YOH were also extracted.

2.4 Results of Systematic Review

Based on the inclusion criteria stated in subsection 2.3.1.1 above, there were 250, 322, and 77 hits in the PubMed, SCOPUS™ and CINAHL® databases, culminating in a total of 649 articles. All these article citations from the three databases were compiled into EndNote X7 software and duplicates were removed. The titles of the remaining 411 articles were screened for eligibility. When the title was unclear, the abstract was retrieved and this was screened. A total of 41 articles met the requirements for inclusion and the full text of these articles were obtained for further assessment. This step resulted in the exclusion of 25 articles for the following reasons: not a population-based study (n = 3), not a prevalence study (n = 1), outcome not related (n = 9), review study (n = 1) and unable to contact authors (n = 11). Further details on the excluded articles can be found in Appendix B.

To supplement the bibliographic database searches, the reference lists of all relevant research articles were also scrutinized to identify additional potential data sources. As a result of searching through the reference list of the identified articles, four additional studies of relevance were found. Additionally, the grey literature search produced 16 hits. All 16 of these titles were screened. However, the eligibility assessment found that none were relevant because the outcomes in these research studies were not related to this

study. Therefore, all 16 articles were excluded. Consequently, at the end of the study selection process, 20 articles were found to fulfil the eligibility criteria and were thus deemed suitable for further analysis. The flow diagram of the literature search and study selection process is illustrated in Figure 2.1.

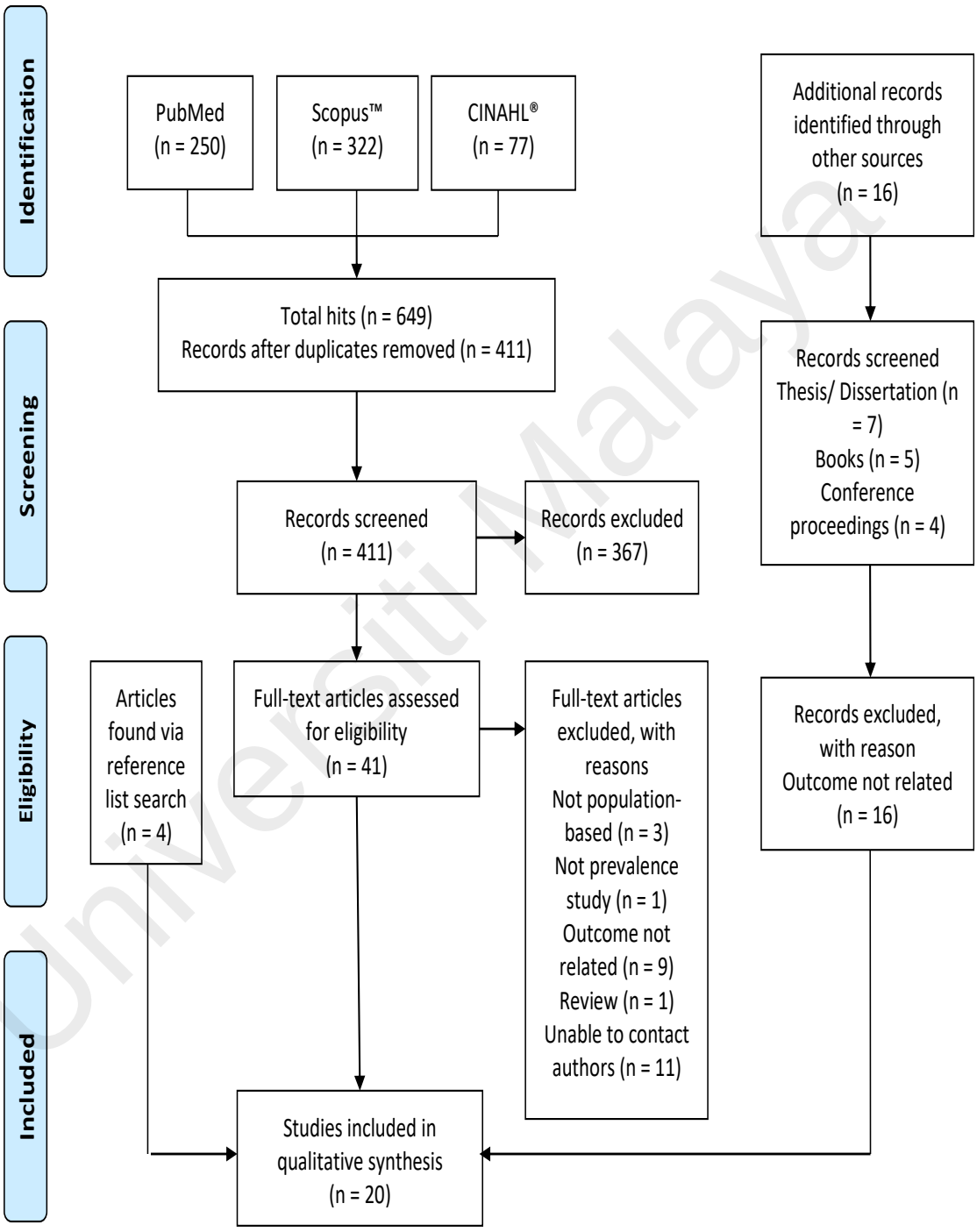

Figure 2.1: PRISMA flow diagram of study selection process

Source: Moher et al. (2009)

2.4.1 Study Characteristics and Results of Individual Studies

The 20 identified articles reported studies conducted in all six WHO regions: the African Region (Cameroon, Uganda, Tanzania, and South Africa), Region of the Americas (United States and Brazil), South-East Asia Region (India and Indonesia), European Region (Greece, Turkey and Poland), Eastern Mediterranean (Saudi Arabia), and Western Pacific Region (Japan and Singapore) (World Health Organization, 2019). Each WHO region is served by a Regional Office to support the member states in the generation and use of appropriate health information in decision-making, healthcare delivery, and management of health services at the national and sub-national levels. The majority of the studies (n = 17) were cross-sectional, two were cohort studies and one was a time-series study. Most of the studies primarily assessed the prevalence of YOH and its associated risk factors among young adults, although three studies looked into atherosclerotic/CVD risk factors among young adults, where hypertension was one of the factors considered (Jardim et al., 2015; Leppert et al., 2019; Mierzecki et al., 2014); three assessed the influence of overweight/obesity/adiposity parameters (and other CVD risk factors) in association with hypertension (Baig et al., 2015; Choukem et al., 2017; Nkeh-Chungag, Mxhosa, & Mgoduka, 2015); and two others investigated the prevalence of metabolic syndrome and its components among young adults (Koziarska-Rościszewska, Panasiuk, & Cypryk, 2010; Soysal et al., 2005).

The sample size used by the studies ranged from 214 to 84,364. Most studies assessed young adults of both genders, with the exception of Al-Mohaissen et al. (2017) who only studied females, as well as Baig et al. (2015) and Gan et al. (2003) who only investigated young adult males. More than half of the studies on young adults were conducted on a study population of university students. The characteristics of the 20 studies are summarized in Table 2.2.

Table 2.2: Characteristics of the Studies Included in the Systematic Review

WHO region	First author (year)	Study location		Study population	Study period (year)	Study design	Sample size	Random sampling	Age range	Class-ification	Prevalence of young-onset hypertension %		
		Country	Setting								Men	Women	Total
African Region	Choukem (2017)	Cameroon	Urban	University students	2009–2012	Time-series	2726	No	18–39	JNC 7	7.0%[b]	4.7%[b]	6.3%[b]
	Kayima (2015)	Uganda	Urban	Community	2012 - 2013	Cross-sectional	3685	Yes	18–40	JNC 7	-	-	15%
	Nkeh-Chungag (2015)	South Africa	Urban	University students		Cross-sectional	216	No	19–31	JNC 7	13.7%	2.10%	6.1%
	Nsanya (2019) [a]	East Africa	Urban	Community – multi-site	2015	Cross-sectional	769	Yes	15–24	JNC 7	18–20 yo: 7% 21–24 yo:13%	18–20 yo: 4% 21–24 yo: 3%	18–20 yo: 6% 21–24 yo: 9%
Region of the Americas	Gooding (2014)	United States	Urban and Rural	National	2007–2008	Cross-sectional	13512	Yes	24–32	JNC 7	-	-	25.5%
	Jardim (2015)	Brazil	Urban	University students	1993 and 2013	Cohort	1993: n = 281 2013: n = 215	No	1993: 17–22 2013: 37–42	2013 ESH/ ESC Guide-lines	-	-	4.6% (1993) 18.6% (2013)
	Leppert (2019)	United States	Urban and Rural	National	1999–2014	Cross-sectional	18803	Yes	20–45	JNC 6 and 7	12% (1999/ 2000) 10.8% (2013/ 2014)	6.3% (1999/ 2000) 7.7% (2013/ 2014)	8.7% (1999/ 2000) 9.1% (2013/ 2014)

Table 2.2, continued

WHO region	First author (year)	Study location		Study population	Study period (year)	Study design	Sample size	Random sampling	Age range	Class-ification	Prevalence of young-onset hypertension %		
		Country	Setting								Men	Women	Total
	Zhang (2017)[a]	United States	Urban and Rural	National	1999–2014	Cross-sectional	15669	Yes	18–39	JNC 7	-	-	7.6% (1999/2000) 7.3% (2013/2014)
South-East Asia Region	Das (2013)	India	Urban	University students	2011	Cross-sectional	600	No	18–24	JNC 7	15%	9.1%	13%
	Widjaja (2013)	Indonesia	Rural	Community	2012	Cross-sectional	111	No	18–25	JNC 7	25%	15%	17.1%
European Region	Bertsias (2003)	Greece	Urban	University students	1989–2001	Cross-sectional	989	No	20–40	JNC 6	13.3%[b]	6.7%[b]	15.1%[b]
	Soysal (2005)	Turkey	Urban	Community	2001–2002	Cross-sectional	885	Yes	20–39	NCEP-ATP III	19.5%[c]	13%[c]	-
	Koziarska-Rościszewska (2010)	Poland	Urban and Rural	University students	2006–2007	Cohort	1019	No	18–38	1) ATP III and IDF criteria 2) WHO criteria	1) 15.16% acc. 2) 6.77% acc.	None	1) 4.61% 2) 2.06%
	Mierzecki (2014)	Poland	Urban and Rural	Community–multi-site			271	Yes	25–45				30%

Table 2.2, continued

WHO region	First author (year)	Study location		Study population	Study period (year)	Study design	Sample size	Random sampling	Age range	Class-ification	Prevalence of young-onset hypertension %		
		Country	Setting								Men	Women	Total
Eastern Medi-terranean Region	Al-Mohaissen (2017)	Saudi Arabia	Urban	University students	2016	Cross-sectional	530	No	17–29	JNC 7	-	4.1%	-
	Baig (2015)	Saudi Arabia	Urban	University students	2014	Cross-sectional	610	No	19–24	JNC 7	7.5%	-	-
	Ibrahim (2014)	Saudi Arabia	Urban and Rural	University students	2012/ 2013	Cross-sectional	214	Yes	20–28	JNC 7	20.8%	5.8%	9.3%
Western Pacific Region	Ejima (2006)	Japan	Urban	University students	2003–2004	Cross-sectional	33496	No	18–29	JSH	-	-	0.10%[b]
	Endo (2011)	Japan	Urban	University students	2003–2009	Cross-sectional	84364	No	18–29	JSH	-	-	0.02%[b]
	Gan (2003)	Singapore	Urban and Rural	National	2001	Cross-sectional + Case-control	3352	No	17–23	Task II Consensus	1.6%	-	-

a = data extracted for young adults. b = period of prevalence. c = age-standardized prevalence rates

ESH/ESC = European Society of Hypertension/European Society of Cardiology. IDF = International Diabetes Foundation. JNC = Joint National Committee. JSH = Japan Society of Hypertension. NCEP-ATP III = National Cholesterol Education Programme – Third Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. WHO = World Health Organization

A variety of hypertension diagnostic classifications were used in the reviewed studies, including the JNC 7 criteria (Chobanian et al., 2003), The Japanese Society of Hypertension Guidelines for the Management of Hypertension (JSH) (Umemura et al., 2019), Task II Consensus (J. A. Staessen et al., 2001), the European Society of Hypertension and the European Society of Cardiology Guidelines (2013 ESH/ESC) (Mancia et al., 2013), the International Diabetes Federation (IDF) criteria and the National Cholesterol Education Programme Adult Treatment Panel III (NCEP-ATP-III) as well as the WHO criteria (Alberti, Zimmet, & Shaw, 2005; Grundy et al., 2005; World Health Organization, 1999) (Table 2.2).

Furthermore, as shown in Table 2.3 below, the methods of BP measurement varied in terms of the device used (oscillometric and/or auscultatory), preparation/rest time, position of the patient, number of measurements, patient's arm (left or right), intervals between measurements, and ascertainment of the final BP record.

Overall, all of the studies were highly heterogeneous in terms of the characteristics of the study participants, study population, methodology, and sample size. As such, the assignment of a weight to each study had no scientific value. As the requirement for a meta-analysis leading to a pooled risk estimate, that is, studies that have comparable methods and similar measurements of exposures and endpoints were not met, an annotated review was conducted instead.

Table 2.3: Blood Pressure Measurement Methods

First author (year)	Device	Preparation/ Rest time (minutes)	Position	No. of measurements/ Arm/ Intervals	Final reading
Al-Mohaissen (2017)	Oscillometric	-	-	3 at 5-min intervals	Mean of final 2 readings (if 3 readings were taken) or 2nd reading only (if 2 readings were taken)
Baig (2015)	Oscillometric	A "few" min	-	2	Mean of 2 readings
Bertsias (2003)	Auscultatory	5 min; no smoking/coffee intake 30 min prior	Seated, arm and back supported at heart level	2 ± 1 (right arm) at 2-min intervals	Mean of 2 ± 1 readings
Choukem (2017)	Oscillometric	5 min	Seated	1	Based on a single measurement
Das (2013)	Auscultatory	5–10 min; no smoking 30 min prior	Seated, feet on floor, not cross-legged	≥ 2 (right arm) at 5-min intervals	Mean of all readings
Ejima (2006)	Oscillometric and Auscultatory	5–30 min	Seated	3 (casual BP) + 1 (home BP) on 4 separate occasions	Home BP (mean of 7 readings)
Endo (2011)	Oscillometric and Auscultatory	5–30 min	Seated	3 (casual BP) + 1 (home BP) on 4 separate occasions	Home BP (mean of 7 readings)
Gan (2003)	Oscillometric and Auscultatory	5–30 min; no smoking/alcohol intake 30 min prior	Seated	1–5 readings, non-dominant arm, at 2-min intervals and ABPM on 4 separate occasions	Based on ABPM on 4th occasion
Gooding (2014)	Oscillometric	5 min rest	Seated	3 (right arm) at 30-sec intervals	Mean of final 2 readings
Ibrahim (2014)	Auscultatory	4 min	Seated	2 (right arm)	Mean of 2 readings
Jardim (2015)	Auscultatory and Oscillometric	5 min	Seated	2 (right arm) at 2-min intervals	2nd reading

Table 2.3, continued

First author (year)	Device	Preparation/ Rest time (minutes)	Position	No. of measurements/ Arm/ Intervals	Final reading
Kayima (2015)	Oscillometric	5 min; no smoking/alcohol intake 30 min prior	Seated	3 (left arm) at 3-min intervals	Mean of the closest 2 readings
Koziarska-Rościszewska (2010)	Auscultatory	5 min	Seated	2	Mean of 2 readings
Leppert (2019)	Auscultatory	5 min	Seated	3 ± 1	Mean of all available readings
Mierzecki (2014)	Auscultatory	5 min	-	3 (right arm)	Mean of 3 readings
Nkeh-Chungag (2015)	Oscillometric	10 min	Seated	3 (right arm)	Mean of 3 readings
Nsanya (2019)	Oscillometric	15 min	Seated	3 (right, left, then right arm) at 2-min intervals	Mean of last 2 readings
Soysal (2005)	Oscillometric	5 min	Seated	3 readings at 1-min interval	Mean of final 2 readings
Widjaja (2013)	Auscultatory	≥ 5 min; no smoking/coffee intake 30 min prior	Seated, arm and back supported	2 (right arm) at 2-min intervals (± 1 additional measurement if readings differed by >5 mmHg)	Mean of 2 ± 1 readings
Zhang (2017)	Auscultatory	5 min	Seated	3 ± 1 if BP measurement interrupted or incomplete	Mean of all available readings

2.4.2 Assessment of Methodological Quality

Overall, the included studies were considered acceptable quality, scoring between 66.67% and 100% according to the JBI criteria for assessing the quality of prevalence studies (Munn et al., 2015). The JBI recommends including primary studies that score ≥ 60% in respect of nine methodological criteria. All of the primary studies (n = 17) in this review fulfilled this recommendation; the other three studies were based on secondary data.

Ten studies scored 66.67% (the lowest score obtained in the assessment), as they did not fulfill three out of the nine methodological criteria. The reasons are listed as follows:

i. The sampling frame in the majority of the studies included in this review was focused on university students. Therefore, the results from those studies may only be generalizable to young educated adults.
ii. Consecutive and convenience sampling methods were employed in the studies among university students with the exception of the one by Ibrahim et al. (2014) who used a multistage stratified random sample method. Mierzecki et al. (2014) stated that their study population was "randomly assigned" (p. 3153); however, the specifics were not reported. A community-based study by Widjaja, Santoso, Barus, Pradana, and Estetika (2013) also employed consecutive sampling.
iii. A sample size calculation was not performed.

Nonetheless, in all 17 primary studies, the subjects and settings were described in good detail (study population, study design, country of study, urban/rural locality, age range) and the data analyses were conducted with sufficient coverage of the identified sample, with appropriate statistical analysis and adequate response rates. Additionally, valid methods were used for the identification of YOH using standard definitions of

hypertension, with the exception of one study that did not describe this, which was consequently rated as ‘unclear’ in respect of this criterion. The results of the evaluation of methodological quality are provided in Table 2.4.

Table 2.4: Quality Assessment of Included Studies Using the Joanna Briggs Institute Criteria for Assessing the Quality of Prevalence Studies

First author (year)	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Score %
Al-Mohaissen (2017)	N	N	Y	Y	Y	Y	Y	Y	Y	77.78
Baig (2015)	N	N	Y	Y	Y	Y	Y	Y	Y	77.78
Bertsias (2003)	N	N	N	Y	Y	Y	Y	Y	Y	66.67
Choukem (2017)	N	N	N	Y	Y	Y	Y	Y	Y	66.67
Das (2013)	N	N	N	Y	Y	Y	Y	Y	Y	66.67
Ejima (2006)	N	N	N	Y	Y	Y	Y	Y	Y	66.67
Endo (2011)	N	N	N	Y	Y	Y	Y	Y	Y	66.67
Gan (2003)	Y	Y	Y	Y	Y	Y	Y	Y	Y	100
Gooding (2014)	Y	Y	Y	Y	Y	Y	Y	Y	Y	100
Ibrahim (2014)	N	Y	Y	Y	Y	Y	Y	Y	Y	88.89
Jardim (2015)	N	N	N	Y	Y	Y	Y	Y	Y	66.67
Kayima (2015)	Y	Y	Y	Y	Y	Y	Y	Y	Y	100
Koziarska-Rościszewska (2010)	N	N	N	Y	Y	Y	Y	Y	Y	66.67

Table 2.4, continued

First author (year)	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Score %
Leppert (2019)	Y	Y	Y	Y	Y	Y	Y	Y	Y	100
Mierzecki (2014)	Y	N	N	Y	Y	U	Y	Y	Y	66.67
Nkeh-Chungag (2015)	N	N	N	Y	Y	Y	Y	Y	Y	66.67
Nsanya (2019)	N	N	N	Y	Y	Y	Y	Y	Y	66.67
Soysal (2005)	Y	Y	Y	Y	Y	Y	Y	Y	Y	100
Widjaja (2013)	N	N	Y	Y	Y	Y	Y	Y	Y	77.78
Zhang (2017)	Y	Y	Y	Y	Y	Y	Y	Y	Y	100

Notes:
Y: Yes, N: No, U: Unclear
Q1 = Was the sample frame appropriate to address the target population?
Q2 = Were study participants sampled in an appropriate way?
Q3 = Was the sample size adequate?
Q4 = Were the study subjects and the setting described in detail?
Q5 = Was the data analysis conducted with sufficient coverage of the identified sample?
Q6 = Were valid methods used for the identification of the condition?
Q7 = Was the condition measured in a standard, reliable way for all participants?
Q8 = Was there appropriate statistical analysis?
Q9 = Was the response rate adequate, and if not, was the low response rate managed appropriately?

2.4.3 Worldwide Prevalence of Young-onset Hypertension

In developed countries such as the United States, a recent national study revealed that hypertension affected 7.3% of young adults aged 18–39 years (Y. Zhang & Moran, 2017). Among undergraduates in North Carolina in the United States, BP readings in the hypertensive range were found in 10.5% of the participants overall; where 7.8% and 5.5% had elevations of SBP and DBP, respectively (Lai, Ward, & Bolin, 2015). However, in an earlier study in Japan, the period prevalence of YOH among Tohoku University students aged 18–29 years was only 0.02% over a seven-year period (2003–2009) (Endo et al., 2011). This result is in contrast to those reported in more recent studies conducted in the East that revealed a general pattern of increasing hypertension burden compared the West (A. R. A. Rahman & Rashid, 2017).

In Uganda, a developing country in Africa, the overall prevalence of YOH was revealed to be 15%, 95% CI [14.2, 19.6] in a young adult population in epidemiological transition (Kayima et al., 2015). The concept of epidemiological transition is the dynamic shift in trends of health and illness (Omran, 1971), as it transforms from one of high mortality levels due to infant/child deaths (such as those attributed to episodic famine epidemics) to one of non-communicable diseases (such as those attributed to smoking). The findings showed that YOH was particularly prevalent, affecting approximately one sixth of the young adult subpopulation. In other countries in Africa, YOH prevalence has been found to range between 6.1% and 9% (Choukem et al., 2017; Nkeh-Chungag et al., 2015; Nsanya et al., 2019). Acculturation through the introduction of Western lifestyles coupled with accelerated urbanization has been blamed for the growing prevalence of hypertension in African countries (Kayima et al., 2015; Nsanya et al., 2019).

In the Middle East in Saudi Arabia, the prevalence of YOH among students aged 19–24 years in an urban university in Jeddah was found to be 7.5% (Baig et al. (2015). These

results are consistent with Ibrahim et al. (2014), in which the prevalence of YOH among students aged 20–28 years attending a mixed urban–rural campus, also in Jeddah, was found to be 9.3%. The findings reported in both these studies were attributed to concomitant diagnoses of overweight and obesity, consumption of a high-fat diet, and physical inactivity as well as a gap between knowledge, attitude and practice regarding the risk factors of CVD (Baig et al., 2015; Ibrahim et al., 2014). On the other hand, Al-Mohaissen et al. (2017), who investigated the prevalence of YOH among Saudi female university students aged 17–29 years reported a prevalence of 4.3%, which is consistent with a Portuguese study that has reported that young Lisboan women have a lower prevalence of hypertension compared to their male counterparts (Dores et al., 2010).

In Europe, a 13-year study conducted among Greek university students in Crete during the period 1989–2001 revealed the period prevalence of YOH to be 15.1% (Bertsias, Mammas, Linardakis, & Kafatos, 2003). Elsewhere, in Turkey, the prevalence of YOH among males and females was found to be 19.5% and 13%, respectively, among urban community dwellers aged 20–39 years (Soysal et al., 2005). In Poland, Koziarska-Rościszewska et al. (2010) found a much higher YOH prevalence of 30%. All of the above results for Europe are consistent with reports that this region has the highest prevalence of arterial hypertension worldwide, a prevalence that has been attributed to the influence of medical inertia, insufficient patient education, and contradictory recommendations from Europe-level and independent national societies, among other reasons (Reuter & Jordan, 2019).

In Southeast Asia, a Singaporean national study by Gan et al. (2003) reported the prevalence of YOH as 1.6% among young adult males aged 17–23 years drafted into military service. In contrast, in Indonesia, the prevalence of YOH among rural community residents was found to be 17.1% (Widjaja et al., 2013). The large difference in YOH

prevalence between these countries could be due to the method of BP measurement employed (Table 2.3). The Singapore study diagnosed YOH based on the Task II Consensus protocol of taking one to five BP readings on two separate occasions, and then further ambulatory blood pressure monitoring (ABPM) readings on another four separate occasions to differentiate between true YOH and white coat hypertension. In contrast, the Indonesian study was performed in a community setting in which BP was measured two to three times during a single visit and where white coat hypertension was not accounted for.

With regard to YOH trends, Jardim et al. (2015) assessed the prevalence of cardiovascular risk factors (which included hypertension) in health professionals (medicine, nursing, nutrition, dentistry, and pharmacy) over a 20-year period. Their study revealed that the prevalence of YOH among the study population when aged 17–22 years in 1993 was 4.6%, whereas 20 years later, the prevalence of YOH in the same cohort aged 37–42 years was 18.6% ($p < .001$). This finding was attributed to similar increases in hypercholesterolaemia, excessive weight, and alcohol consumption over the two decades. However, although there were significant increases in cardiovascular risk factors among health professionals, these rates were lower than those observed in the general population (Jardim et al., 2015), which stresses the value of health education as an important component for the prevention and management of chronic NCDs. Additionally, several other studies have found that the trend in YOH has tended to remain unchanged in both genders over the years (Choukem et al., 2017; Leppert et al., 2019; Y. Zhang & Moran, 2017). However, although young adults display the largest percentage point improvement in hypertension awareness, treatment, and control over time, the rates for these three factors still lag behind those reported for older adults (Leppert et al., 2019; Y. Zhang & Moran, 2017).

2.4.4 Awareness, Treatment, and Control of Young-onset Hypertension

Of the 20 studies included in the systematic review, two investigated the prevalence of awareness, treatment, and control in the young adult population. Kayima et al. (2015) found that in their study population of young African adults aged 18–40 years, less than a sixth of the subjects with hypertension were aware of their condition (13.7%). All who were aware of their hypertensive condition were on some form of therapy (100%), but the target of achieving control over the condition was achieved in only one fifth of those being treated (19.7%). In contrast, among a sample of young American adults aged 18–39 years in the NHANES 2013/2014 cycle, almost three quarters were aware of their condition (74.7%), of which half were undergoing treatment (50%), and control was achieved in four fifths (80.4%) of those being treated (Table 2.5). These two countries have vastly different health systems; in which the health expenditure as a share of gross domestic product was 6.2% in Uganda (World Data Atlas, 2017) vs 17.7% in the United States (Centers for Medicare & Medicaid Services, 2018). In light of the above comparison, it is of concern that it has been reported that hypertension has a disproportionate effect on communities in middle- and low-income countries with vulnerable health systems, and where heart disease and stroke occur in younger people (World Health Organization, 2013).

Table 2.5: Awareness, Treatment, and Control of Young-onset Hypertension

First author (year)	Study period (year)	Age range	Prevalence (%)	Awareness (%)	Treatment (%)	Control (%)
Kayima, J. (2015)	2012–2013	18–40	15.0	13.7	100	19.7
Zhang, Y. (2017)	2013–2014	18–39	7.3	74.7	50	80.4

Based on the results of the literature review conducted for this study, there is scant research that focuses exclusively on the prevalence of awareness, treatment, and control

of hypertension among young adults. The extraction of data from other population-based studies (i.e. those not included in this review, mainly due to reason of full data not being accessible) revealed varying rates of awareness, treatment, and control. In Turkey, among young men aged 18–29 years, only 7.5% were found to be aware of their diagnosis, with 2.9% on treatment and 2.9% with their BP under control. Awareness among young adult females in the same age group was found to be higher at 12.5%, with 5.5% undergoing treatment and 2.8% having their BP under control (Altun et al., 2005). In China, the prevalence of hypertension among men and women aged 18–44 years was reported to be 17.5%; with women displaying higher rates of awareness (38% vs 20.8%) and treatment (27.3% vs 12.0%), but men having slightly better control over their BP (36.2% vs 33.2%) (J. Wang et al., 2014). In a community study in Cameroon in central Africa, the prevalence of YOH in males aged < 35 years was 31.7%, of which only 6.3% were aware of their diagnosis, of which in turn 50% were on treatment and 66.6% had their BP under control (Dzudie et al., 2012). As a final example, in a national study of hypertension among the Saudi adult population, 12.9% of hypertensives aged 25–34 years were found to be aware of their diagnosis, with 35.1% undergoing treatment and 75% having their BP under control (Saeed et al., 2011).

The 'rule of halves' originated when some earlier studies demonstrated that of those who had hypertension, half were aware of having raised BP, half of those who were aware had treatment and half of those who were treated had their BP adequately controlled (W. C. Smith, Lee, Crombie, & Tunstall-Pedoe, 1990; Wilber & Barrow, 1972). The rule of halves still seems to be applicable in some countries, specifically developing or middle-income countries (Deepa, Shanthirani, Pradeepa, & Mohan, 2003; Faizi et al., 2016). Nonetheless, some later studies provided evidence of an improvement to this rule (Antikainen et al., 2006; Marques-Vidal & Tuomilehto, 1997), which then evolved into the 'rule of thirds' (Lindblad et al., 2012). One possible explanation for this proportional

shift may be increased awareness and improved control of raised BP as an important attributable risk factor for disease burden globally (Kearney et al., 2005; Scheltens, Bots, Numans, Grobbee, & Hoes, 2007). The intensive marketing of antihypertensive drugs by doctors has also been shown to influence treatment both in middle-income (Y. Wu et al., 2008) and higher-income countries (Vitry & Lai, 2009; T. J. Wang, Ausiello, & Stafford, 1999).

2.4.5 Risk Factors Associated with the Development of Young-onset Hypertension

The numerous risk factors for CVD other than hypertension are usually categorized as non-modifiable (e.g., increasing age, male gender, and family history of premature CVD) and modifiable (e.g., dyslipidaemia, smoking, diabetes, abdominal obesity, excess alcohol intake, and sedentary lifestyle). The concept of risk factor identification is based on the idea that exposure to environmental factors increases the statistical risk of developing a disease and the alteration of these factors should postpone or prevent the disease (Al-Asadi, Habib, & Al-Naama, 2006). Thus, the identification of the risk factors in play at a young age is important as risk factors modification was found to be yield better outcomes in younger patients than in older patients (Lewington et al., 2002; Pasternak et al., 2003; Vasan et al., 2002). The risk factors associated with YOH that have been investigated by the reviewed studies are presented in the following matrix (Table 2.6).

Table 2.6: Risk Factors Associated with Young-onset Hypertension

First author (year)	Sex	Age	Marital status	Local-ity	Ethnic-ity	Edu-cation	Income	Housing	FH	Alcohol intake	Smoking status	PA	Diet	Sleep	DM	Chol	Obesity
Al-Mohaissen, M. A. (2017)		●	●				●		●		●	●	●			●	●
Baig, M. (2015)		●	●									●					
Bertsias, G. (2003)	●								●	●	●				●	●	●
Choukem, S. P. (2017)		●															●
Das, P. (2013)	●	●					●	●	●	●	●	●	●				●
Ejima, Y. (2006)		●							●								●
Endo, Y. (2011)	●	●							●								●
Gan, S. K. E. (2003)					●	●	●		●	●	●		●	●			●
Gooding, H. C. (2014)	●	●			●	●	●			●	●						●
Ibrahim, N. K. (2014)	●						●		●		●	●	●		●	●	●
Jardim, T.V. (2015)									●	●	●	●			●	●	●
Kayima, J. (2015)	●	●						●	●	●	●	●			●	●	●
Koziarska-Rościszewska, M. (2010)																	●
Leppert, M. H. (2019)											●				●	●	●
Mierzecki, A. (2014)				●							●	●				●	●

Table 2.6, continued

First author (year)	Sex	Age	Marital status	Local-ity	Ethnic-ity	Edu-cation	Income	Housing	FH	Alcohol intake	Smoking status	PA	Diet	Sleep	DM	Chol	Obesity
Nkeh-Chungag, B. N. (2015)																	●
Nsanya, M. K. (2019)	●	●								●	●	●	●				●
Soysal, A. (2005)	●	●		●						●	●	●			●	●	●
Widjaja, F. F. (2013)	●	●		●					●								●
Zhang, Y. (2017)	●	●			●												●

FH = family history, PA = physical activity, DM = diabetes mellitus, Chol = cholesterol.
Obesity includes measurements based on body mass index, waist-to-height ratio, waist circumference, and waist-to-hip ratio

2.4.5.1 Sociodemographic Characteristics

Several sociodemographic factors have been evaluated in the literature on hypertension. The most commonly investigated factors in studies that have focused on hypertension among older adults are gender, age, locality, ethnicity, socioeconomic status (SES; based on education and income levels), and family history (Lloyd-Sherlock et al., 2014; Peltzer & Phaswana-Mafuya, 2013; Seow, Subramaniam, Abdin, Vaingankar, & Chong, 2015; Shukuri, Tewelde, & Shaweno, 2019; Sousa et al., 2019). These factors are all considered in this study. Some other sociodemographic risk factors have also been explored in the literature but are not investigated in this study: outpatient care visits, healthcare utilization, and insurance status, which have been considered in studies on older adults (Bosu, Aheto, Zucchelli, & Reilly, 2019; Y. Zhang & Moran, 2017), and recent preventive care and self-rated excellent health, which have been considered in a study among young adults (Gooding et al., 2014). In the following sections, the risk factors addressed in this study are reviewed.

(a) ***Gender***

Several studies worldwide have found a preponderant association between the male gender and YOH (Bertsias et al., 2003; Choukem et al., 2017; Das et al., 2013; Ibrahim et al., 2014; Koziarska-Rościszewska et al., 2010; Leppert et al., 2019; Nkeh-Chungag et al., 2015; Nsanya et al., 2019; Soysal et al., 2005; Widjaja et al., 2013). In a study conducted among young people in Tanzania and Uganda, males compared to females were identified as having more than threefold increased odds of high BP, a result that still remained statistically significant despite adjustments for body mass index (BMI), economic, sociodemographic, and behavioural factors, adjusted odds ratio (aOR) = 3.2, 95% CI [2.4, 4.4] (Nsanya et al., 2019). Also, in a study in Tanzania, which was conducted among young adults aged 18–40 years, the female participants were found to be less likely to be hypertensive compared to their male counterparts, odds ratios (OR) = 0.7, 95% CI

[0.6, 0.8], $p < .001$ (Kayima et al., 2015). In Europe, a study among 1019 Polish young adults aged 18–38 years, none of the studied females were identified as having hypertension, whereas 2.06% of the males were found to be hypertensive (Koziarska-Rościszewska et al., 2010). In Turkey, YOH prevalence was found to be significantly higher in men than in women aged 30–39 years, and moreover, the age-adjusted prevalence was also found to be higher in men than in women (19.5% vs 13%) (Soysal et al., 2005). Additionally, in an analysis of a seven-year (2003–2009) continuous targeted screening system for hypertension among young adults conducted at Tohoku University, Japan, it was revealed that only one female was diagnosed with YOH, and this was due to a secondary cause (renovascular hypertension) (Endo et al., 2011). This indicated that there was an extremely low incidence of hypertension in young Japanese female subjects (Ejima et al., 2006).

Nonetheless, although young women have been found to have a lower prevalence of hypertension than their male counterparts (Dores et al., 2010), where there has been prolonged follow-up, the prevalence of hypertension among young women has been reported to increase steeply. In the Framingham offspring study, the incidence of hypertension in female subjects deemed normotensive at the first examination in their twenties increased eightfold when the subjects were in their fifties compared with threefold in men over the same timeframe, with similar incidence rates of hypertension seen in both genders only after 40 years of age (Garrison, Kannel, Stokes, & Castelli, 1987). Therefore, YOH should be seen as an important health concern for females, even in the younger age group.

(b) ***Age***

There is clear evidence to show that there is increasing prevalence of hypertension with increasing age in both men and women (Al-Nozha et al., 2007; K. M. Choi et al.,

2006; Erem, Hacihasanoglu, Kocak, Deger, & Topbas, 2009). In Uganda, compared to the younger age group (18–29 years), hypertension was found to be more prevalent in the older age group (30–40 years) (10.8% vs 21.6%, p = .001) (Kayima et al., 2015). A similar finding was reported in another Africa-based study on young people in Tanzania and Uganda by Nsanya et al. (2019), who observed a positive association between high BP and age, p = .001.

The risk of developing future cardiovascular events is influenced by the length and duration of hypertension onset (Buck et al., 1987). K. M. Choi et al. (2006) found that for every ten-year increment in age, the risk of developing hypertension increases 2.3-fold. Moreover, a meta-analysis on one million adults aged 40–89 years gathered from 61 prospective studies demonstrated that BP is strongly associated with age-specific mortality rates for stroke, ischaemic heart disease, and other vascular diseases (Lewington et al., 2002). More recent prospective studies conducted on young adults showed similar findings, where higher BP trajectories in young adulthood are associated with elevated coronary artery calcification risk (Allen et al., 2014) which subsequently influences left ventricular dysfunction later on in middle age (Chobanian et al., 2003; Kishi et al., 2015).

(c) ***Locality***

Research has also focused on the effect of locality as a factor in YOH. Soysal et al. (2005) investigated YOH only among urban adults aged 20–39 years in Izmir (the third biggest city in the Aegean region of Turkey), where diet and lifestyle play a dominant role in this study population. The study determined that the aged-adjusted prevalence of YOH in this urban population was 19.5% and 13% among men and women, respectively. Widjaja et al. (2013) focused on young adults aged 18–25 years living in a rural community in Indonesia and found the prevalence of YOH to be 17.1%. On the other hand, in a peri-urban district in Uganda undergoing epidemiological transition, Kayima

et al. (2015) found that young adults aged 18–40 living in the rural areas were less likely to develop YOH compared to those living in the peri-urban areas, although the relationship was not statistically significant (p = .833). Mierzecki et al. (2014) compared the prevalence of YOH among rural and urban dwellers aged 25–45 years in Poland, the results of which revealed a 30% frequency of arterial hypertension in both locations. However, there was no statistically significant relationship between occurrence of arterial hypertension and place of residence (rural or urban) in the examined population.

Significant urban–rural differences in the status of hypertension as well as the associated risk factors have been observed in other studies (J. Wang et al., 2014; Xing et al., 2019). This phenomenon may be attributable to the 'care-gap' discrepancy which is known to be more marked in middle-income countries particularly in rural and under-resourced settings (Adler et al., 2015). Additionally, in this era of epidemiological transition, urbanization is considered to be one of the major socio-environmental factors linked with a global increase in NCDs. Urbanization has been correlated with behavioural changes, such as a decline in physical activity, and the consumption of an unhealthy diet, which may in turn lead to obesity (Angkurawaranon, Jiraporncharoen, Chenthanakij, Doyle, & Nitsch, 2014). This situation is compounded in urban populations because, despite hypertension-related knowledge showing improvement among recently urbanized residents, there seems to be no significant improvement in their behaviour (W. Zhang, Meng, Yang, Luo, & Liu, 2018).

(d) ***Ethnicity***

In the United States, Gooding et al. (2014) constructed five racial/ethnic categories to distinguish the level of YOH among young adults aged 24–32 years and found that the prevalence of YOH was higher among non-Hispanic blacks (28.7%). Similarly, another United States study among young adults aged 18–39 years conducted on the data derived

from eight consecutive NHANES cycles (1999/2000–2013/2014) revealed that when stratified by ethnicity/race, a higher prevalence of hypertension was seen among non-Hispanic blacks compared with non-Hispanic whites and Mexican Americans across the cycles (Y. Zhang & Moran, 2017). In a study closer to home in Singapore, the prevalence of white coat hypertension was 1.6 times ($p = .05$) higher in Malays, while the prevalence of YOH was found to be two times ($p = .03$) higher in Malays than in the majority Chinese race (Gan et al., 2003).

The racial disparity in hypertension has been recognized for decades (Gillum, 1979). According to a study in the United States that sought to identify the explanatory factors behind BP control, it was concluded that racial differences can potentially explain the disparity between African Americans and whites in terms of poor adherence and compliance with medical care (Bosworth et al., 2008). In addition, the findings of a national study conducted in the United States that examined longitudinal trends (from 1994/1995–2001/2002) in race/ethnic disparities from adolescence to young adulthood indicated a strong and unprecedented decline in health during the transition period with substantial ethnic disparities in a diverse range of health indicators (such as diet, inactivity, obesity, healthcare access, and substance use) (Harris et al., 2006). Similarly, in Malaysia, YOH may be affecting the various ethnic groups differently. Hence, it is especially important to understand the extent of the influence of this factor when formulating culturally and ethnically appropriate national health promotion efforts to reduce and ameliorate YOH among young adults.

(e) ***Education***

Socioeconomic status has long been inversely associated with health outcomes for a wide range of disease outcomes, including hypertension (Krieger, Williams, & Moss, 1997). Key determinants of SES usually include environmental factors such as education,

income, type of employment, and measures of poverty and wealth (Grotto, Huerta, & Sharabi, 2008).

Jardim et al. (2015), in a 20-year follow-up study undertaken in Brazil, compared the number of hypertensive individuals among a group of health professionals (medicine, nursing, nutrition, dentistry, and pharmacy) in 1993 and 2013 with an urban population in the same area. The findings showed that although there was an increase in the prevalence of hypertension between the two phases, overall, health professionals had reduced levels of hypertension in both phases of the study. These results support the association between the low rates of education and hypertension. In a similar vein, Ibrahim et al. (2014) determined the prevalence of a university-level education in the parents of a study population of university students aged 20–28 years. However, no further analysis was performed to ascertain whether level of education may be associated with YOH in the student population. In other YOH studies, no significant association was established between education status and hypertension among young male adults in Singapore in military service (Gan et al., 2003) or in young adults in the United States (Gooding et al., 2014).

(f) ***Household Income***

In a study conducted in the early 2000s in Singapore, compared with 17.6%, 95% CI [3.8, 43.4] in the high-income (> S$5,000) and 21.6%, 95% CI [15.9, 28.3] in the middle-income (S$1,000–5,000) groups, 40.9%, 95% CI [20.7, 63.6] of subjects in the low total family income group (< S$1,000/month) were found to have hypertension (Gan et al., 2003). In a similar vein, another study that investigated the relationship between the prevalence of hypertension and income as percentage of poverty level among 24–32 year olds in the United States found a higher prevalence (29.6%) among participants who reported being in receipt of < 100% of the federal poverty level of income (Gooding et

al., 2014). These results are in contrast to those reported in a study by Das et al. (2013) among university students aged 18–24 years in India, in which it was found that the proportion of students with hypertension increased as per-capita monthly income increased. Nonetheless, in a study among young people in Tanzania and Uganda, Nsanya et al. (2019) found no associations between YOH and economic indicators (such as monthly income and items owned by the household). Similarly Al-Mohaissen et al. (2017) reported that income was not a predictor for developing YOH among young female adults going to university in Saudi Arabia.

The above notwithstanding, generally, low SES is associated with higher BP, for which possible explanations include awareness of hypertension prevention and control and better accessibility and adherence to medical treatment among groups with higher SES, as well as low birth weight and higher job strain among groups with lower SES (Grotto et al., 2008).

(g) ***Family History***

Previous research has indicated that a family history of hypertension, diabetes, obesity, and atherosclerotic heart disease is higher in hypertensive patients than in healthy individuals (Jenei, Pall, Katona, Kakuk, & Polgar, 2002; Shanthirani et al., 2003). Additionally, in other previous studies, a positive family history has been shown to be important in predisposition to hypertension (Carretero & Oparil, 2000; Goldstein, Shapiro, & Guthrie, 2006).

In Al-Mohaissen et al. (2017), it was found that in an overall study population of 530 young Saudi female adults, a family history of hypertension was reported by 46.5% of all participants. In Das et al. (2013), it was reported that among a study population of 600 young Indian adults, the prevalence of YOH was 14% among those who had positive family history and 11.6% among those who had no family history of hypertension. Ejima

et al. (2006) and Endo et al. (2011) too reported that the prevalence of YOH (whether essential hypertension or white coat hypertension) was higher among young adults whose father and/or mother exhibited a familial history of hypertension. Among young Singaporean men, as compared with normotensive controls, 31.4%, 95% CI [22.7, 41.2] and white coat hypertensives, 57.6%, 95% CI [44.8, 69.7], a high proportion of hypertensives, 69.2%, 95% CI [54.9, 81.3] had a history of hypertension in one or both parents (Gan et al., 2003). Widjaja et al. (2013) went one step further in their study among young rural adults when exploring the influence of family history of hypertension by further differentiating this factor into family history of hypertension on the mother's and on the father's side. However, in further analyses, family history from neither father nor mother were associated with hypertension.

From the above studies, it seems that a positive family history is a strong predictor of hypertension, particularly in young adults. In related work, Chen, Wu, and Pan (2004) demonstrated that a marker of lipoprotein lipase gene (D8S1145) is significantly associated with YOH. This gene is known to play an important role in human lipid metabolism by modulating the circulating triglyceride level and hence regulating BP by a direct effect on the vascular wall. Accordingly, genetic factors such as the lipoprotein lipase gene may provide a potential link in the chain between the serum triglyceride level and the presence of YOH. Further studies are ongoing to clarify this issue.

2.4.5.2 Lifestyle Factors

The findings on the lifestyle factors associated with hypertension in young adults are consistent with those in studies conducted among older adults with hypertension (Lloyd-Sherlock et al., 2014; Peltzer & Phaswana-Mafuya, 2013; Seow et al., 2015; Shukuri et al., 2019; Sousa et al., 2019) and include alcohol intake, smoking, physical activity, and

diet. Additionally, in their cohort of young adults drafted into military service, Gan et al. (2003) investigated sleep patterns in association with YOH.

(a) ***Alcohol Intake***

In their analysis of the prevalence of cardiovascular risk factors among the same study population of health professionals in 1993 and 2013, Jardim et al. (2015) revealed that a significant increase in alcohol consumption was reported by the 215 respondents involved in both phases (32.7% vs 34.9%, p = .037). Similarly, a higher prevalence of YOH was observed by Das et al. (2013) among young Indian adults in respect of history of alcohol consumption compared to those that did not imbibe alcohol (14.28% vs 12.8%). However, some other YOH studies have found no significant association between alcohol drinking and high BP (Gan et al., 2003; Kayima et al., 2015; Nsanya et al., 2019). Similarly, Widjaja et al. (2013) concluded that alcohol consumption did not play a role in YOH among their study population. However, out of a total of 111 subjects, only seven had ever drunk alcohol and none were regular drinkers, making meaningful conclusions impossible.

In the much larger Framingham offspring study, alcohol consumption was found to be a significant independent predictor of hypertension (Garrison et al., 1987). Also, according to another previous study, the association between alcohol consumption and risk of chronic hypertension follows a J-shaped curve, with light drinkers demonstrating a modest decrease in risk and more regular heavy drinkers demonstrating an increase in risk (Thadhani et al., 2002). Several possible mechanisms in alcohol-induced hypertension include imbalance of the central nervous system, enhanced sympathetic activity, increased cortisol levels, and increased vascular reactivity due to an increase in intracellular calcium levels (Husain et al., 2014).

(b) ***Smoking***

In Das et al. (2013), in the study population of undergraduate medical students, 14.5% had a smoking habit and the prevalence of YOH was higher among smokers (58.6%) than non-smokers (5.3%). Moreover, this difference was statistically significant. Smoking was also associated with elevated BP ($\chi^2 = 160.00$, $p < .05$). However, in other YOH studies no association was found between smoking and BP (Gan et al., 2003; Kayima et al., 2015; Koura, Al-Dabal, Rasheed, Al-Sowielem, & Makki, 2012; Nsanya et al., 2019; Widjaja et al., 2013). One possible explanation for this discrepancy in the results may be that smoking raises BP acutely, but can also increase cerebrovascular disease and CVD through chronic atherogenic processes (Chobanian et al., 2003; Nakamura et al., 2008). Indeed, single measurements of cardiovascular risk factors may not accurately reflect a person's past exposure to such risk factors (Wilson et al., 1997). Nsanya et al. (2019) hypothesized that no associations were found between smoking and high BP (despite this being an established risk factor) in their study populations in Uganda and Tanzania because this habit may have been underestimated due to social disapproval or potential stigma.

(c) ***Physical Activity***

Of concern, most studies among young adults have revealed a high prevalence of sedentary lifestyle/physical inactivity among their respective study populations. The study by Das et al. (2013) among young adult university students in India (n = 600) indicated that less than half of the students (40%) had the habit of exercise and that hypertensive prevalence was lower (12.5%) among persons who were more physically active as compared to their less-active counterparts (13.3%). Similarly, in a study by Ibrahim et al. (2014) on 214 medical students, 57.9% were found to be physically inactive. Additionally, a community study in East Africa revealed that the majority (56%) of participants (n = 769) spent their time watching television or sleeping during weekends

and/or after classes (as opposed to engaging in manual work or sports) (Nsanya et al., 2019).

Furthermore, the results of a study by Al-Mohaissen et al. (2017) among young adult female university students in Saudi Arabia indicated that a sedentary lifestyle was a predictor for hypertension ($p = .007$), where the fewer days per week that the student walked for a duration of ten minutes or more the greater the likelihood of hypertension. Das et al. (2013) too revealed that decreased physical activity and sedentary lifestyle were determinants for hypertension in their study population. On the other hand, some YOH studies have shown no association between YOH and physical activity (Kayima et al., 2015; Widjaja et al., 2013).

A previous study has found that low activity is associated with the incidence of hypertension, thus a sedentary lifestyle is an important modifiable risk factor for hypertension (Shanthirani et al., 2003). A known mechanism in the pathogenesis is endothelial dysfunction, a process characterized by reduced vascular endothelial vasodilation in addition to elevated prothrombic and pro-inflammatory markers, both which are associated with hypertension and atherosclerosis (Booth et al., 2012). In just seven days, lack of shear stress as a result of extreme physical inactivity causes 32% and 59% reduction in basal flux and endothelial dependent vasodilation due to microvascular deficiency (Navasiolava et al., 2010).

(d) ***Diet***

With regard to dietary habits, Das et al. (2013) found that among a study population comprising university students aged 18–24 years that the majority (88.5%) consumed a non-vegetarian/mixed diet and the prevalence of hypertension was 13.5% among these students as compared to 8.7% among those who reported that they consumed a solely vegetarian diet. Furthermore, more than two thirds (76.55%) of the students in the study

population added extra salt to their diet and hypertension was more prevalent (13.72%) among this group than among those who did not perform this practice.

Nsanya et al. (2019) found that a daily intake of at least one serving of vegetables and/or fruit was protective against hypertension, aOR 0.73, 95% CI [0.54, 0.98]. Al-Mohaissen et al. (2017) revealed that among their study population of young female university students aged 17–29 years, specific dietary factors, namely, the consumption of less fish and shrimp content in the diet and the consumption of more sugar and energy beverages, were the most predictive of YOH in their study population.

The above studies indicate that multiple dietary factors affect BP. They also support the idea that the adoption of healthier eating habits may substantially reduce hypertension, as has been demonstrated in previous studies (Pickering, 2006; Sacks et al., 2001). For instance, a specific intervention called Dietary Approaches to Stop Hypertension (DASH) and a vegetarian diet have both been found to lower BP (Pickering, 2006).

(e) ***Sleep***

In their study population of young male military recruits, Gan et al. (2003) recorded for one month the mean number of hours of sleep per night, and categorized the number of hours of sleep into > 7 hours, 5–7 hours, and < 5 hours. However, the association between hours of sleep and the development YOH was not further elaborated upon in their study.

Nonetheless, sleep-related disorders that cause a rise in BP are expected to have a significant effect on cardiovascular risk. Sleep impairs the physiological processes that affect BP such as the function of the autonomic nervous system. Both sleep deprivation and insomnia have been linked to increases in both the incidence and prevalence of hypertension (D. A. Calhoun & Harding, 2010). Also, a strong association between the

risk and severity of hypertension and the severity of OSA has been found in observational studies, whereas prospective studies among OSA patients have demonstrated a positive relationship between the risk of incident hypertension and OSA (Duran-Cantolla, Aizpuru, Martinez-Null, & Barbe-Illa, 2009). More recently, a study in Korea revealed that a sleep duration of fewer than five hours increased the recommended pharmacological treatment of hypertension rate by 1.864-fold, 95% CI [1.446, 2.403] according to the JNC 7 guidelines (Hwang et al., 2015).

2.4.5.3 Cardiovascular Risk Factors

Young-onset hypertension has been investigated for its association with other cardiovascular risk factors/comorbidities (such as diabetes mellitus (DM), cholesterol, and obesity), consistent with the literature on hypertension among older adults (Lloyd-Sherlock et al., 2014; Peltzer & Phaswana-Mafuya, 2013; Seow et al., 2015; Shukuri et al., 2019; Sousa et al., 2019). Additional risk factors that have been investigated among the older population include history of stroke (Peltzer & Phaswana-Mafuya, 2013) and psychosocial factors such as depression (Babatsikou & Zavitsanou, 2010; Bosworth, Bartash, Olsen, & Steffens, 2003).

(a) ***Diabetes Mellitus***

In a study among young African adults aged 18–40 years, the participants' diabetes status was found to be positively associated with hypertensive status, aOR = 3.1, 95% CI [0.9, 10.8], p = .0007 (Kayima et al., 2015). Additionally, it has been reported that, in a group of school teachers in Jeddah, a concomitant diagnosis of DM increased the estimated odds of hypertension by aOR = 2.04, 95% CI [1.17, 3.53] (Ibrahim, Hijazi, & Al-Bar, 2008).

An association between diabetes and hypertension has long been recognized and a syndrome that consists of hyperinsulinemia, glucose intolerance, reduced levels of high-

density-lipoprotein cholesterol, hypertriglyceridemia, and central obesity (all of which are related to insulin resistance) has been found to have an association with hypertension (Kumar & Clark, 2012). This association (also called 'metabolic syndrome') is a major risk factor for CVD (Kumar & Clark, 2012).

(b) ***Hypercholesterolaemia***

Hypertension and hypercholesterolemia have synergistic pro-thrombotic, pro-oxidant, and proinflammatory effects (Ivanovic & Tadic, 2015). The connection between hypercholesterolaemia and hypertension and the association between increased atherosclerosis and these risk factors can be clarified using several bio-humoral pathways. The renin-angiotensin-aldosterone system, endothelial dysfunction, increased production of endothelin-1, and oxidative stress are among the most studied pathways (Tuñón, Martín-Ventura, Blanco-Colio, Tarín, & Egido, 2007). However, despite the known relationship between hypertension and hypercholesterolaemia, no significant association was found by Al-Mohaissen et al. (2017) and Kayima et al. (2015) in their studies on YOH.

(c) ***Obesity/Body Mass Index***

Among young people in Tanzania and Uganda, Nsanya et al. (2019) demonstrated a positive association between BMI categories and high BP ($p = .005$), where compared to those with normal BMI, obese students had almost sevenfold increased odds of elevated BP, aOR = 6.7, 95% CI [2.2, 20.0]. A similar picture was revealed by Kayima et al. (2015), also in Uganda, among young adults in epidemiological transition, where over one third of the study population was obese or overweight and this factor was significantly associated with hypertension. In another country in Africa, namely, Cameroon, Choukem et al. (2017) found that BMI was an independent predictor of hypertension in young adults

in a Cameroonian university, where. according to multivariate modelling, where an 11% increase in YOH prevalence was found with every 1 kg/m^2 rise in BMI.

In Southeast Asia, among young Indonesian adults attending primary healthcare in a rural area, BMI has been shown to be strongly associated with hypertension, OR = 3.354, 95% CI [1.013, 11.102], p = .041 (Widjaja et al., 2013). Also in Southeast Asia, Gan et al. (2003) found a strong positive association between YOH and BMI, aOR = 1.19, 95% CI [1.11, 1.26], p < .001, in young Singaporean male military recruits.

Meanwhile, in a northern Indian urban community, being overweight or obese was found to increase the odds of having hypertension by 2.2 times (Yadav et al., 2008). Elsewhere in India, in the study by Das et al. (2013) among 600 Bengalese university students aged 18–24 years, the prevalence of hypertension in those students who were classified as either obese or overweight was 35.5% and 13% respectively. Similar findings were published in Saudi Arabia (Al-Mohaissen et al., 2017) and Greece (Bertsias et al., 2003), where it has been shown that BMI was a strong determinant for hypertensive risk among young adults. Therefore, overweight and obesity were associated with higher prevalence of YOH in these young adult populations.

Since the 1980s, initial reports of CVD risk factors in young adults, adolescents, and children in association with obesity have been emerging (Smoak et al., 1987). The ObEpi survey in France revealed that in the subpopulation aged 18–34 years, people classified as obesity or overweight had increased risk of hypertension by 3.6-fold and 2.3-fold, respectively (Eschwege, Charles, Basdevant, & Moisan, 2012). Hence, the results revealed by this systematic review are consistent with the literature elsewhere (Erem et al., 2009; Ishikawa et al., 2008; Koura et al., 2012; Pang et al., 2008; Yu et al., 2008).

(d) ***Abdominal Obesity***

Waist circumference (WC) is related to percentage abdominal fat mass and is a measure of central or abdominal obesity. Hypertension as well as other cardiometabolic risk factors appear to be associated with abdominal obesity (Choukem et al., 2017). Nkeh-Chungag et al. (2015) found that among young adults aged 19–31 years in South Africa, WC correlated strongly with both SBP and DBP in both genders. Also, in their multivariate models, Choukem et al. (2017) found that among young adults aged 18–39 years attending a university in Cameroon, WC was an independent predictor of hypertension; where a 9% rise in YOH prevalence was seen with every 1 cm increase in WC.

Furthermore, evidence from some other previous studies shows that central obesity is a greater risk factor for CVD compared to other types of obesity (Boden & Salehi, 2013; C. M. Lee, Huxley, Wildman, & Woodward, 2008; Prasad, Kabir, Dash, & Das, 2011). Therefore, in order to facilitate the accurate assessment of a patient's CVD risk profile, there is a need to ascertain the distribution of fat in patients.

2.4.5.4 Other Risk Factors

Two other risk factors were explored by the studies included in this review, namely, heart rate and human immunodeficiency virus (HIV) infection (NB: these are not depicted in the matrix in Table 2.6).

(a) ***Heart Rate***

Increased heart rate implies cardiovascular reactivity to mental stress and has been used as a tool to predict hypertension risk in adults and children (Hamer, Kivimaki, & Batty, 2016). Accordingly, Al-Mohaissen et al. (2017) showed that increasing heart rate was predictive of YOH in their study population of young adult Saudi females (mean age 20.5 ± 1.8 years) ($p = .005$).

(b) ***Human Immunodeficiency Virus Infection***

In a study by Kayima et al. (2015) on a young adult Ugandan population, modification of the survey tool was performed to collect data on unconventional risk factors for CVD, such as HIV infection. The results revealed that there was a significantly lower prevalence of hypertension among participants with HIV, OR 0.6, 95% CI [0.4, 0.8], p = .007 (Kayima et al., 2015). There are several hypothesized explanations for this phenomenon including dysregulation of the sympathetic nervous system and hypoadrenalism from HIV infection (Bloomfield et al., 2014; Compostella, Compostella, & D'Elia, 2008; Meya et al., 2007).

2.5 Definition of Young-onset Hypertension

The definition of hypertension differs according to the classifications used (Table 2.2):

i. The JNC 7, 2013 ESH/ESC, and WHO criteria define hypertension as BP ≥ 140/90 mmHg (Chobanian et al., 2003; Mancia et al., 2013; World Health Organization, 1978).
ii. The Task II Consensus classifies hypertensives as individuals with ABPM readings of average 24-hour reading > 135/85 mmHg, and/or nocturnal > 125/75 mmHg, and/or diurnal > 140/90 mmHg (J. A. Staessen et al., 2001).
iii. The NCEP-ATP-III and IDF use the cut-off BP value of ≥ 130/85 mmHg (Alberti et al., 2005; Grundy et al., 2005; World Health Organization, 1999).
iv. The JSH definitively diagnose hypertension based on an office BP of ≥ 140/90 mmHg and a home BP of ≥ 135/85 mmHg based on an average of readings taken on several different occasions (Umemura et al., 2019).

For the purposes of this study, hypertension (whether due to primary or secondary causes) is defined in accordance with JNC 7 (Chobanian et al., 2003) and local Malaysian

Society of Hypertension (2018) guidelines, that is, the persistent elevation of SBP of 140 mmHg or greater and/or DBP of 90 mmHg or greater, or taking hypertension medication. This is the same definition employed by the NHMSs, from which the data is obtained for this study. Interestingly, from a different perspective, Kaplan (2010) defines hypertension as "that level of BP at which benefits of action (minus the risks and costs) exceed the risks and costs (minus benefits) of inaction" (p. 3). This definition is plausible when one takes into account the global burden of hypertension and the cost of DALYs to countries at large.

However, defining an age range for YOH is more challenging and the definitions that have been used may sometimes seem arbitrary because there are no specific guidelines for defining the term 'young adult'. From the systematic review conducted for this study, the ages of young adults ranged from as young as 15 years in an East African study (Nsanya et al., 2019) to as old as 45 years in research carried out in the United States and Poland (Leppert et al., 2019; Mierzecki et al., 2014). The difference in the scope of the young adult age group could be due to the population age structure in specific countries. Africa is the world's youngest continent; 60% of the population is under 25 years of age (United Nations, 2011). Therefore, this could be an underlying reason for the definition of young adulthood sometimes starting as young as 15 years in studies in this context. On the other hand, the median age provides an important single indicator of the age distribution of a population. Hence, in contrast, overall, higher-income countries across North America, Europe, and East Asia tend to have a higher median age (Mahmud, Mazalan, Razak, & Rasyidee, 2017) and this could be the reason behind the older age ranges used to define young adults in these studies.

In other disease settings, young-onset diabetes is characterized by an age of diagnosis < 40 years, whereas late-onset diabetes is characterized by an age of diabetes diagnosis ≥

40 years (J. C. N. Chan et al., 2014; Song & Hardisty, 2009). The 40 years old cut-off was based on the use of comparable age strata (20–39 years, 40–59 years, and 60–79 years) in the latest IDF figures on the global prevalence of diabetes (Shaw, Sicree, & Zimmet, 2010). In a review of oncology studies by Coccia (2019), the adolescents and young adults (AYA) group is defined as individuals aged 15–39 years and the older adults group includes those aged ≥ 40 years. In the field of psychology, Erikson (1963), in his work on the eight stages of psychosocial development, defines a young adult as a person between 19 and 39 years of age.

Similarly, in the cardiology setting, specifically in the area of CVD, Andersson and Vasan (2018) define young adults as, in general, individuals aged 18–45 years. Likewise, Egred, Viswanathan, and Davis (2005) term cases of coronary artery disease (CAD) that develop in individuals below the age of 45 years as young CAD. However, various studies have used an upper age limit that ranges from 35 to 55 years in defining young CAD (Aggarwal, Srivastava, & Velmurugan, 2016). With regard to stroke, previously published studies and registries commonly define young adults as those younger than 45 or 49 years (Smajlović, 2015). The overall consensus nonetheless is that high SBP is an important risk factor in the development of CVDs and long-term cumulative BP levels are correlated with increased CVD risk (Bonifonte, Ayer, Veledar, Clark, & Wilson, 2015; Pool, Ning, Wilkins, Lloyd-Jones, & Allen, 2018). Also, hypertensive target organ damage is robustly associated with early-onset hypertension, which emphasizes the importance of assessing the age of hypertension onset in order to prevent target organ damage and overt CVD (Suvila et al., 2019).

In the local Malaysian context and for the purposes of this study, young adults are defined as those aged 18 to 39 years inclusive. The minimum age of 18 was selected because the NHMSs consider those aged ≥ 18 years to be adults (Institute For Public

Health, 2006, 2011, 2015a). Additionally, Section 2 of the Age of Majority Act 1971 determines that "within Malaysia at the age of eighteen years and every such male and female attaining that age shall be of the age of majority" (p. 5). The cut-off of < 40 years was selected as per the latest CPGs published by the MSH (Malaysian Society of Hypertension (2018). This selection was also based on the use of similar age strata in a national study by Y. Zhang and Moran (2017), in which they compared the trends in the prevalence, awareness, treatment, and control of hypertension among young adults (aged 18–39 years) with those for middle-aged (40–59 years) and older (≥ 60 years) adults. The selected cut-off is also in line with several other relevant works (Chen et al., 2004; Choukem et al., 2017; Mangena et al., 2016; M. A. Omar et al., 2016; Sung Sug Yoon et al., 2015). Additionally, collaborators in the latest global burden of disease study on long-term and recent trends in hypertension awareness, treatment, and control in high-income countries among older adults used an age range of 40–79 years to recruit participants for the NCD risk factor component of the study (Zhou et al., 2019). Hence, the utilization of the age range of 18–39 years to define young adults is considered appropriate for this study.

2.6 Living with Young-onset Hypertension

Hypertension affects many aspects of life; each person affected by hypertension is unique and adopts a lifestyle consistent with their beliefs, perceptions, and knowledge (Barros et al., 2014). The results of a systematic review conducted by Marshall, Wolfe, and McKevitt (2012) on qualitative research in this area revealed that among different ethnicities, patients' knowledge on the causes of high BP or aggravation factors are different and varied. These causes included genetics, race, attitudes, and beliefs, as well

as cultural, social, environmental, and economic reasons (Marshall et al., 2012; Tu & Pratt, 2013; Viruell-Fuentes, Ponce, & Alegria, 2012).

In the United Kingdom (UK), a study on hypertension beliefs held by Nigerian immigrants revealed an interesting finding: while most of the respondents believed that the presence of symptoms (such as headaches and palpitations) signified hypertension, some believed that the lack of symptoms equated to the absence of hypertension. This meant that they did not initiate treatment because they believed themselves to be asymptomatic and disease-free (Akinlua, Meakin, & Freemantle, 2017). Therefore, elucidating individuals' views and beliefs about hypertension is crucial as this information can aid in developing and establishing culturally appropriate BP management programmes and care plans.

With regard to barriers to hypertension control, multiple studies have highlighted the numerous factors underlying this issue (Cook et al., 2006; Holland et al., 2008; Gbenga Ogedegbe, 2008; Walsh, Sundaram, McDonald, Owens, & Goldstein, 2008). These factors include patient, provider, and healthcare system factors (O'Connor, 2003; O'Connor, Sperl-Hillen, Johnson, Rush, & Biltz, 2005), low rates of documented lifestyle counselling (Johnson et al., 2015) and significant delays in prescribing initial antihypertensive medication (Johnson et al., 2014a). Additionally, patients stated that the lack of attention given by the health team to the issue of hypertension was one of the key obstacles standing in the way of the success of hypertension-related health programmes (Marshall et al., 2012).

In the local Malaysian setting, a qualitative study conducted by Shima, Farizah, and Majid (2014) explored the experiences of hypertensive patients' with their disease and the factors that influenced them to not adhere to antihypertensive recommendations (diet changes, physical activity, and intake of antihypertensive medication). The study

population consisted of hypertensives of all ages (mean age 49 ± 9.3 years) who were attending government primary health clinic follow-ups. Some of the important results drawn from the study included evident lack of community support, patient and self-empowerment as well as lack of counselling and monitoring procedures by healthcare providers. The applicability of these findings to the younger adult age group specifically still warrants investigation.

Hence, patients' health beliefs, understanding, and knowledge, as well as their perceived barriers to treatment and control (among others), play a significant role in the process of hypertension treatment and in patient adherence to treatment regimens (Izadirad, Masoudi, & Zareban, 2014). Recognition of these factors from the perspectives of patients as based on their experiences will thus lead to a more precise understanding of the disease. This will ultimately assist healthcare professionals in developing effective interventions for the control and treatment of hypertension.

2.7 Research Gaps on Young-onset Hypertension

In developed countries, national and international programmes and initiatives have been remarkably successful in increasing the awareness, treatment, and control of hypertension (Kearney, Whelton, Reynolds, Whelton, & He, 2004). However, in developing countries such as Malaysia, there is a paucity of epidemiological data and information regarding hypertension, especially with regard to YOH. This hampers the development of a systematic and inclusive policy for the management of hypertension among young adults (Kayima et al., 2015).

The epidemiology of hypertension in adults as one entity, as well as in the older adult age group and even among adolescents, has been thoroughly investigated and reported.

Therefore, as elaborated in the foregoing, studies that identify the prevalence, awareness, treatment, control, trends, and risk determinants of hypertension among different populations are explicit and wide-ranging. In the case of young adults however, a focus on YOH has only emerged in the early years of the 21st century, as evidenced by a number of editorials, review articles, and commentaries that highlighted this problem (Chia, 2003; De Venecia et al., 2016; Irwin, 2010; L. S. Neinstein & Irwin, 2013) and research studies based on surveys in urban and rural communities (Kayima et al., 2015; Tadvi & Bandi, 2016), universities (Al-Mohaissen et al., 2017; Dores et al., 2010), and military academies (Gan et al., 2003) in addition to a few national studies (Nguyen et al., 2011; Y. Zhang & Moran, 2017).

Other studies have shown that cumulative exposure to high BP during young adulthood is independently associated with an elevated risk of CVD and all-cause mortality several decades later, regardless of BP level in later life (Gray, Lee, Sesso, & Batty, 2011; Mark J. Pletcher, Vittinghoff, Thanataveerat, Bibbins-Domingo, & Moran, 2016). Hence, recognizing that young adulthood represents an important period for the introduction of early prevention and treatment programmes, certain countries are devoting time and effort to investigate YOH in their populations (Table 2.1), with the common goal of attempting to narrow the knowledge gap on YOH. Nonetheless, no systematic review has yet been performed to gather the evidence from YOH studies in all regions of the world in order to estimate the global prevalence of YOH. Verification that YOH is a global phenomenon will underscore the importance of this issue and hopefully persuade health policymakers and relevant stakeholders to address this public health epidemic as a matter of urgency and to implement early intervention programmes.

Ever since Wilber and Barrow (1972) published their classic paper on the rule of halves in hypertension, more effort has been put into prevention and detection in hypertension

control programmes internationally. Therefore, it would be interesting to investigate if the same rule is applicable in Malaysia, a developing upper-middle-income country, as compared to its counterparts in the Western Pacific Region (Y. Wu et al., 2008) and even globally. In general, it seems that the prevalence of hypertension in the adult population in Malaysia is evolving towards one that reflects the rule of thirds (Rampal et al., 2008). However, as yet, no national studies have been conducted to delve into the pervasiveness of this disease among young adults in Malaysia.

In addition to investigating the depth and breadth of YOH, it is vital to analyse trend data on hypertension prevalence in order to monitor the burden of cardiovascular outcomes and to evaluate the impact of available public health interventions over time. Young adults are distinct from older adults and adolescents in respect of the way in which they respond to prevention and treatment programmes. Yet, research on trends in prevalence, awareness, treatment, and control among young adults remains scarce. Past research did not investigate age-specific patterns in hypertension and primarily concentrated on hypertension among the general population; although when they did, the sample sizes of young adults was limited, therefore preventing reliable assessments of disease patterns in this age group (Guo et al., 2012). Only one study thus far, which was conducted in the United States, has looked exclusively into hypertension trends from 1999 to 2014 among young adults and compared this trend with that for middle-aged (40–59 years) and older (≥ 60 years) adults (Y. Zhang & Moran, 2017).

Identification of the factors influencing the prevalence, awareness, treatment, and control of hypertension, such as sociodemographic, lifestyle, and cardiovascular risk factors, is equally important when seeking to elucidate the epidemiology of YOH (Table 2.2). Not least because the results reported by the aforementioned studies indicate that

these risk factors may be affecting young adults in different ways as compared to older adults and may also affect subpopulations of young adults differently.

A comprehensive systematic review of qualitative hypertension studies in 16 countries focusing on compliance to hypertension therapy among different ethnic groups documented barriers such as disliking hypertension therapy, deliberately halting treatment, and established obstacles to therapy such as time, memory and income (Marshall et al., 2012). However, all of these studies included hypertensives from a broad age group. None solely focused on the perceptions and experiences of young adults living with hypertension.

In conclusion, data on the prevalence of YOH is scarce (Dores et al., 2010), and evidence regarding its risk factors and management is also very limited. Yet, such data is of paramount importance because the increasing incidence of hypertension among young adults calls for early surveillance and prompt treatment to prevent future cardiac events (De Venecia et al., 2016).

2.8 Conceptual Framework

To understand the occurrence of YOH in Malaysia, this study utilizes a conceptual framework adapted from the multilevel eco-epidemiological life course framework for the health, disease and mortality cross-continuum in human populations proposed by Kuate Defo (2014) and the EM of illness framework developed by M. Weiss (1997) and Kleinman et al. (1978) (Figure 2.2).

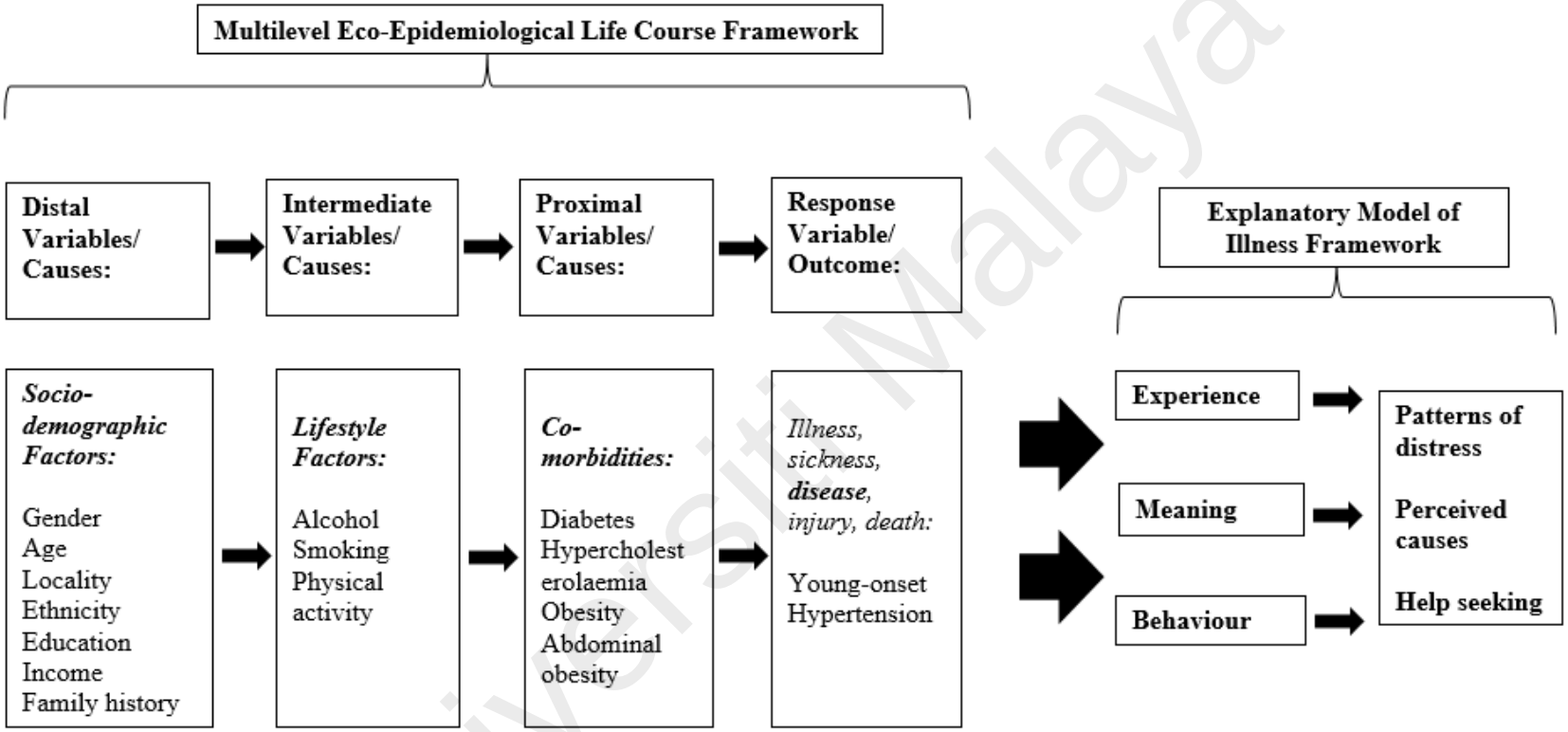

Figure 2.2: Conceptual framework

2.8.1 Multilevel Eco-epidemiological Life Course Framework

The multilevel eco-epidemiological life course framework deepens the understanding of changes in demography and epidemiology which leads to multilevel responses in the healthcare system. This framework links together the processes and mechanisms through which a response or outcome (in this case, the development of YOH) is influenced by proximal pathophysiological causes (individual general health status; existing comorbidities), intermediate causes (environmental influences; lifestyle factors), and distal causes (social and cultural determinants). This framework is formulated to aid in comprehending the processes involved in the design of a research project, planning of health policies and development of effective strategies which can lead to the emergence of healthier communities. Collectively, they have an impact on the health, development of disease, and mortality of a population (Kuate Defo, 2014).

A distal factor is a variable that remotely influences the event outcome. Distal-level variables (multilevel 4) are the conditions/environments and stable dispositional variables that precede the (immediate) proximal and intermediate variables. Environmental mechanisms that influence disease susceptibility in adulthood have been shown to operate throughout the life course which includes the pre-conceptional, conceptional/foetal, and infant phases of life. Distal variables are also known as social determinants of health, according to a theory developed by McKeown (1988) that originated from the belief that socioeconomic factors are the underlying causes of the health of and diseases in populations. The results of the systematic review (Table 2.6) aided the researcher in the selection of the appropriate distal variables. Hence, in the context of this study, the distal variables investigated for their potential association with YOH are gender, age, locality, ethnicity, SES (education and household income) and family history of hypertension.

In a causal pathway, the multilevel 3/intermediate variable is a variable that induces variability in the response variable and is itself caused to vary by the distal variables. These variables include nutrition, lifestyle, behaviours, and medical technology. In the context of this study, the intermediate variables are physical activity, alcohol intake, and smoking.

A multilevel 2/proximal variable is a variable near in occurrence/time to the event or initiation of the behaviour of interest, that is, the outcome variable. Proximal factors include early life health-related conditions, biology, and frailty; functional health and general health status; physical health status; and psychosocial and mental health status. In the context of this study, the proximal variables are cardiovascular risk factors/comorbidities. These variables are pre-existing or concurrent diseases such as DM, hypercholesterolaemia, and obesity.

The response variables (multilevel 1) may include both indicators of burden of disease and population health as well as individual-based measures (disease, injury, and death). In the context of this study, the response variable is the development of YOH.

2.8.2 Explanatory Model of Illness Framework

Research has demonstrated that patient beliefs are important determinants of health outcomes (Beune, Haafkens, Schuster, & Bindels, 2006). An EM reveals how people make sense of their illness and provides a framework whereby researchers and healthcare providers can engage with patients in order to gain a comprehensive understanding of patients' lived experience of illness. This study adapts the EM of illness framework developed by M. Weiss (1997) and Kleinman et al. (1978). This model denotes people's views about the disease aetiology, its progression, the occurrence of symptoms, the significance of the illness, its diagnosis, and therapeutic strategies (Kleinman et al., 1978).

The provider and patient each have their own EM. A practitioner's EM is often grounded in their medical training and represents how providers understand and treat diseases. A patient's EM reflects how they perceive their disease and how they choose to interpret and select therapeutic or preventive recommendations; it is more deeply embedded in the experiences of their ethnicity, culture, family's outlook, and social networks (Fitzpatrick, 1984; Helman, 2007). Consequently, patients and healthcare providers often hold different EMs of the disease onset, aetiology, and progression. Concordance between the EMs of healthcare providers and their patients have been shown to positively impact patient outcomes (M. Weiss, 1997). On the other hand, discordant views can lead to miscommunications, disagreement, reduced compliance with medical advice, or other adverse outcomes (Taylor et al., 2012). The EM is a method used in both the clinical setting and qualitative research as a way to obtain individual explanations of a particular phenomenon and relies on gaining information on patterns of distress, perceived causes and help seeking among patients.

The term patterns of distress refers to the full range of problems associated with a respondent's condition, including symptoms, social and economic disruptions, and stigma. The variable perceived causes refers to ideas held by patients that answer the questions of why and how they have been affected by a particular disease or condition. On the other hand, help seeking refers to the sources people look to in order to find treatment or support, and can include family and informal providers, generalists and specialists practising mainstream Western medicine, and various traditional healers. By using questions to elicit views on these concepts, one can then use the answers to understand patients' experiences, beliefs, and behaviours towards an illness or disease.

The EM provides guidance to clinicians and researchers by stressing the importance of exploring medicinal decision-making, health-seeking behaviours, and beliefs within a

cultural context (Kleinman, 1978). The biggest strength of this approach is that it provides clinicians and researchers the opportunity to elicit illness experiences from their participants in a structured manner. In other words, EMs allow researchers and clinicians to conceptualize how patients interpret and perceive their conditions. Consequently, EMs aid in explaining why some people refuse to comply with a prescribed therapy or reject medication; answers which can help to design appropriate interventions or therapies. This helps health researchers to understand their subjects, thereby improving quality of care. Moreover, the depth of scientific understanding of illness and disease is improved with the utilization of EMs as this method is able to "integrate clinical, epidemiological and social science frameworks" (M. Weiss, 1997). These interview findings can be utilised to enhance quantitative data, thus providing researchers with access to lived illness experiences that would otherwise be overshadowed by statistics and numbers.

2.8.3 Justification of Conceptual Framework

The multilevel eco-epidemiological life course framework was utilized in this study because it was thought to be the most comprehensive framework to incorporate an overview of changing population and disease trends in developing countries (Kuate Defo, 2014). This framework establishes a systematic foundation for the development of a data collection method to reflect the dynamic epidemiological and demographic profiles of global communities and the health system's responses to these changes. Given that a broad variety of hypotheses from various disciplines including climatology, and economics, as well as biomedical, environmental physical and social sciences are included; this framework is considered to be transtheoretical in nature. Of particular significance, the life course perspective is embedded in the framework as it recognizes the fact that the development of most chronic diseases and conditions proceeds over years or decades until the actual disease state is reached. In contrast, other existing frameworks have limitations that include a lack of emphasis on epidemiological transitions, such as

the UK National Institute for Health and Care Excellence's conceptual framework for public health in Kelly et al. (2009); or a predominant focus on death rather than disability and disease causality, such as the epidemiological transition theory developed by Omran (1998).

An understanding of patients' views using EMs is the key to increasing and maintaining compliance to treatment for two reasons. First, understanding patients' EMs of illness effectively addresses their illness concerns, lifestyles, and priorities in the context of their everyday lives which can facilitate the development of culturally appropriate treatment plans (McSweeney, Allan, & Mayo, 1997). This can, in effect, help in encouraging patients to comply with medical recommendations (Garrity, 1981). Second, EMs of illness may illuminate patients' cultural beliefs and contribute to a corresponding improvement in the provider–patient relationship and doctor–patient communication (Dula, 1994) because incongruity between the patients' belief systems and their doctors can be one explanation for poor communication (Betancourt, Carrillo, & Green, 1999). Hence, in light of the above, this framework was chosen for this study over other models of health behaviour change such as the transtheoretical model (Prochaska & DiClemente, 1983), the theory of cognitive dissonance (Festinger, 1957) and the theory of reasoned action (Fishbein & Ajzen, 1977). Finally, when utilised in combination, this conceptual framework holistically combines the mixed-methods components chapter by applying the principles of the EBM triad (Sackett et al., 1996), that is, this study attempts to integrate clinical experience/expertise and patients' unique values and expectations with the best available research information.

2.9 Summary of the Chapter

This chapter assessed the burden of hypertension and highlighted the implications of this NCD among young adults. The results of a rigorously conducted systematic review

of the research pertaining to the sociodemographic, lifestyle, and cardiovascular risk factors that influence YOH were also presented herein. The results of this review in respect of most of the determinants of YOH were as expected. However, the review revealed that several other factors associated with YOH have been explored by certain studies (such as sleep, heart rate, and HIV infection). The results of the systematic review also allowed the researcher to determine that the definition of young adults in this study should encompass those aged 18–39 years.

The review revealed that previous studies have underscored the importance of detecting and mitigating YOH to prevent the progression of detrimental vascular changes that are more difficult to manage when they emerge during advanced years. Nonetheless, despite the significance of identifying and treating YOH, scant data pertaining to its prevalence and determinants exists, thus highlighting a research gap that this study attempts to fill.

In light of the above, it may well be that young adults have a different approach to coping with hypertension compared to their older counterparts. However, in order to identify the barriers and facilitators to hypertension management and control particularly for young adults and subsequently develop successful interventions, it is necessary to elicit the insights of young adults about their experiences of hypertension, especially in the Malaysian context.

Therefore, in order to answer the research question and fulfil the research objectives, this study utilizes a conceptual framework adapted from the multilevel eco-epidemiological life course framework for health, disease and mortality cross-continuum in human populations in order to understand the multilevel development of YOH through the distal, intermediate, and proximal influences of certain variables. In addition, this study also employs the EM of illness framework to explore the medicinal decision-

making, health-seeking behaviours, and beliefs of young adults within a cultural context. These two models are employed in combination because when linked together sequentially it is envisaged that they will be able to help explain the phenomena behind the quantitative findings of this study.

CHAPTER 3: METHODOLOGY

To fulfil the objectives of this study, the methodology comprised three phases. In Phase I, a systematic review was conducted to answer the first specific research objective. The purpose of this review was to collate and synthesize the information and data required to enable decisions to be made in respect of the operational definitions and variables for Phase II, the secondary data analysis. The systematically gathered evidence helped to select the appropriate age range of YOH that was utilized in this study, which it was determined should include adults aged 18–39 years. Furthermore, the results of the review assisted in identifying a comprehensive set of variables for Phase II. The methodology and output of Phase I was elaborated in Chapter Two in great detail. Hence, this chapter will focus on the methods employed in Phases II and III.

In Phase II, an analysis of the secondary data derived from three NHMSs was performed to achieve the second and third specific research objectives. This approach was adopted in view of the duration of the Doctor of Public Health (DrPH) programme, which restricted the feasibility of determining trends in YOH with regard to prevalence, awareness, treatment, control, and risk determinants over a period of ten years, meaning that it was only possible to achieve this goal by extracting data from studies that had already been conducted.

Following on from Phase II, Phase III was constructed to explore the phenomena that may lie behind certain aspects of the results obtained in Phase II, that is, the experiences and perspectives of young hypertensive adults that influence the awareness, treatment, and control rates of YOH in Malaysia. Specifically, a qualitative study was undertaken to explore young Malaysian adults' unique perspectives about living with hypertension. In-depth interviews were conducted to elicit young Malaysian adults' understandings of

hypertension, their personal experiences of living with a chronic disease, the factors influencing their treatment adherence and their needs in managing hypertension.

3.1 Phase II Method – Quantitative Study: Secondary Data Analysis

3.1.1 Study Location

Situated in Southeast Asia, Malaysia consists of two regions separated by some 640 miles of the South China Sea. Classified as an upper-middle-income economy, Malaysia is a multi-religious, multi-ethnic federation of 13 states and three federal territories boasting a population of 32.6 million (Department of Statistics Malaysia, 2019). Based on the 2010 Population and Housing Census of Malaysia (Census 2010), those aged 15–39 years constitute 40% of the country's total inhabitants (Department of Statistics Malaysia, 2010). Geographically, all three of the NHMSs utilized in this study cover all the areas, both urban and rural, in the 13 states (Johor, Kedah, Kelantan, Melaka, Negeri Sembilan, Pahang, Penang, Perak, Perlis, Selangor, Terengganu, Sabah, and Sarawak) and three federal territories (Labuan, Kuala Lumpur, and Putrajaya) of Malaysia (Figure 3.1).

Figure 3.1: Map of Malaysia

Source: Maps of World (2015)

The NHMS is a cyclical survey commissioned by the Ministry of Health (MoH), Malaysia, to provide community-based data on the patterns of common health problems, health service utilization, and health expenditures of the population (Institute For Public Health, 2015a). First initiated in 1986, it was conducted once every ten years until NHMS III in 2006, following which it was shortened to a four-yearly cycle to ensure the collection of timely data to facilitate the design of effective health programmes. It is now partway through its sixth cycle (NHMS VI), which runs from 2019 to 2022. The findings from this large government-funded study assist the MoH in the allocation of resources, review of health programmes, and evaluation of the impact of health strategies (Institute For Public Health, 2015a).

3.1.2 Study Population

For the purposes of this study, the data on the study population was extracted from NHMSs III, IV, and V, which were conducted in 2006, 2011, and 2015, respectively.

3.1.2.1 National Health and Morbidity Survey

The first NHMS commenced in 1986 with the aim of providing data on the trend of expenditure, needs and problems pertaining to community health. The primary goal was to allow the MoH to evaluate the effectiveness of health programmes, examine the effect of its different health policies, and determine the potential distribution of future resources. The scope of the survey included uptake of health care utilization, coverage of immunization activities, morbidity rates, health expenditure, diabetes, hypertension, smoking, asthma, and injuries. The penultimate survey, which was partially supported by a WHO grant, was spearheaded by the IPH and only focused on Peninsular Malaysia (Institute For Public Health, 1986).

The second NHMS (NHMS 2) was conducted ten years later in 1996. It was funded by the Intensification of Research in Priority Areas Programme, which was a fund

administered by the Government of Malaysia and the MoH. The need for this second survey was identified during a discussion on research priority areas for the Seventh Malaysia Plan. The scope of this survey covered health-seeking behaviour, load of illness, cost of healthcare consumption, health-related lifestyles (breast examination, pap-smear examination, breast-feeding practices, alcohol intake, exercise, smoking, adolescent risky behaviour, sexual practices, and substance misuse), as well as specific health conditions (hypertension, DM, blood cholesterol level, asthma, acute respiratory infections, injury, cancer, and physical impairments). This survey covered the whole of Malaysia, that is, Peninsular Malaysia as well as Sabah and Sarawak (Institute For Public Health, 1996).

The third NHMS was carried out by the IPH in 2006. The survey covered similar topics to those in the first two NHMSs, with the addition of some new areas such as women's health, infant feeding, prevention of dengue, and psychiatric morbidity (Institute For Public Health, 2006). However, the ten-yearly format of the survey was deemed untimely for the coordination of health programmes. At the beginning of 2010, the Minister of Health reflected on the long interval between each cycle and proposed that the surveys should be conducted more frequently to ensure access to up-to-date information for policymakers, specifically in support of the five-yearly Malaysia Plans and the implementation of healthcare transformation strategies.

Hence, beginning with the fourth NHMS in 2011, the survey is conducted in four-yearly cycles with annual data collections. The fourth and subsequent NHMSs have similar overall scope to previous NHMSs and this scope is addressed in the first year of the survey cycle, following which various focus areas are addressed throughout the next three years. Currently, the NHMSs focuses primarily on national prevalence, which has resulted in reduced sample sizes relative to previous NHMSs. Hence, the fourth NHMS was implemented on a 2011–2014 cycle, where NHMS 2011 examined similar issues to

those included in the previous NHMSs but with the addition of new modules such as mental health problems among adults and children, as well as home injuries (Institute For Public Health, 2011).

Then, NHMS 2015 was the first survey conducted in the new NHMS cycle for the 2015–2018 period. Specifically, NHMS 2015 encompassed a majority of the scopes in NHMS 2011 especially those related to healthcare demands and NCDs plus an additional traditional and complementary medicine (T&CM) module (Institute For Public Health, 2015a).

The NHMS study population encompasses respondents from all age groups (0 to 75+ years). The methodological approaches used for a population survey of this type (from the planning of the survey to the determination of sample size, sampling design, development and validation of questionnaires, data collection techniques, quality assurance measures, and data processing) ensure the retrieval of valid and quality data that is representative of the Malaysian population (Fadhli et al., 2013)

In NHMS 2006, the age ranges were categorized into ten-year age bands (0–9, 10–19, 20–29, etc.). However, in NHMS 2011 and 2015, five-year age bands were utilized (0–4, 5–9, 10–14, etc.). The total sample size in each cohort was 56,710, 26,498, and 29,460 respondents for NHMS 2006, 2011, and 2015, respectively. With regard to the present analysis, the data on young adults was extracted from these three NHMSs by using two inclusion and two exclusion criteria.

3.1.2.2 Inclusion Criteria

i. Any individual aged 18–39 years within the selected living quarters (LQs)

ii. Individuals residing in Malaysia for at least two weeks prior to data collection.

3.1.2.3 Exclusion Criteria

i. Institutionalized populations, for example, those residing in hotels, hospitals, prisons, etc.

ii. Pregnant women.

3.1.3 Study Design

The study design used for NHMSs 2006, 2011 and 2015 was cross-sectional. Sampling was conducted using a two-stage stratified random selection procedure that was applied throughout Malaysia and provided by the Department of Statistics Malaysia (DOSM). Enumeration blocks (EBs) were considered the first stage sampling unit and, within each sampled EB, the LQs were chosen as the second stage sampling unit. All eligible individuals in these households within each selected LQ were included in the study. Criteria for eligibility is based on individual surveys or sub-surveys. To be eligible for the hypertension module in the NHMS, respondents were required to be ≥ 18 years (Institute For Public Health, 2006, 2011, 2015a).

3.1.4 Sampling Frame

The DOSM also provided the sampling frame, which was updated in 2004, 2010 and 2014 (prior to each NHMS). In Malaysia, the EBs are geographically contiguous areas of land with identifiable boundaries. Each EB holds 80 to 120 LQs with an average population of 500 to 600 persons in each LQ (Institute For Public Health, 2006, 2011, 2015a). The EBs are categorized further into either rural or urban areas according to the DOSM classification which is derived from the population composition of the gazetted areas in the years 2004, 2010 and 2014. An urban area is defined as a gazetted area with a combined population of ≥ 10,000; a rural area is defined as a gazetted area with a combined population of < 10,000 (Munn, Moola, Riitano, & Lisy, 2014; Murphy et al., 2016; Murray et al., 2015).

3.1.5 Sample Size Calculation

The sample size was determined using a single proportion formula to estimate the prevalence (Pourhoseingholi, Vahedi, & Rahimzadeh, 2013):

$$n = \frac{Z^2 \times p\,(1-p)}{M^2}$$

Where:

n = sample size for an infinite population

Z = Z statistics for the level of confidence (set at 1.96 for a 95% confidence level)

p = population proportion (assumed to be 0.5 or 50% for maximal sample size)

M = margin of error (set at 3% or 0.03 for maximal sample size).

Hence, the calculation gives $n = [1.96^2 \times 0.5\ (1–0.5)]\_/0.03^2 = 1068$.

As the study participants were chosen by cluster selection procedures (households), a greater level of similarity was expected among the respondents within a group than in the general population. This selection method leads to a loss of precision, which needs to be compensated by increasing the sample size. Hence, the principle followed was that the total estimated variance may have been reduced as a consequence of cluster selection (Martínez-Mesa, González-Chica, Bastos, Bonamigo, & Duquia, 2014). Thus, the value 2 was applied to represent the design effect, which gave a minimum sample size (n) = 1068 x 2 = 2136.

The sample size for each variable associated with YOH was calculated independently, with the CI and the power of the study set at 95% and 80%, respectively. The ORs were

obtained from various studies that had been conducted locally and internationally (Gan et al., 2003; Gupta et al., 2013; Rampal et al., 2008; Son et al., 2012; J. Wang et al., 2014). All calculations were conducted using Epi Info™ version 7.2 (Centers for Disease Control and Prevention, United States) (Dean, Sullivan, & Soe, 2013) with the aim of obtaining equal samples of exposed and unexposed groups as well as taking into consideration that one in three adults develop hypertension (Guest, Bunce, & Johnson, 2006) (Table 3.1).

Table 3.1: Estimated Sample Sizes for Factors Associated with Young-onset Hypertension

Associated Factor	Odds Ratio	Sample Size
Age ≥ 30 years	2.4	194
Male gender	1.8	426
Urban areas	1.4	1300
Ethnicity – Other Bumiputeras	1.3	2142
No formal education	2.1	268
Low household income	2.57	564
Family history	1.8	1602
Alcohol intake	1.4	1300
Smoker	1.3	2142
Physical inactivity	1.4	1300
Diabetes mellitus	4.4	72
Hypercholesterolaemia	3.0	128
Obesity (BMI ≥ 30)	8.1	40
Abdominal obesity	5.8	54

From the results in Table 3.1, the selected minimum sample size required to ascertain whether the considered factors were associated with YOH was 2142, which also satisfied the minimum sample size required for a prevalence study (Pourhoseingholi et al., 2013). It was important to conduct sample size calculations for each subgroup as stated in Table 3.1 in order to ensure that the sample sizes in the secondary dataset provided sufficient power to investigate the new research questions (which are different from the NHMS objectives) (Boo & Froelicher, 2013). All calculations were conducted by the PI.

3.1.6 Study Variables

3.1.6.1 Dependent Variables

i. Young-onset hypertension

ii. No hypertension

3.1.6.2 Independent Variables

i. Gender

ii. Age group

iii. Locality

iv. Ethnicity

v. Education level

vi. Household income

vii. Family history

viii. Alcohol intake

ix. Smoking status

x. Physical activity

xi. Diabetes mellitus

xii. Hypercholesterolaemia

xiii. Obesity

xiv. Abdominal obesity

3.1.6.3 Confounders

Sociodemographic, lifestyle, and cardiovascular risk factors were all potential confounders. Therefore, during the statistical analysis, adjustments were performed to examine associations between the dependent and independent variables.

3.1.6.4 Operational Definitions

The working definitions for the variables are presented in Tables 3.2–3.5.

Table 3.2: Operational Definitions for Dependent Variables

Variable	Definition
Hypertension	The definition of hypertension used in this study was individuals who reported a pre-existing diagnosis of hypertension, were receiving BP-lowering treatment, or had an average SBP of 140 mmHg and/or an average DBP of 90 mmHg or greater, as classified by the JNC 7 (Chobanian et al., 2003).
Young-onset hypertension	Respondents aged 18–39 years were classified as having YOH if they met any of the criterion above.
Awareness	Awareness of hypertension also called 'known hypertension' was defined as the respondent having been told they have hypertension by a medical doctor or paramedic (Institute For Public Health, 2008, 2011, 2015a).
Treatment	Treatment was defined as the self-report of respondents that they were taking antihypertensive medication (Institute For Public Health, 2006, 2011, 2015a) or receiving advice for hypertension (e.g., to lose weight, reduce salt intake, start or do more exercise) (Institute For Public Health, 2011, 2015a).
Control	Controlled hypertension was defined as respondents with hypertension having a desirable BP level (< 140/< 90 mmHg) (Institute For Public Health, 2008).

Table 3.3: Operational Definitions for Sociodemographic Variables

Variable	Definition
Gender	Gender was documented as male or female.
Age	Age was documented based on date of birth.
Locality	Locality was categorized as either rural or urban based on the DOSM definition.
Ethnicity	Ethnicity was categorized as Malay, Chinese, Indian, Other Bumiputeras (other indigenous natives apart from Malay natives) or Others (any Malaysians other than the four ethnicities above). Examples of Other Bumiputeras include the Iban, Senoi, Bajau, Murut, and Kadazan/Dusun peoples in the West Malaysia states of Sabah and Sarawak. Examples of the Others category include people of Eurasian, Indonesian, Thai, Filipino, and Myanmar ethnicities who have settled in Malaysia over time (Department of Statistics Malaysia, 2010; Nagaraj, Tey, Ng, Lee, & Pala, 2015).
Education	Education was categorized as no formal/none, primary, secondary, tertiary, or unclassified (other education level not fitting into the aforementioned categories).
Household income	Household income was defined according to DOSM categories (Department Of Statistics Malaysia, 2016b) as either T20 (top 20%) with a median household income of ≥ RM 13,148; M40 (middle 40%) with a median household income of ≥ RM 6,275 or B40 (bottom 40%) with a median household income of ≥ RM 3,000; otherwise colloquially termed as upper, middle and lower classes.
Family history	Respondents were classified as having a positive family history of hypertension if they answered yes to the question: "Have any of your parents/siblings been diagnosed or treated for high BP?"

Table 3.4: Operational Definitions for Lifestyle Variables

Variable	Definition
Alcohol intake	Within the scope of the NHMS, drinking alcohol was defined as the consumption of any drink containing ethanol irrespective of concentration and those consumed for medical purposes such as alcoholic tonic. The Alcohol Use Disorder Identification Test (AUDIT) (World Health Organization, 2001) was utilized and will be explained in a later section.
Smoking status	A smoker was defined as a person who smokes any tobacco product (including smokeless tobacco products) occasionally or daily (A. Omar et al., 2013).
Physical activity	Physical activity was defined as expenditure of energy by skeletal muscles (Moher et al., 2009). This included activities such as travelling, playing, working, and engaging in recreational pursuits.

Table 3.5: Operational Definitions for Cardiovascular Risk Factors

Variable	Definition
Diabetes mellitus	Respondents who had either known or undiagnosed diabetes mellitus were categorized as having this cardiovascular risk factor. Known diabetes was defined as self-reported or being informed to have diabetes by an assistant medical officer or a doctor. Undiagnosed diabetes was defined as the respondent not being known to have diabetes but who was found to have a fasting capillary blood glucose of ≥ 6.1 mmol/L (or non-fasting blood glucose of > 11.1 mmol/L) (Mustapha, Ghani, Tan, Wan Mohamed, & Siew Swee, 2014) when tested during the interview.
Hypercholesterolaemia	Respondents who had either known or undiagnosed hypercholesterolaemia were categorized as having this cardiovascular risk factor. Known hypercholesterolemia was defined as self-reported or being informed to have hypercholesterolaemia by an assistant medical officer or a doctor. Undiagnosed hypercholesterolemia was defined as the respondent not being known to have hypercholesterolaemia but who was found to have a total fasting capillary blood cholesterol of ≥ 5.2 mmol/L (National Institutes of Health, 2002) when tested during the interview.
Obesity	Obesity was defined according to WHO guidelines as having a BMI of ≥ 30 (Institute For Public Health, 2008, 2011, 2015a).
Abdominal obesity	Abdominal obesity was defined as having a WC of ≥ 90 cm in men and ≥ 80 cm in women (World Health Organization, 2008).

3.1.6.5 Scales of Measurement

The scales of measurement utilized in this study are presented in Table 3.6.

Table 3.6: Scales of Measurement

Variable	Scales of Measurement
Blood pressure	Blood pressure was measured according to WHO recommendations (Institute For Public Health, 2015a). The average measurements of two readings of SBP and DBP taken 15 minutes apart in a sitting position by trained nurses with the Omron Digital Automatic BP Monitor Model HEM-907 were utilized.
Alcohol use	Data on alcohol was obtained through the WHO-designed AUDIT which was wholly self-administered (World Health Organization, 2001). For the purposes of this study, two measurements were used: (i) alcohol intake – *yes* included 'risky drinkers' (respondents with an AUDIT score of between 8 and 40 and those who consumed alcohol in excess of WHO low-risk guidelines); (ii) alcohol intake – *no* included 'low-risk drinkers' (respondents with an AUDIT score of between 0 and 7 and those who consumed alcohol up to the AUDIT cut-off point set by the WHO).
Smoking	The global adult tobacco survey (GATS) questionnaire (short version) (A. Omar et al., 2013) was utilized. Respondents were classified as smokers if they answered yes to the following two questions: "*Have you ever smoked shisha, cigarettes, cigars or pipes?*" and "*Do you currently smoke?*" Those who answered no to the question "*Have you ever smoked shisha, cigarettes, cigars or pipes?*" were classified as non-smokers.
Physical activity	The short version of the international physical activity questionnaire (IPAQ, 2005) was used to classify respondents into one of the following three levels of physical activity: low, moderate or high. In the context of this study, those who did not fit the description of 'moderately active' or 'highly active' were categorized as physically inactive, whereas those who met the criteria were categorized as physically active.
Diabetes mellitus	The Accutrend GC (Roche Diagnostics, Germany), which is a diagnostic battery-operated gluco-photometer, was used to assess capillary blood glucose via finger-prick test in 2006; the Cardiochek® PA Analyzer (PTS Diagnostics, United States) was used in 2011 and 2015.
Hypercholesterolaemia	The Accutrend GC (Roche Diagnostics, Germany) was used to assess capillary blood cholesterol via finger-prick test in 2006; the Cardiochek® PA Analyzer (PTS Diagnostics, United States) was used in 2011 and 2015.
Obesity	To assess the weight of the respondents to the nearest 0.1 kg, a digital weighing scale (Tanita, Japan) was used. The standing height to the nearest 0.1 cm was measured using the SECA Portable Stadiometer (SECA, Germany).
Abdominal obesity	SECA measuring tape (SECA 201, Germany) was used to measure waist circumference.

3.1.7 Study Instruments

3.1.7.1 Questionnaire and Instrument Validation

(a) ***Omron Digital Automatic Blood Pressure Monitor Model HEM-907***

The Omron Digital Automatic BP Monitor Model HEM-907 that was used for BP measurements in all three surveys had previously been validated by El Assaad, Topouchian, Darne, and Asmar (2002) according to the international validation protocol (O'Brien, 2000). The validation study was divided into two phases and the Omron HEM-907 passed both phases.

(b) ***Alcohol Use Disorders Identification Test***

The WHO developed the AUDIT to identify individuals exhibiting the full range of alcohol misuse. In this study, the validated Malay version of the test (AUDIT-M) (S.-I. Wu et al., 2008) was utilized.

(c) ***Global Adult Tobacco Survey Questionnaire***

The GATS serves as a global standard for systematically tracking key tobacco control indicators and monitoring adult tobacco use. Malaysia has also participated in this survey. The adapted GATS questionnaire that has been used in Malaysia was translated, back-translated, and field pre-tested. The GATS Questionnaire Review Committee then reviewed and approved the final version of the questionnaire (A. Omar et al., 2013). A short version of this GATS questionnaire has been used in the NHMSs.

(d) ***International Physical Activity Questionnaire***

The use of the IPAQ short form is advocated for the monitoring of physical activity levels at the national level (Craig et al., 2003). In the IPAQ, the overall physical activity level is estimated by evaluating three categories of physical activity (walking, moderate-intensity activities, and vigorous-intensity activities) across a broad set of domains. The

English version of the IPAQ (Craig et al., 2003) that had been translated into the national language of Bahasa Malaysia and validated (Teh et al., 2014) was utilized in this study.

(e) ***Cardiochek® PA Analyzer***

Fasting blood glucose and cholesterol was assessed via finger-prick test using the Cardiochek® PA Analyzer (PTS Diagnostics, United States). This instrument was validated in a study among 252 clients to compare reference laboratory measurements with abnormal levels of blood glucose and total cholesterol. Pearson correlation coefficients were fair to moderate and yielded statistical significance (Ani, Nadiah, Azah, Akmal, & Tahir, 2012).

3.1.8 Methods of Secondary Data Collection

In order to obtain secondary data from the IPH, a brief research proposal together with a formal letter of application was submitted to the Director of the IPH and to the DG of Health, Malaysia for approval. The flow chart of the data application process is shown in Figure 3.2.

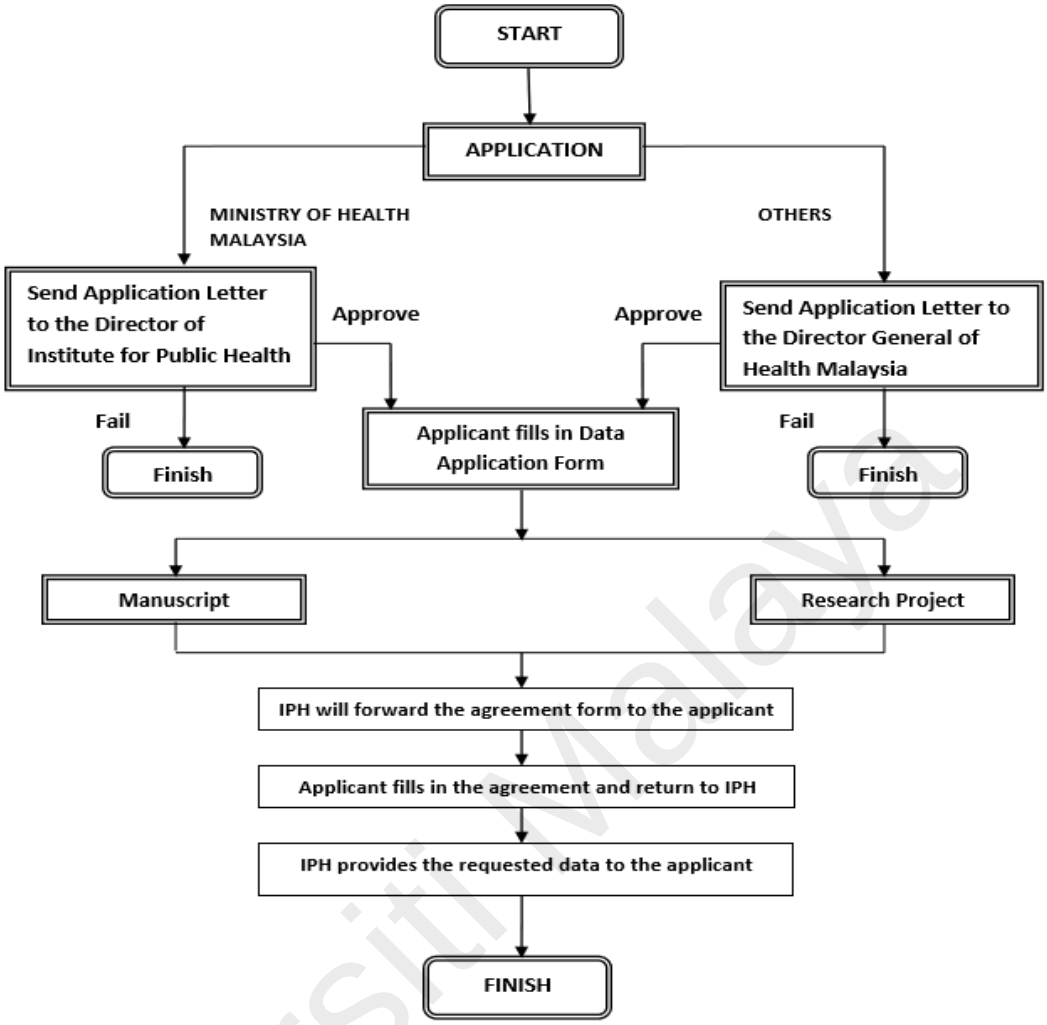

Figure 3.2: Flow chart of application process for access to data held by the Institute for Public Health

When approval had been acquired, the secondary data from NHMSs 2006, 2011, and 2015 were obtained from the IPH. The approval letter from the DG of Health can be found in Appendix C.

3.1.8.1 Data Processing and Management

The sampling design and sampling frame used in the NHMS have been described in subsections 3.1.3. and 3.1.4, respectively. The sample size calculation used for the original study data and further methodological details are described elsewhere (Fadhli et al., 2013). The researcher recalculated the minimum sample size required for a prevalence

study and to ascertain factors associated with YOH, as detailed in subsection 3.1.5 and Table 3.1. The operational definitions, scales of measurements, and study instruments that were used in this study were in accordance with NHMS manuals.

First, data on young adults aged 18–39 years was extracted from NHMSs 2006, 2011, and 2015. Next, in order to ensure that familiarization with the original studies and data from the three NHMSs was at the forefront of data collection and processing, the researcher read all the NHMS technical manuals and reports. In addition, the questionnaires and interview protocols were examined to identify the skip patterns used for the coding of missing data as well as to determine whether identical constructs were considered (e.g., measurement scales and interview questions that had changed over time).

3.1.8.2 Missing Data Analysis

All the dependent variables (YOH and no YOH) and independent variables (socio-demographics, lifestyle factors, and comorbidities) were checked for missing values. Patterns for missing values were identified to determine whether they were missing completely at random (MCAR), missing at random (MAR), or missing not at random (MNAR) (Little & Rubin, 2019). The analysis of missing data revealed that from all three NHMSs, ten variables had missing values (Table 3.7), with the percentages of missing values ranging from 0.3% to 20.8%.

Table 3.7: Missing Values Recorded for Selected Variables in the Three NHMSs (n = 34,149)

Variables	Type	Missing values	%
Distal	**Sociodemographic factors**		
	Education	189	0.6
	Household income	765	2.2
Intermediate	**Lifestyle factors**		
	Alcohol	7099	20.8
	Smoking	354	1
	Physical activity	608	1.8
Proximal	**Comorbidities**		
	DM	392	1.1
	Hypercholesterolaemia	1117	3.3
	Obesity	2490	7.3
	Abdominal obesity	2423	7.1
Response	**Outcome**		
	Young-onset hypertension	116	0.3

According to Dawson (2003), alcohol intake is considered a 'sensitive behaviour', and more so in a Muslim country such as Malaysia. Hence participants in the NHMSs may not have been as forthcoming in their responses to the alcohol-related questions, which would then account for the large number of missing data for this variable. Based on this prior scientific knowledge, and the examination of missing values (Table 3.7) which revealed that responses on key items differed greatly, we proceeded under the assumption that the missing data was MNAR. This means that the missing data mechanism is said to be non-ignorable and thus, it must be modelled to get good estimates of the parameters of interest (Soley-Bori, 2013). Therefore, multiple imputation was used to address the issue of missing data in this study. This method was chosen because it has the following advantages:

i. It has been shown to be superior in accuracy as compared to the dropping of cases or the use of hot deck imputation (Langkamp, Lehman, & Lemeshow, 2010).

ii. It increases the efficiency of estimation using imputation values which are randomly drawn attempts to represent the distribution of the data (Rubin, 2004).

iii. It results in a valid statistical inference (Rubin, 1996) because it analyses missing data in a way that allows for uncertainty about the missing data by creating several different plausible imputed data sets and appropriately combining the results obtained from each of them (Sterne et al., 2009).

iv. It has been shown to produce results that are unbiased and valid estimates, while preserving the sample size and statistical power (McCleary, 2002).

The complete multiple imputation analysis of the NHMS data was performed in three steps. First, an imputation model was created with the variables identified as having missing values (Table 3.7) by computing the proportions of missing values for said variables, and determining the nature of the reason for the missing values (e.g., sensitive questions, data entry errors) (Soley-Bori, 2013). Second, all the key analysis variables which consisted of other variables that were correlated with the analysis variables and those that predicted item missing data were included. Subsequently, the *m* complete data sets ($m = 5$) were analysed using standard procedures (Heeringa, West, & Berglund, 2010). Third and finally, the parameter estimates from each imputed data set were combined to get a final set of parameter estimates. The missing data was addressed using Stata Software version 15 (StataCorp, United States). The data management and processing procedure is summarized in the following flow chart (Figure 3.3).

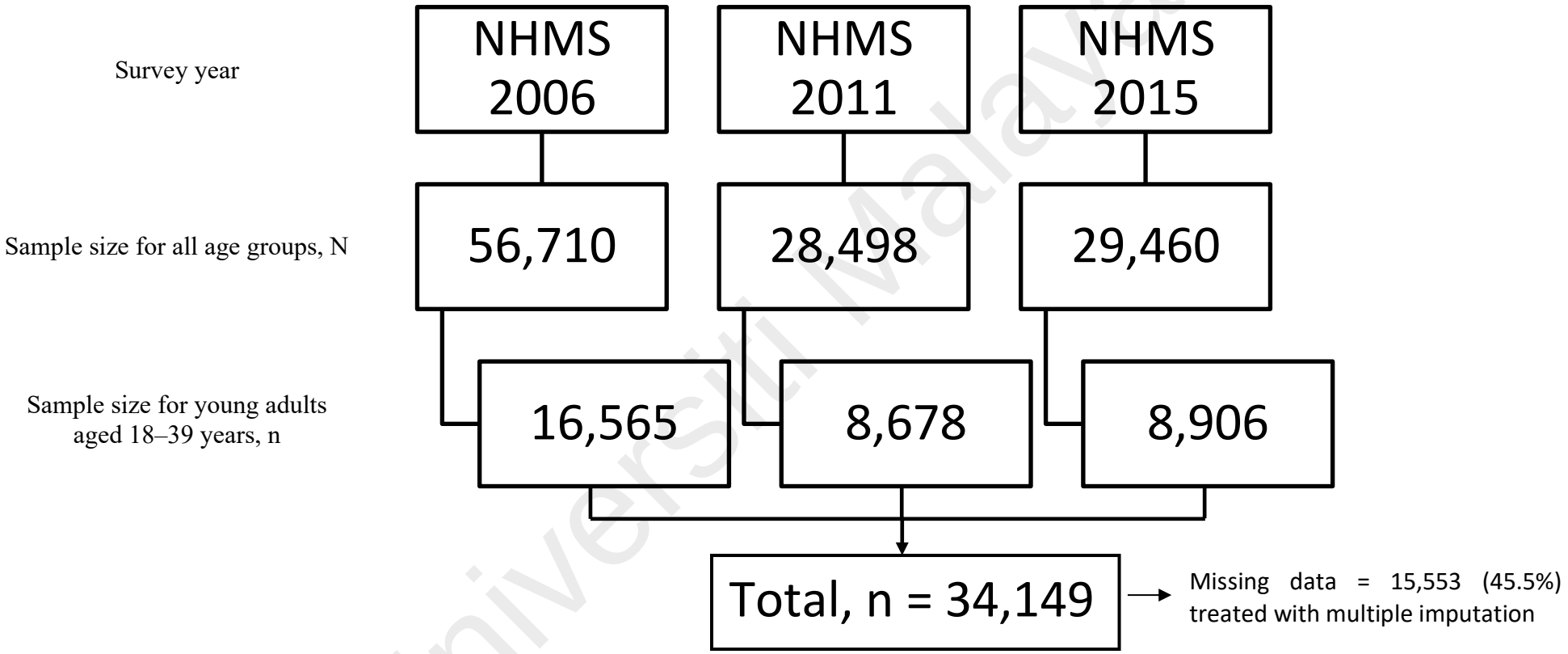

Figure 3.3: Flow chart of data processing and management procedure

Following on from this, variables were recoded and new variables created when there was disagreement with the original conceptualization, for example, the age group and household income variables were recategorized. The researcher produced proper documentation by creating an electronic codebook that included the recoded as well as the original variables of interest. The original data file was kept unaltered while all data of interest were moved to a new file.

3.1.9 Data Analysis and Interpretation of Results

First, the age-adjusted prevalence of hypertension and the percentage of awareness, treatment, and control among young adults were calculated using the 2010 census data, obtained from the DOSM. This allowed comparisons across different survey cycles. In addition to crude prevalence, the prevalence estimates were weighted to represent the total young adult population in Malaysia throughout the three NHMS cycles. Synthesized weights were determined by generating the following three components: population weight, non-response weight, and sampling weight. These weights were used to adjust for differential response proportions, differential selection probabilities, and deviations in the sample compared with the standard population, especially with regard to age and gender composition. The Statistical Package for the Social Sciences (SPSS) ® version 20.0 (IBM, United States) was utilized to conduct the statistical analyses.

Diagnostic descriptive analyses were performed on all variables. These analyses encompassed measures of central tendency, measures of dispersion, data distribution, extreme values, and data normality. Apart from household income, which was presented as median because of the high skewness, continuous variables were presented as mean and standard deviation. Categorical variables were reported as frequencies and percentages. Frequency distribution and cross-tabulation were used to illustrate the sociodemographic characteristics of the respondents.

The associations between YOH and baseline characteristics were assessed using univariate analysis. The Chi-square test was conducted for categorical variables and an analysis of variance was done for continuous variables. As for the multivariate analysis, all potential confounding factors were adjusted for using multiple logistic regression. Each category of the predictor variables was contrasted with the initial category (reference category). The adjusted measure of the association between the risk factors and hypertension was expressed as an aOR with a 95% CI. Adjusted ORs with 95% CI that did not include 1.0 were considered significant and independently associated with high BP. The adjusted values for awareness, treatment, and control of YOH were demonstrated for the study population. Statistical significance was set as a p-value < .05.

3.2 Phase III Method – Qualitative Study: In-depth Interviews

The objective of Phase III was to explain the phenomena behind certain aspects of the quantitative results, that is, to explore the experiences and perspective of young hypertensive adults that could have led to the awareness, treatment, and control rates obtained in Phase II. Hence the results of Phase III were used to complement and reinforce the quantitative data of Phase II, thus providing evidence on the lived illness experiences of young hypertensive adults that would otherwise have been overshadowed by statistics and numbers.

3.2.1 Study Type and Design

This study utilized a qualitative approach by employing interpretive phenomenological analysis (IPA). Qualitative methods aim to pursue differences in experiences and perspectives in order to facilitate the development of themes (Crabtree & Miller, 1999; Yamazaki et al., 2009). Out of the five approaches to qualitative research described by Creswell and Poth (2017), the researcher utilized the phenomenological approach, which

can generally be described as inductive in nature, involving a naturalistic interpretative, approach to the subject matter, because it most closely aligned with the objectives of the study.

A modern way of conducting phenomenological research is to use IPA (Tuffour, 2017). Interpretive phenomenological analysis has two primary aims: to examine in detail how participants are making sense of their personal and social world (i.e., in this context their lived experiences of illness), and to provide interpretations of the accounts to understand the experiences (J. A. Smith, Flowers, & Larkin, 2009). The approach is phenomenological in that within a particular group, the commonality of a lived experience is emphasized (Creswell & Poth, 2017). This type of analysis involves detailed examination of the participant's life-world in an attempt to explore personal experience and is concerned with the individual's personal perception or account of an event. Generally, interviews are performed on a group of participants with first-hand knowledge of an experience, situation, or event. The objective is to answer two main questions: "What contexts or situation have typically influenced your experiences of the phenomenon?" (Creswell & Poth, 2017) and "What have you experienced in terms of the phenomenon?" (Moustakas, 1994). The phenomenological method was utilized to generate disease domains of hypertension as it has been proven to be a highly effective way of evoking and interpreting the sense of a given phenomenon (Taylor et al., 2012).

At the same time, IPA places an emphasis on hermeneutics, which is the art and science of interpretation or meaning. An IPA researcher is said to engage in 'double hermeneutics', in that the researcher is making sense of the participants' sense-making (Tuffour, 2017). Hence the researcher assumes a central role in the analysis and interpretation of the participants' experiences (J. A. Smith et al., 2009). This approach is a dynamic process in which the researcher plays an active role in terms of opening up

new insights, revisions, interpretations, and reinterpretations of the participants' experiences. Insightful interpretative perspectives of the participants' lived experiences can be obtained when utilizing the hermeneutic underpinnings of IPA, as this approach allows researchers the ability to probe beyond surface-level description of findings by reading in between the lines for deeper understanding (Finlay, 2011; Peat, Rodriguez, & Smith, 2019).

Interpretive phenomenological analysis is explicitly idiographic in its commitment to the detailed analysis of a phenomenon under investigation (Shinebourne & Smith, 2010) because each case is analysed in turn, prior to the moving towards making more general claims (J. A. Smith et al., 2009). When researchers engage in this method of qualitative enquiry it facilitates their construction of insightful interpretative accounts of patient experiences that can enrich understanding and bring to light prominent matters within healthcare (Peat et al., 2019).

3.2.2 Study Population and Sampling

The results from Phase II were used to inform the selection of the study population in Phase III. Multivariate analysis revealed that young adults from rural localities were more likely to develop YOH in 2006, but the converse was found for 2015. Trend analysis indicated that there was an increase in YOH among young adults from urban areas from 2006 to 2015, a result that was statistically significant, aOR, 1.15, [95% CI 1.03, 1.27]. Additionally, according to DOSM data, 77.8% of the Malaysian population currently resides in urban areas, and this percentage has steadily increased since 1955 (Figure 3.4) with 66.9% and 19.7% of the increase due to urban–urban and rural–urban migration, respectively (Department of Statistics Malaysia, 2018). Hence, participants for Phase III of this study were recruited from the Department of Primary Care Medicine (RUKA) at UMMC, a semi-governmental medical institution in Pantai Dalam, Kuala Lumpur that

caters to patients who live in predominantly urban areas. Participants residing from rural areas were not included in this study.

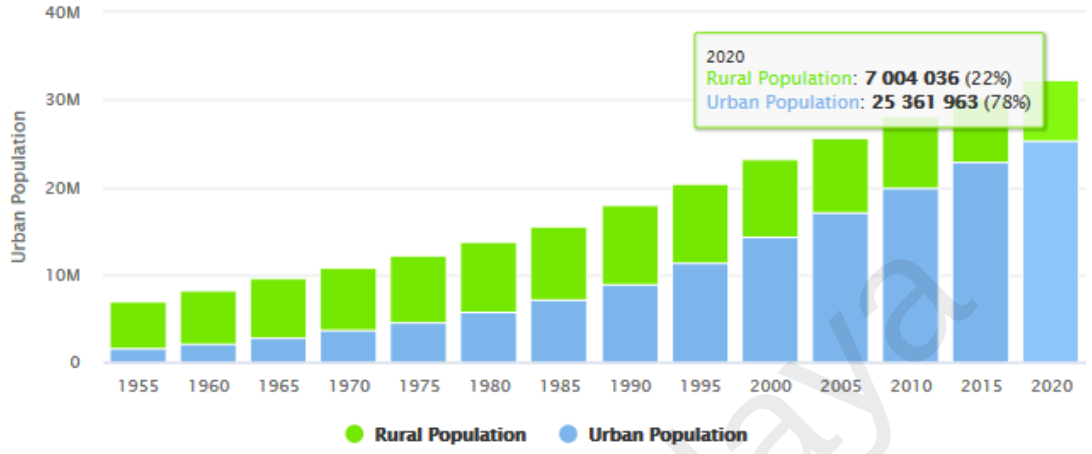

Figure 3.4: Size of urban and rural populations in Malaysia from 1955 to 2020

Source: Department of Statistics Malaysia (2018)

Participants who fit the study criteria were identified using RUKA's electronic health record database and during their usual clinic appointments. They were informed by their regular RUKA healthcare provider (with whom they were familiar) about the study and their participation was sought. When the patients had given verbal consent, RUKA doctors informed the PI who then contacted the patients directly via telephone or face to face. At this point, the information that was conveyed to the potential participants included details on the type, purpose, and importance of the study, as well as some other aspects of the study and research procedures. Participants were then allowed sufficient time to consider whether they wished to participate in the study. When they were agreeable, the PI arranged a date, time, and location for the interview that was convenient for the participant.

To ensure the representativeness of the views obtained from participants of different backgrounds, recruitment was done via purposive sampling which was criterion based. Criterion sampling involves selecting cases that meet some predetermined criteria of importance (Patton, 2001, p. 238). Criterion sampling can be useful for identifying and understanding cases that are information rich (in this instance, young adults with hypertension) and provide an important qualitative perspective to quantitative data (Cohen & Crabtree, 2006). In this study, care was taken to ensure that certain sociodemographic characteristics were fulfilled, for example, there was a good mix of genders and variation in age groups, education levels, income levels, and family history. The sampling process also ensured that the selected respondents had a variety of comorbidities that were associated with YOH (as determined from the secondary data analysis). With regard to ethnicity, the selected participants represented the different races in Malaysia. However, participants from the Other Bumiputeras category could not be recruited. One possible explanation for this could be because the study was located in an urban hospital in West Malaysia.

The one-on-one interview was used to gather information from the participants. This technique was adopted in order to provide an environment for patients to freely and openly share information about their perceptions and experiences about living with hypertension, their current treatment regime, and long-term expectations about their treatment. The participants were interviewed until information reached saturation point through ongoing thematic analysis. For phenomenological studies, Creswell and Poth (2017) recommend that 5–25 and Morse (1994) suggests that at least six participants are needed to reach this point. On the other hand, Guest et al. (2006) state that saturation often occurs in homogeneous groups when there are approximately 12 participants. The sampling and recruitment for IPA also emphasizes on homogenous and small groups to allow for a thorough microlevel examination of the participants' views (J. A. Smith et al.,

2009). Moreover, exploration of the research question should be meaningful to individuals who are deliberately chosen as they have experience of the phenomenon (Peat et al., 2019). The participants in this study were relatively homogenous to a certain degree because they were diagnosed with YOH. Therefore, a suitable sample size for this study was estimated to be 5–12 participants or until saturation point was achieved (whichever came first).

3.2.3 Inclusion Criteria

i. Young adults of Malaysian nationality, aged 18–39 years, who reported a diagnosis of hypertension as classified by the JNC 7 (Chobanian et al., 2003) for at least 12 months

ii. Young-onset hypertensives who attend follow-up/walk-in clinic appointments with RUKA.

3.2.4 Exclusion Criteria

i. Pregnant women

ii. Institutionalized populations.

3.2.5 Data Collection

3.2.5.1 Study Instrument

Typically, the data collection for an IPA involves the utilization of in-depth semi-structured interviews with the goal of enabling participants to share important experiences. The participant usually leads direction of the interview, although an interview topic guide may be used as an aid. During the interview, the researcher's role is to facilitate the conversation to concentrate on the lived experience of the phenomenon of interest (Peat et al., 2019).

Hence, data collection was performed by the researcher using a semi-structured interview guide which was derived from the literature review and included elements of the EM of illness framework (Figure 2.2) (Johnson et al., 2016; Taylor et al., 2012; M. G. Weiss et al., 1992). The initial topic guide was constructed during Semester One of the DrPH programme in October 2017 as part of the Qualitative Methods in Health Research module. It was piloted in November 2017 on a young adult who met the criteria for inclusion in the study. Following the pilot study, certain constructs such as underlying moderators (self-efficacy) and a causal chain (barriers leading to benefits of behavioural change) were found to be lacking. Therefore, slight amendments to the topic guide were made by incorporating some elements of the health belief model (Barros et al., 2014; Becker, 1974)

The researcher conducted all the interviews using the finalized topic guide (Appendix D) as a reminder of areas to be covered during the interview sessions. In order to ensure all valuable information was captured, two voice recorders (Huawei Technologies Co., Ltd, China) were used to audiotape the entire interview session. The voice recorders were checked for functionality prior to the start of the interview and intermittently examined throughout the interview.

3.2.5.2 Study Setting

Ideally, the interviews were conducted in RUKA at UMMC. However, in view of the fact that the participants were young adults who were invariably leading busy lives, interviews were also conducted at their place of work/business or at their homes. In RUKA, a quiet room was used for the interviews to ensure the privacy and confidentiality of the participants. In offices or homes, quiet and private rooms were allocated for the interviews by the respondents. However, in public areas such as coffeehouse chains (as

chosen by the respondents), privacy was maintained as much as possible by selecting a quiet corner in such venues.

The interview began with a brief introduction detailing the purpose of the study and the conduct of the interview. The participant was given the opportunity to ask any questions prior to the start of the interview. A demographic questionnaire was administered, along with a patient information sheet and a consent form in both the Malay and English languages (Appendices E, F, and G, respectively). Some opening questions such as, "What is the name of your illness?" and "How would you describe it in your own words?" were used to give the participant the opportunity to opine their views on the subject matter and the conversation would build from there. The interview guide was designed to contain open-ended questions and care was taken by the interviewer to remain neutral and non-judgemental throughout the interview. Probing questions were used intermittently to guide the participant to key focus areas and they were afforded the opportunity to express additional comments and views. The participants' facial expressions and emotions were recorded by the researcher as written memos throughout the interview. The duration of the interview ranged from approximately 20 minutes (shortest interview) to one hour (longest interview).

3.2.6 Data Analysis

Data collection and analysis was an ongoing and iterative process. Interim analysis provided insights on emerging themes and allowed subsequent interview questions to develop. In order to derive coding categories from the text data, a double hermeneutic approach to content analysis was utilized. This is a process of rich engagement and interpretation involving both the researcher and the researched, whereby the researcher seeks to make sense of the participant(s) making sense of their world(s) (Peat et al., 2019).

The data from the IDIs was transcribed and cross-checked by two researchers (the PI and a research assistant with a background in Psychology). The two transcribers transcribed the data verbatim and listened to interview recordings at least three times to ensure the completeness and accuracy of the transcription process. After the transcriptions had been cross-checked, they were entered into NVivo 9 software (QSR International, Australia) for proper storage and analysis as well as to facilitate the coding process. The input transcripts were then analysed independently by two researchers using thematic analysis.

The thematic analysis began with the two researchers independently undertaking a close examination of the first case to achieve immersion and context as well as to generate emergent codes, which led to the development of case themes and, subsequently, consideration of themes across the data set. The data was supplemented by additional notes (memoing) taken during the interview process detailing the body language and emotions of the participant to add to the robustness of the interview content. Supplementary memoing, i.e. memos taken during the transcription analysis process, was recorded in NVivo 9 software (QSR International, Australia). The transcript of the first interview was studied multiple times and like phrases and themes were highlighted; these were then clustered together to form groups of similar meaning (Creswell & Poth, 2017). Throughout this process, each researcher searched for connections across emergent themes and constructed the meaning of each respondent's experiences by considering how these experiences related to one another. Following on with the next interview, themes that were generated from the previous interview were 'bracketed' because the new case was considered with 'fresh and open eyes', so again, the two researchers became immersed in the specific case (Peat et al., 2019) and the above process was repeated. The above steps were conducted for each case before continuing to the next step of the data analysis, that is, the seeking of patterns across cases and the interpretation of the data to

achieve at a deeper comprehension of the phenomenon that is YOH. When there were any disagreements, the two researchers met for a discussion in order to reach a consensus on the transcription findings.

Hence rather than the codes being produced a priori, they were all generated from the transcribed texts. The two researchers independently coded all the transcripts. Subsequently, they met to examine the codes, resolve disagreements by consensus, and refine said codes. In addition, further categorization was conducted to allow the emergence of common themes and to make sense of the essential meanings of the phenomenon.

3.2.7 Rigour, Reflection, and Reflexivity

During the process of data collection through the semi-structured interviews, the researcher was very careful not to ask questions that could reflect the answers (Z. C. Chan, Fung, & Chien, 2013). Participants were given ample time to answer in an honest and open manner in an unpressured environment, then their replies were reported as recorded. Memos were taken to provide supplementary material for triangulation during data analysis (Birks, Chapman, & Francis, 2008). Triangulation refers to the application of various approaches or data sources in qualitative research to establish a detailed interpretation of the phenomena (Carter, Bryant-Lukosius, DiCenso, Blythe, & Neville, 2014). First, method triangulation was utilised which included interviews, observation, and field notes on the phenomenon. Next, prior to data analysis, investigator triangulation was conducted whereby two researchers independently listened to the recordings at least three times and cross-checked all the transcriptions. Subsequently, these two same independent researchers reviewed, analysed, and coded the data. Where there were discrepancies between the two, the researchers met for discussions in order to come to an agreement. The above steps were taken to assure trust in the data and the credibility of

the results as proposed by Graneheim and Lundman (2004). Further, this type of triangulation can bring both confirmation of findings and different perspectives, adding breadth to the phenomenon of interest (Carter et al., 2014).

Additionally, clarifications were made during interviews between the interviewer and the subject to accomplish member checking (Shenton, 2004). After the interview, the conversation was summarized by the PI and checked with the respondent to verify its content. Furthermore, a peer group (comprising a public health specialist, epidemiologist, and primary care physician) commented on the transparency of the interpretation of the data and findings and critiqued each stage of the research process. The usage of an audit trail which included memos taken by the researcher during the IDIs, coding records generated from NVivo 9 software (QSR International, Australia) aided in addressing confirmability and reliability issues.

As mentioned above, bracketing was also undertaken during the analysis of the IDIs. Bracketing is a methodological device of phenomenological inquiry that requires the deliberate putting aside of one's own belief about the phenomenon under investigation or what one already knows about the subject prior to and throughout the phenomenological investigation (Carpenter, 2007). However, in the hermeneutic phenomenological approach, it is acknowledged that pre-understanding cannot be eliminated or 'bracketed' (Koch, 1995). Hence, the concept of bracketing was in the researcher's mind throughout the research process – from the literature review to the data collection and analysis phases. This was achieved via reflexivity; a key thinking activity and honest examination that helps identify the potential influence of a researcher's interests and values that may have an impact on research work (Primeau, 2003). This aids researchers who are conducting qualitative research to determine and mitigate potential areas of bias by bracketing such areas (Ahern, 1999). The researcher used a reflexive diary to bring reflexivity into

consciousness by recording the feelings, perceptions, and thoughts throughout the research process. This was also part of the audit trail which allowed ease of re-examination of viewpoints when the circumstances arose.

In order to determine the credibility of an IPA, four broad criteria are used: commitment and rigour in undertaking the analysis; sensitivity to context; impact and importance; and transparency and coherence of the narrative produced; (Finlay, 2011). Overall, the above-described strategies of 'bracketing', triangulation, participant verification, and peer critique aided in establishing trust in and the credibility of the IPA methodology employed in this study (Graneheim & Lundman, 2004; Peat et al., 2019).

3.3 Ethical Considerations

Approval for this study was obtained from the DG of Health (Appendix C) and the MREC of both the MoH at the national level and the UMMC at the hospital level (ID No. 20190426-7361) (Appendices H and I, respectively). The study has been assigned the National Medical Research Register (NMRR) research identification (ID) number NMRR-19-2045-49266.

Although the data in the NHMSs is freely available in the public domain, permission was sought from the Director of IPH for the use of this data and the ownership of the original data was acknowledged. The use of the data in all three NHMSs (2006, 2011, 2015) was approved by the MREC of the MoH. Informed written consent from the respondents is a requirement for participation in all NHMSs. Therefore, consent of the subjects for this study can be reasonably presumed.

The personal data of the participants that was obtained during the course of this research was handled, processed, stored, and destroyed in accordance with the Data

Protection Act 1998. In order to protect the information provided during the course of this research and to maintain the confidentiality of the subjects, the following precautionary measures were taken:

i. All research team members and enumerators were made aware of and were confirmed to have clearly understood the procedures involved in the handling, storing, and sharing of research data to ensure that information would remain protected from unauthorized persons.
ii. The participants were assured that their confidentiality would be maintained when obtaining their informed consent.
iii. During data processing and management using SPSS® version 20.0 software (IBM, United States), each respondent was identified by an ID code, that is, identifiers such as name and contact details were removed during data cleaning. Thus, the cleaned data set did not include any identifiable information (e.g., address and name) and such information was stored elsewhere (in separate, secure archives).
iv. During data management and analysis using NVivo 9 software (QSR International, Australia), each respondent was identified by an ID code.
v. When reporting the findings, each respondent was identified only by combinations of traits, e.g., gender, age, occupation etc., and this will also be done in future journal articles.
vi. All electronic data were stored on a computer protected by a password known only by the PI and other authorized persons such as the research team members and regulatory authorities/auditors for quality monitoring.
vii. A master list linking participants to the codes/themes identified in the study was held on a password-protected computer accessed only by the PI and other

authorized persons such as the co-investigators and regulatory authorities/auditors for quality monitoring.

viii. Hard-copy paper and audio-taped data were stored securely and accessed only by authorized persons such as the PI, the co-investigators and regulatory authorities/auditors for quality monitoring.

3.4 Summary of the Chapter

In this chapter, the quantitative (secondary data analysis) and qualitative (IPA) methods employed in this study were elaborated. With regard to the quantitative analysis, because the NHMS methodology is available in the public domain, particular emphasis was given to the researcher's contribution to the secondary data analysis which included:

i. Data collection: Writing the research proposal and formal letter submitted to the Director of IPH and the DG of Health;

ii. Data processing and management: Calculating the minimum sample size required for a prevalence study and ascertaining the factors associated with YOH using Epi Info™ version 7.2, exploring three NHMS data sets for various issues such as quality and missing values, and examining and treating missing data accordingly using Stata Software version 15 (StataCorp, United States);

iii. Data analysis: Establishing the age adjustment according to the 2010 national census data obtained from the DOSM, calculating the weightage of prevalence estimates to represent the total young adult population in Malaysia, undertaking diagnostic descriptive analyses as well as univariate and multivariate analyses using SPSS® version 20.0 (IBM, United States).

The chapter also elucidated how the results from Phase II were used to inform the study type and design as well as the study population and sampling of Phase III. It then explained that the IPA approach was utilized in this phase of the study because this method offers insights into how a given person, in a given context, makes sense of a given phenomenon – in this case, it was used to explore the experiences and perspectives of young hypertensive adults influencing the awareness, treatment, and control rates of YOH. The chapter then went on to describe the data collection process using IDIs which was conducted using a semi-structured interview guide until saturation point and explained the data analysis process, where attention was given to maintaining rigour through employing reflection and reflexivity. Finally, the chapter highlighted the ethical considerations of the study, demonstrating that the study adhered to both university and current national guidelines.

CHAPTER 4: RESULTS

This chapter is divided into two sections: section 4.1 elaborates the results of Phase II (secondary data analysis) and section 4.2 elaborates the results of Phase III (qualitative results from IDIs). The results of Phase I (systematic literature review) have already been presented in great detail in Chapter Two.

Section 4.1 details the results of the quantitative component of this study to provide evidence on the prevalence, awareness, treatment, and control of YOH in Malaysia as well as the associated risk factors over a ten-year period from 2006 to 2015. Several results from Phase II (i.e., the awareness, treatment, and control rates) were utilized by the researcher to contextualize the findings derived from the IDIs conducted in Phase III, the details of which are presented in section 4.2. Thus, this chapter provides answers to the research questions posed regarding the YOH phenomenon that is affecting the young adult subpopulation in Malaysia.

4.1 Phase II Results – Quantitative Study: Secondary Data Analysis

This results on Phase II was submitted to the Journal of Human Hypertension on 2nd July 2020 and the manuscript is currently under peer review consideration.

4.1.1 Characteristics of the Study Population

The number of respondents included in this study from NHMS 2006, 2011, and 2015 was 16,565, 8,678, and 8,906, respectively. In all three surveys, over half of the respondents were female. Also, approximately 60% of participants were aged < 30 and resided in urban localities in all three NHMSs. The majority ethnic group was Malay (ranging from 55.2% to 62.0% across the three surveys), followed by Chinese (12.2%–16.0%), Other Bumiputeras (9.8%–13.1%), and Indian (7.0%–8.3%). More than half of

the respondents attained secondary level education (51.9%–60.9%), followed by tertiary education (14.3%–33.7%) and primary education (10.5%–21.0%). More than three quarters of the study population had a household income in the bottom 40% range (63.6%–88.8%), followed by the middle 40% range (8.3%–28.6%), while a small proportion had a household income within the top 20% range (1.9%–7.8%). With regard to family history of hypertension, 40% of the respondents had a positive family history in 2006 and 2011, increasing to 55% in the 2015 survey.

In respect of the lifestyle factors considered in this study, in 2006 8.2% of the respondents were alcohol drinkers, increasing to 10.7% in 2011 and decreasing in 2015 to 6.9%. Throughout the decade 2006–2015, approximately one quarter of the respondents were current smokers. Over half of the respondents were physically active with an increasing trend from 59.2% in 2006 to 64.1% in 2011 and 69.7% in 2015.

Less than 10% of the selected respondents over the past decade had a diagnosis of DM, but this proportion increased over the ten-year period covered by this study. Also, over the study period an increasing number of the selected participants had hypercholesterolaemia: in 2015, over one third of respondents (38.0%) had this diagnosis. Similarly, there was an increase in the number of obese respondents: by 2015, almost one fifth (18.6%) and two fifths (41.9%) of the participants were obese according to the BMI and WC cut-off points, respectively. The characteristics of the study population are presented in Table 4.1.

Table 4.1: Characteristics of the Study Population (Young Adults Aged 18–39 Years), NHMS 2006 – 2015

NHMS Year (N = 34149)							
Variables		**2006 (N = 16565)**		**2011 (N = 8678)**		**2015 (N = 8906)**	
		N	**%**	**N**	**%**	**N**	**%**
Gender	Male	7318	44.2	4129	47.6	4352	48.9
	Female	9247	55.8	4549	52.4	4554	51.1
Age group (years)	< 30	10064	60.8	5406	62.3	5330	59.8
	≥ 30	6501	39.2	3272	37.7	3576	40.2
Locality	Urban	10229	61.8	5287	60.9	5459	61.3
	Rural	6336	38.2	3391	39.1	3447	38.7
Ethnicity	Malay	9147	55.2	5102	58.8	5519	62.0
	Chinese	2650	16.0	1271	14.6	1085	12.2
	Indian	1369	8.3	649	7.5	620	7.0
	Other Bumiputeras	2162	13.1	900	10.4	871	9.8
	Others	1237	7.5	756	8.7	811	9.1
Education	None	438	2.6	152	1.8	202	2.3
	Primary	3477	21.0	992	11.4	937	10.5
	Secondary	10086	60.9	4629	53.4	4620	51.9
	Tertiary	2364	14.3	2788	32.1	3002	33.7
	Unclassified	200	1.2	117	1.3	144	1.6

Table 4.1, continued

Variables		NHMS Year (N = 34149)					
		2006 (N = 16565)		2011 (N = 8678)		2015 (N = 8906)	
		N	%	N	%	N	%
Household income	Bottom 40%	14705	88.8	6149	70.9	5662	63.6
	Middle 40%	1546	8.3	2123	24.5	2543	28.6
	Top 20%	314	1.9	406	4.7	701	7.8
Family history	No	9878	59.6	5135	59.2	4007	45.0
	Yes	6687	40.4	3543	40.8	4899	55.0
Alcohol drinker	Yes	817	8.2	922	10.7	600	6.9
	No	9106	91.8	7708	89.3	8034	93.1
Current smoker	Yes	3947	24.2	2262	26.3	2265	25.4
	No	12382	75.8	6332	73.7	6638	74.6
Physical activity	Active	9646	59.2	5507	64.1	6122	69.7
	Inactive	6659	40.8	3081	35.9	2666	30.3
Diabetes mellitus	Yes	623	3.8	610	7.2	848	9.5
	No	15930	96.2	7835	92.8	8058	90.5
Hypercholesterolaemia	Yes	2088	12.7	2170	25.4	3387	38.0
	No	14417	87.3	6389	74.6	5519	62.0
Obesity	Yes	1857	11.9	1207	15.2	1521	18.6
	No	13799	88.1	6754	84.8	6651	81.4

Table 4.1, continued

NHMS Year (N = 34149)							
Variables		**2006 (N = 16565)**		**2011 (N = 8678)**		**2015 (N = 8906)**	
		N	**%**	**N**	**%**	**N**	**%**
Abdominal obesity	Yes	4512	29.0	2830	34.7	3404	41.9
	No	11073	71.0	5324	65.3	4719	58.1

4.1.2 Prevalence of YOH by Sociodemographic, Lifestyle, and Cardiovascular Risk Factors, NHMS 2006 – 2015

The prevalence of YOH by sociodemographic, lifestyle, and cardiovascular risk factors as obtained from NHMS 2006, 2011, and 2015 are listed in Table 4.2. Overall, throughout the decade under study, the age-adjusted prevalence of YOH in Malaysia was 17.7%, 95% CI [17.0, 18.3] in 2006, 17.0%, 95% CI [16.0, 17.9] in 2011, and 18.4%, 95% CI [17.4, 19.4] in 2015 (Table 4.2 and Figure 4.1). This equates to approximately two million young adults being diagnosed with YOH for each survey year. Almost one fifth of the population aged 18–39 years were diagnosed as having YOH, with the prevalence remaining stable from 2006 to 2015.

With a male to female ratio of 1.5: 1, there was an obvious male preponderance of YOH between 2006 and 2015. Young-onset hypertension was twice as common among those aged ≥ 30 years compared to their older counterparts. The trend analysis showed that the prevalence based on age and gender remained stable throughout the decade.

Although the prevalence of YOH decreased in the rural population from 2006 to 2015, compared to their urban counterparts, this group still displayed a higher overall prevalence of YOH (20.9% vs 15.6% in 2006, 17.7% vs 16.5% in 2011, and 19.8% vs 17.5% in 2015). Interestingly, however, the rate of change from 2006 to 2015 was more pronounced in the urban community, a trend which was statistically significant, aOR 1.15, 95% CI [1.03, 1.27].

In terms of ethnicity, YOH was most prevalent among Other Bumiputeras (indigenous groups other than Malays) in all three surveys (20.1% in 2006, 21.5% in 2011, and 22.9% in 2015). The Chinese and Indian ethnic groups had the lowest prevalence rates among all ethnicities throughout the ten years covered by this study. In general, the YOH trends for all racial groups were stable during the period 2006–2015.

In respect of level of education, throughout the decade, the prevalence of YOH was lowest among those who attended tertiary education (13.6% in 2006, 14.7% in 2011, and 16.8% in 2015). In NHMS 2006, the prevalence of YOH was highest among those with no formal education at 23.7%, 95% CI [19.8, 28.0], while, in NHMS 2011 and 2015, the prevalence was highest among those who had a primary education at 20.0%, 95% CI [17.6,22.5], and 25.0%, 95% CI [22.1, 28.1] respectively. With regard to the trend, the rate of change increased significantly from 2006 to 2015 for those with primary and tertiary education, but decreased significantly among those with no formal education.

In all three surveys, the proportion of hypertensives was lowest among young adults from families with the highest SES (i.e., in the top 20%, as indicated by total household income) at 12.7%, 95% CI [8.2, 19.1] in 2006, 11.7%, 95% CI [8.8, 15.4] in 2011, and 15.8%, 95% CI [13.1, 18.8] in 2015. The highest prevalence of YOH was found among the bottom 40% income group at 18.1%, 95% CI [17.4, 18.8] in 2006, 17.7%, 95% CI [16.7, 18.8] in 2011, and 19.3%, 95% CI [18.1, 20.5] in 2015. There was an increasing trend in YOH over the ten-year period in all income groups; however, it was only statistically significant for the middle 40% group, aOR 1.21, 95% CI [1.01, 1.47].

A family history of hypertension also seems to be associated with YOH, where it was more prevalent among young adults with a positive family history (22.7% vs 14.1% in 2006, 20.5% vs 14.5% in 2011, and 28.0% vs 6.3% in 2015). Also, the proportion of young adults who responded in the affirmative to having a family history of hypertension increased by 5.3% from 2006 to 2011, an increase that was statistically significant, aOR 1.32, 95% CI [1.20, 1.46].

In regard to the three lifestyle factors considered in this study, the prevalence of YOH in those who imbibed alcohol increased steadily from 19.6%, 95% CI [17.5, 21.8] in 2006 to 20.5%, 95% CI [17.8, 23.5] in 2011 and subsequently to 24.6%, 95% CI [21.2, 28.5]

in 2015, a trend which was statistically significant, aOR 1.34, 95% CI [1.06, 1.71]. The prevalence of current smokers with YOH hovered at around one fifth of the population. In all three NHMSs, YOH was more prevalent among those who were physically active.

As regards the prevalence of YOH among those with comorbidities, over one third of young adults with hypertension had a concomitant diagnosis of DM (36.5%, 32.4%, and 36.0% in 2006, 2011, and 2015, respectively). Over one quarter of young adults who had YOH also had a diagnosis of hypercholesterolaemia (28.2%, 22.8%, and 25.1% in 2006, 2011, and 2015, respectively). Approximately two fifths and almost one third of young adults with hypertension were obese, based on BMI and WC, respectively. Overall, the prevalence of YOH was higher among those who had a positive history of cardiovascular risk factors/comorbidities as compared to their counterparts with no such history.

The prevalence of YOH among those who had a concurrent diagnosis of DM and among those who were obese (based on BMI) remained stable over ten years. In contrast, a decreasing trend was seen in the prevalence of respondents with YOH and hypercholesterolaemia (28.2% in 2006 to 25.1% in 2015) and abdominal obesity (32.0% in 2006 to 29.5% in 2015), results which were statistically significant, aOR 0.86, 95% CI [0.75, 0.98] and aOR 0.89, 95% CI [0.80, 0.97], respectively.

Table 4.2: Prevalence of YOH by Sociodemographic, Lifestyle, and Cardiovascular Risk Factors, NHMS 2006–2015

NHMS Year		2006 (N = 16287)			2011 (N = 8612)			2015 (N = 8906)				
		n	Estimated population	% (95% CI)	n	Estimated population	% (95% CI)	n	Estimated population	% (95% CI)	Change, 2006 to 2015 % (95% CI)	Odd ratio (2006-2015)
	Overall	2943	1937274	17.7 [17.0, 18.3]	1507	1861730	17.0 [16.0, 17.9]	1699	2017955	18.4 [17.4, 19.4]	0.7 [0.4, 1.1]	1.05 [0.97,1.14]
Sociodemographic Factors												
Gender	Male	1590	1228767	21.4 [20.4, 22.5]	844	1153626	20.1 [18.8, 21.5]	969	1248683	21.8 [20.4, 23.2]	0.4 [0.0, 0.7]	1.02 [0.92,1.13]
	Female	1353	708506	13.5 [12.8, 14.3]	663	708104	13.5 [12.5, 14.7]	730	769171	14.7 [13.6, 15.8]	1.2 [0.8, 1.5]	1.10 [0.99,1.23]
Age Group (years)	< 30	1333	1014717	13.9 [13.2, 14.7]	675	921872	12.6 [11.6, 13.7]	779	1063051	14.6 [13.5, 15.7]	0.7 [0.3, 1.0]	1.06 [0.94,1.18]
	≥ 30	1610	922557	25.0 [23.8, 26.1]	832	939858	25.7 [24.2, 27.3]	920	954903	25.9 [24.4, 27.4]	0.7 [0.6, 1.3]	1.05 [0.95,1.16]
Locality	Urban	1597	1055853	15.6 [14.8, 16.5]	888	1097883	16.5 [15.3, 17.7]	982	1171573	17.5 [16.3, 18.7]	1.9 [1.5, 2.2]	1.15 [1.03,1.27]*
	Rural	1346	881421	20.9 [19.8, 22.1]	619	763847	17.7 [16.3, 19.3]	717	846381	19.8 [18.2, 21.5]	-1.1 [-1.6,-0.6]	0.93 [0.83,1.06]

Table 4.2, continued

NHMS Year		2006 (N = 16287)			2011 (N = 8612)			2015 (N = 8906)				
		n	Estimated population	% (95% CI)	n	Estimated population	% (95% CI)	n	Estimated population	% (95% CI)	Change, 2006 to 2015 % (95% CI)	Odd ratio (2006-2015)
Ethnicity	Malay	1681	1110063	18.2 [17.4, 19.1]	903	1111610	17.2 [16.0, 18.4]	1061	1260622	18.5 [17.3, 19.7]	0.3 [-0.1,0.6]	1.02 [0.92,1.12]
	Chinese	399	264902	15.3 [13.8, 16.9]	191	239578	15.1 [13.2, 17.3]	165	196044	14.9 [12.8, 17.3]	-0.4 [-1.0,0.4]	0.97 [0.78,1.20]
	Indian	196	128289	14.2 [12.4, 16.2]	100	124350	15.2 [12.6, 18.3]	101	119583	15.6 [12.7, 19.0]	1.4 [0.3,2.8]	1.16 [0.84,1.48]
	Other Bumi-puteras	441	286171	20.1 [18.3, 22.2]	195	246089	21.5 [18.8, 24.6]	206	244390	22.9 [20.0, 26.1]	2.8 [1.7,3.9]	1.18 [0.95,1.45]
	Others	226	147847	17.9 [15.4, 20.7]	118	140102	14.7 [12.0, 17.8]	166	197313	19.8 [16.5, 23.6]	1.9 [1.1,2.9]	1.14 [0.85,1.51]
Education Level	None	100	64014	23.7 [19.8, 28.0]	27	33238	17.8 [12.2, 25.4]	34	40840	16.2 [11.3, 22.6]	-7.5 [-8.5,5.4]	0.62 [0.39,0.99]*
	Primary	696	439330	19.5 [18.2, 21.0]	208	246077	20.0 [17.6, 22.5]	241	274239	25.0 [22.1, 28.1]	5.5 [3.9,7.1]	1.37 [1.14,1.65]*

Table 4.2, continued

NHMS Year		2006 (N = 16287)			2011 (N = 8612)			2015 (N = 8906)				
		n	Estimated population	% (95% CI)	n	Estimated population	% (95% CI)	n	Estimated population	% (95% CI)	Change, 2006 to 2015 % (95% CI)	Odd ratio (2006-2015)
	Second-ary	1806	1196389	17.8 [17.0, 18.7]	854	1051677	17.9 [16.7, 19.2]	886	1048806	18.2 [17.0, 19.5]	0.4 [0.0,0.8]	1.03 [0.93,1.13]
	Tertiary	303	1604449	13.6 [12.1, 15.2]	407	516560	14.7 [13.3, 16.2]	510	618716	16.8 [15.4, 18.3]	3.2 [3.3,3.1]	1.29 [1.09,1.52]*
	Un-classified	30	19565	14.4 [10.3, 19.7]	11	14178	8.9 [4.7,16.0]	28	35342	19.0 [13.3, 26.3]	4.6 [3.0,6.6]	1.39 [0.79,2.45]
Household income	Bottom 40%	2688	1763700	18.1 [17.4, 18.8]	1121	1381005	17.7 [16.7, 18.8]	1147	1349486	19.3 [18.1, 20.5]	1.2 [0.7,1.7]	1.08 [0.99,1.19]
	Middle 40%	218	147811	14.5 [12.8, 16.5]	338	421360	15.7 [14.0, 17.5]	438	533719	17.1 [15.5, 18.8]	2.6 [2.7,2.3]	1.21 [1.01,1.47]*
	Top 20%	37	25762	12.7 [8.2,19.1]	48	59365	11.7 [8.8,15.4]	114	134749	15.8 [13.1, 18.8]	3.1 [4.9,9.7]	1.29 [0.76,2.19]
Family history	No	1421	907728	14.1 [13.4, 14.8]	758	925261	14.5 [13.5, 15.5]	260	308234	6.3 [5.5, 7.2]	-7.8 [-7.9,-7.6]	0.41 [0.35,0.48]*

Table 4.2, continued

NHMS Year		2006 (N = 16287)			2011 (N = 8612)			2015 (N = 8906)				
		n	Estimated population	% (95% CI)	n	Estimated population	% (95% CI)	n	Estimated population	% (95% CI)	Change, 2006 to 2015 % (95% CI)	Odd ratio (2006-2015)
	Yes	1522	1029545	22.7 [21.5, 23.9]	749	936469	20.5 [18.9, 22.1]	1439	1709720	28.0 [26.6, 29.4]	5.3 [5.1,5.5]	1.32 [1.20,1.46]*
Lifestyle Factors												
Alcohol drinker	No	2641	1712420	17.4 [16.7, 18.1]	1318	1610265	16.5 [15.6, 17.5]	1540	1817377	17.9 [16.9, 18.9]	0.5 [0.2,0.8]	1.03 [0.95,1.12]
	Yes	302	224854	19.6 [17.5, 21.8]	189	251465	20.5 [17.8, 23.5]	159	200577	24.6 [21.2, 28.5]	5.0 [3.7,6.7]	1.34 [1.06,1.71]*
Current smoker	No	2098	1282256	16.8 [16.1, 17.6]	1085	1284843	16.4 [15.4, 17.5]	1201	1380268	17.2 [16.2, 18.3]	0.4 [0.1,0.7]	1.03 [0.94,1.13]
	Yes	845	655018	19.6 [18.4, 20.9]	422	576887	18.3 [16.8, 20.0]	498	637686	21.5 [19.7, 23.4]	1.9 [1.3,2.5]	1.12 [0.98,1.29]
Physical activity	Inactive	1114	691164	16.1 [15.2, 17.1]	487	597802	15.3 [14.0, 16.7]	473	560907	16.8 [15.4, 18.4]	0.7 [0.2,1.3]	1.06 [0.93,1.20]

Table 4.2, continued

NHMS Year		2006 (N = 16287)			2011 (N = 8612)			2015 (N = 8906)				
		n	Estimated population	% (95% CI)	n	Estimated population	% (95% CI)	n	Estimated population	% (95% CI)	Change, 2006 to 2015 % (95% CI)	Odd ratio (2006-2015)
	Active	1829	1246110	18.7 [17.8, 19.5]	1020	1263928	17.9 [16.8, 19.0]	1226	1457047	19.1 [18.0, 20.2]	0.4 [0.2,0.7]	1.03 [0.94,1.13]
Cardiovascular Risk Factors												
Diabetes mellitus	Yes	231	146394	36.5 [32.6, 40.5]	209	248976	32.4 [28.9, 36.2]	311	359836	36.0 [32.6, 39.6]	-0.5 [0.0,-0.9]	0.98 [0.78,1.24]
	No	2712	1790879	16.9 [16.3, 17.6]	1298	1612754	15.8 [14.9, 16.8]	1388	1658118	16.6 [15.7, 17.6]	-0.3 [-0.6,0.0]	0.98 [0.90,1.06]
Hypercholesterolaemia	Yes	592	369304	28.2 [26.2, 30.2]	535	638133	22.8 [21.0, 24.7]	878	1009396	25.1 [23.6, 26.8]	-3.1 [-2.6,-3.4]	0.86 [0.75,0.98]*
	No	2351	1567969	16.2 [15.5, 16.9]	972	1223596	15.0 [14.0, 16.0]	821	1008558	14.5 [13.4, 15.6]	-1.7 [-2.1,-1.3]	0.86 [0.79,0.87]*
Obesity	Yes	793	494203	40.1 [37.8, 42.4]	522	635326	40.2 [37.5, 42.9]	694	809227	41.8 [39.2, 44.5]	1.7 [1.4, 2.1]	1.07 [0.93,1.24]

Table 4.2, continued

NHMS Year		2006 (N = 16287)			2011 (N = 8612)			2015 (N = 8906)				
		n	Estimated population	% (95% CI)	n	Estimated population	% (95% CI)	n	Estimated population	% (95% CI)	Change, 2006 to 2015 % (95% CI)	Odd ratio (2006-2015)
	No	2150	1443071	14.8 [14.2, 15.5]	985	1226404	13.1 [12.2, 14.0]	1005	1208728	13.4 [12.5, 14.3]	-1.4 [-1.7, 1.2]	0.89 [0.81,0.98]*
Abdominal obesity	Yes	1454	896977	32.0 [30.5, 33.6]	485	569286	35.3 [32.8, 38.0]	1110	1276062	29.5 [27.9, 31.1]	-2.5 [-2.6,-6.9]	0.89 [0.80,0.97]*
	No	1489	1040296	12.7 [12.1, 13.4]	1022	1292444	13.8 [12.9, 14.8]	589	741892	11.2 [10.2, 12.2]	-1.5 [-1.9,-1.2]	0.86 [0.77,0.97]*

4.1.3 Prevalence of Awareness, Treatment and Control of YOH, NHMS 2006–2015

In 2015, 16.1%, 95% CI [14.3, 18.1] of young adults with YOH were aware of their diagnosis, with 48.4%, 95% CI [42.6, 54.2] on treatment (whether lifestyle advice given or on medication) and BP was controlled in 39.2%, 95% CI [31.3, 47.6] of those who were on treatment. Awareness and treatment rates remained stable during the period 2006–2015 at 1.7% (p trend = .397) and 2.4% (p trend = .662), respectively. There was a non-statistically significant increase in the proportion of those with controlled BP (among those who were on treatment) by 7.4% (p = .179) from 2006 to 2015 (Table 4.3 and Figure 4.1).

Table 4.3: Prevalence of Awareness, Treatment, and Control of YOH, NHMS 2006–2015

	Prevalence %			Change, 2006 to 2015	
NHMS Year	**2006**	**2011**	**2015**	**%**	**P-value**
Awareness					
Among all hypertensives	14.4 [13.1, 15.8]	21.7 [19.7, 24.0]	16.1 [14.3, 18.1]	1.7 [1.2, 2.3]	0.397
Treatment					
Among those who are aware	46.0 [41.2, 50.9]	39.8 [34.7, 45.1]	48.4 [42.6, 54.2]	2.4 [1.4, 3.3]	0.662
Control					
Among those treated	31.8 [25.8, 38.5]	39.1 [31.1, 47.7]	39.2 [31.3, 47.6]	7.4 [5.5, 9.1]	0.179

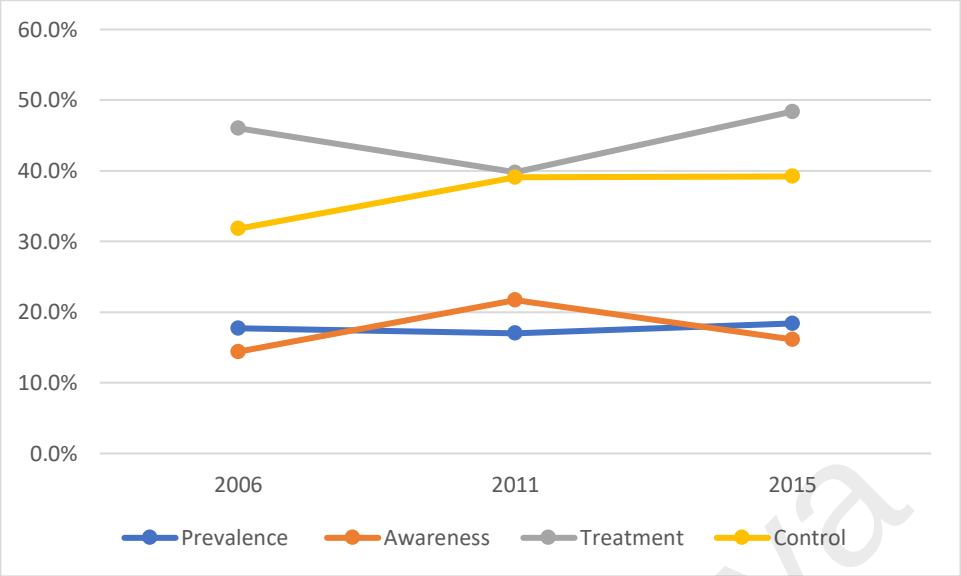

Figure 4.1: Age-standardized weighted prevalence, awareness, treatment, and control rates of young-onset hypertension in Malaysia, 2006–2015

The separate effects of age, gender, and ethnicity on YOH awareness, treatment, and control were also evaluated (Table 4.4). With regard to YOH awareness, although the rate of change among those aged < 30 years increased significantly from 9.2%, 95% CI [7.7, 11.0] in 2006 to 13.6%, 95% CI [11.4, 16.2] in 2015, aOR 1.56, 95% CI [1.17, 2.07], overall, YOH awareness was still lower among the younger age group as compared to their older counterparts. A similar pattern was seen in YOH treatment rates between 2006 and 2015. However, among young adults who were on treatment for YOH, better control was achieved in the younger age group than in the older age group.

During the period 2006–2015, YOH awareness rates remained stable in both genders, with women having generally higher awareness and treatment rates as compared to men, but lower control rates. In men, YOH treatment and control rates increased by 7.7%, 95% CI [5.9, 9.2] and 7.0%, 95% CI [4.8, 8.4] from 2006 to 2015, respectively, although non-significantly: aOR 1.37, 95% CI [0.87, 2.14] and aOR 1.35, 95% CI [0.66, 2.73], respectively.

YOH awareness rates were unchanged in all racial/ethnic groups between 2006 and 2015. Treatment rates also remained stable for all ethnic groups with the exception of the Chinese group, decreasing 21.5% from 64.3%, 95% CI [50.4, 76.2] in 2006 to 42.8%, 95% CI [25.8, 61.8] in 2015, aOR 0.42, 95% CI [0.16, 1.09]. On the other hand, control rates improved by at least 20% for almost all ethnicities with the exception of the Malay group which remained stable at 29.4%, 95% CI [21.5,38.8] in 2006 and 30.9%, 95% CI [21.9,41.6] in 2015, aOR 1.07, 95% CI [0.57, 2.01].

Table 4.4: Awareness, Treatment, and Control of YOH by Age, Gender, and Ethnicity, 2006–2015

NHMS Year	Prevalence			Change, 2006 to 2015	Odd Ratio
	2006	2011	2015	% (95% CI)	2006–2015
Awareness					
Age group (years)					
< 30	9.2 [7.7,11.0]	19.0 [16.3,22.0]	13.6 [11.4,16.2]	4.4 [3.7,5.2]	1.56 [1.17,2.07]*
≥ 30	20.1 [18.1,22.2]	24.4 [21.6,27.5]	19.0 [16.3,21.9]	-1.1 [-1.8,-0.3]	0.93 [0.75,1.16]
Gender					
Male	11.9 [10.3,13.7]	18.9 [16.4,21.7]	13.8 [11.7,16.3]	1.9 [1.4,2.6]	1.19 [0.93,1.53]
Female	18.7 [16.7,20.9]	26.4 [23.1,30.0]	19.9 [17.1,23.0]	1.2 [0.4,2.1]	1.08 [0.86,1.36]
Ethnicity					
Malay	14.0 [12.3,15.8]	23.6 [20.9,26.5]	15.3 [13.2,17.7]	1.3 [0.9,1.9]	1.11 [0.89,1.40]
Chinese	14.1 [10.9,18.2]	19.5 [14.5,25.6]	16.6 [11.5,23.4]	2.5 [0.6,5.2]	1.21 [0.72,2.05]
Indian	16.8 [11.9,23.2]	16.7 [10.6,25.2]	22.5 [15.2,32.0]	5.7 [3.3,8.8]	1.44 [0.77,2.71]
Other Bumiputeras	17.1 [13.9,20.8]	22.4 [16.8,29.3]	22.3 [16.7,29.2]	5.2 [2.8,8.4]	1.40 [0.91,2.16]
Others	10.8 [7.4,15.4]	14.3 [9.1,21.8]	9.4 [5.8,15.0]	-1.4 [-1.6,-0.4]	0.87 [0.44,1.69]
Treatment					
Age group (years)					
< 30	31.6 [23.7,40.8]	27.8 [20.8,36.2]	30.7 [22.6,40.3]	-0.9 [-1.1,-0.5]	0.96 [0.54,1.71]
≥ 30	53.2 [47.6,58.8]	48.9 [42.0,55.8]	62.5 [54.7,69.7]	9.3 [7.1,10.9]	1.46 [0.99,2.1]
Gender					
Male	40.3 [33.6,47.4]	35.5 [28.5,43.0]	48.0 [39.5,56.6]	7.7 [5.9,9.2]	1.37 [0.87,2.14]
Female	52.3 [46.0,58.5]	44.8 [37.6,52.3]	48.8 [41.0,56.8]	-3.5 [-5.0,-1.7]	0.87 [0.58,1.31]

Table 4.4, continued

NHMS Year	Prevalence			Change, 2006 to 2015 % (95% CI)	Odd Ratio 2006–2015
	2006	2011	2015		
Ethnicity					
Malay	43.8 [37.5,50.4]	41.3 [35.0,47.9]	49.9 [42.7,57.0]	6.1 [5.2,6.6]	1.28 [0.86,1.89]
Chinese	64.3 [50.4,76.2]	38.6 [24.4,55.1]	42.8 [25.8,61.8]	-21.5 [-24.6,-14.4]	0.42 [0.16,1.09]
Indian	49.8 [33.9,65.7]	41.2 [20.5,65.5]	56.6 [36.4,74.8]	6.8 [2.5,9.1]	1.32 [0.26,3.78]
Other Bumiputeras	41.6 [30.9,53.2]	34.4 [22.1,49.2]	43.0 [28.5,58.8]	1.4 [-2.4,5.6]	1.06 [0.48,2.34]
Others	32.8 [17.6,52.7]	36.6 [19.1,58.6]	46.8 [25.1,69.8]	14.0 [7.5,17.1]	1.80 [0.51,6.43]
Control					
Age group (years)					
< 30	38.2 [24.1,54.6]	49.1 [33.5,64.9]	49.4 [32.3,66.6]	11.2 [8.2,12.0]	1.58 [0.60,4.20]
≥ 30	29.9 [23.6,37.1]	34.8 [25.9,44.8]	35.1 [26.7,44.6]	5.2 [3.1,7.5]	1.27 [0.76,2.11]
Gender					
Male	34.0 [24.4,45.5]	37.8 [26.5,50.5]	41.0 [29.2,53.9]	7.0 [4.8,8.4]	1.35 [0.66,2.73]
Female	30.0 [23.0,38.0]	40.3 [30.0,51.7]	37.1 [26.5,49.2]	7.1 [3.5,11.2]	1.38 [0.75,2.54]
Ethnicity					
Malay	29.4 [21.5,38.8]	33.6 [24.5,44.1]	30.9 [21.9,41.6]	1.5 [0.4,2.8]	1.07 [0.57,2.01]
Chinese	38.3 [24.4,54.4]	62.6 [39.0,81.5]	61.4 [34.0,83.1]	23.1 [9.6,28.7]	2.57 [0.70,9.44]
Indian	44.4 [24.8,65.9]	30.8 [7.8,69.9]	67.1 [40.3,86.0]	22.7 [15.5,20.1]	2.56 [0.62,10.51]
Other Bumiputeras	28.7 [16.9,44.3]	53.1 [27.3,77.4]	49.7 [27.4,72.1]	21.0 [10.5,27.8]	2.46 [0.76,7.99]
Others	20.4 [4.9,55.9]	36.3 [9.9,74.8]	17.6 [2.5,63.5]	-2.8 [-2.4, 7.6]	0.83 [0.06,11.65]

4.1.4 YOH and Associated Risk Factors

Regression analysis was performed to assess the independent association of YOH prevalence with sociodemographic, lifestyle, and cardiovascular risk factors. In each of the three surveys, men and those aged ≥ 30 years had significantly higher odds (approximately twofold) of developing YOH as compared to women and those < 30 years old, respectively. The likelihood of developing YOH was higher among those living in rural areas, and this was statistically significant during 2006; however, the converse was seen in 2015. With regard to ethnicity and using the Malay ethnicity as the referent group, Chinese and Indian ethnic groups had lesser odds of developing YOH.

In terms of SES, young adults with lower levels of education (no formal, primary, and secondary education) were more likely to develop hypertension as compared to those who had attended tertiary education. This result was statistically significant for primary education in all three surveys over the decade 2006–2015. Furthermore, young adults with lower levels of household income (bottom 40% and middle 40%) were more likely to develop YOH, and this result was statistically significant in the bottom 40% income group throughout the ten-year period. Also, the analysis showed that a positive family history of hypertension increased the risk of developing YOH from twofold, aOR 2.05, 95% CI [1.86, 2.26] in 2006 to sixfold in 2015, aOR 6.74, 95% CI [5.73, 7.94].

With regard to lifestyle factors, YOH was more common in those who consumed alcohol, and this association was statistically significant for 2006 and 2011. On the other hand, YOH was less common among smokers and those who were physically inactive. A concurrent separate diagnosis of DM, hypercholesterolaemia, obesity (BMI ≥ 30), and abdominal obesity was more common in young hypertensive adults, and these results were statistically significant throughout the decade. The aOR and the 95% CIs for YOH as the dependent variable are shown in Table 4.5.

Table 4.5: Associations of Sociodemographic, Lifestyle, and Cardiovascular Risk Factor with YOH, NHMS 2006–2015

Factors	2006		2011		2015	
	Unadjusted OR	Adjusted OR	Unadjusted OR	Adjusted OR	Unadjusted OR	Adjusted OR
Sociodemographic factors						
Gender (Referent: female)	1.74 [1.60,1.89]	2.56 [2.28,2.89]*	1.61 [1.43,1.81]	2.30 [1.96,2.70]*	1.61 [1.44,1.81]	2.33 [1.99,2.74]*
Age Group (years) (Referent: < 30)	2.05 [1.88,2.24]	1.92 [1.75,2.11]*	2.40 [2.13,2.71]	2.32 [2.03,2.65]*	2.04 [1.83,2.28]	1.97 [1.73,2.24]*
Locality (Referent: Urban)	1.43 [1.30,1.57]	1.22 [1.10,1.36]*	1.09 [0.96,1.26]	0.95 [0.82,1.10]	1.17 [1.02,1.33]	0.86 [0.74,0.99]*
Ethnicity (Referent: Malay)						
Chinese	0.81 [0.71,0.93]	0.80 [0.69,0.92]*	0.86 [0.72,1.03]	0.76 [0.62,0.94]*	0.77 [0.64,0.93]	0.69 [0.55,0.87]*
Indian	0.74 [0.63,0.88]	0.61 [0.51,0.73]*	0.87 [0.68,1.10]	0.63 [0.47,0.85]*	0.82 [0.64,1.05]	0.50 [0.38,0.66]*
Other Bumiputeras	1.13 [0.99,1.29]	1.15 [0.99,1.32]	1.33 [1.10,1.60]	1.38 [1.12,1.71]*	1.31 [1.08,1.58]	1.15 [0.92,1.43]
Others	0.98 [0.81,1.18]	1.27 [1.04,1.55]*	0.83 [0.65,1.06]	0.95 [0.73,1.22]	1.09 [0.86,1.38]	1.49 [1.14,1.94]*
Education Level (Referent: Tertiary)						
None	1.97 [1.52,2.56]	1.75 [1.31,2.35]*	1.27 [0.79,2.01]	1.05 [0.63,1.76]	0.95 [0.62,1.46]	0.99 [0.63,1.55]
Primary	1.54 [1.32,1.81]	1.41 [1.18,1.68]*	1.45 [1.20,1.75]	1.26 [1.01,1.58]*	1.65 [1.37,1.98]	1.32 [1.05,1.65]*
Secondary	1.38 [1.20,1.59]	1.25 [1.07,1.46]*	1.27 [1.12,1.45]	1.09 [0.94,1.26]	1.10 [0.97,1.24]	0.93 [0.81,1.07]
Unclassified	1.07 [0.72,1.60]	1.14 [0.72,1.79]	0.57 [0.29,1.13]	0.72 [0.35,1.50]	1.15 [0.76,1.77]	1.49 [0.94,2.35]

Table 4.5, continued

Factors	2006		2011		2015	
	Unadjusted OR	**Adjusted OR**	**Unadjusted OR**	**Adjusted OR**	**Unadjusted OR**	**Adjusted OR**
Household income (Referent: Top 20%)						
Bottom 40%	1.52 [0.93,2.47]	1.59 [1.04,2.43]*	1.62 [1.18,2.24]	1.67 [1.16,2.40]*	1.28 [1.02,1.59]	1.55 [1.20,2.00]*
Middle 40%	1.17 [0.70,1.95]	1.26 [0.80,2.00]	1.40 [0.99,1.96]	1.31 [0.91,1.89]	1.10 [0.86,1.40]	1.11 [0.85,1.44]
Family History (FH) (Referent: No FH)	1.79 [1.64,1.96]	2.05 [1.86,2.26]*	1.52 [1.34,1.73]	1.74 [1.51,2.00]*	5.73 [4.92,6.68]	6.74 [5.73,7.94]*
Lifestyle factors						
Alcohol (Referent: Non-alcoholic)	1.15 [1.00,1.33]	1.18 [1.01,1.38]*	1.30 [1.09,1.57]	1.40 [1.11,1.76]*	1.50 [1.22,1.84]	1.26 [0.97,1.63]
Current smoker (Referent: Non-current smoker)	1.21 [1.11,1.32]	0.76 [0.67,0.86]*	1.14 [1.01,1.29]	0.71 [0.60,0.83]*	1.31 [1.16,1.49]	0.93 [0.78,1.11]
Physical activity (Referent: Active)	0.84 [0.77,0.91]	0.92 [0.84,1.01]	0.83 [0.74,0.93]	0.98 [0.86,1.11]	0.86 [0.76,0.97]	1.03 [0.89,1.18]
Cardiovascular risk factors						
Diabetes Mellitus (Referent: Normal)	2.81 [2.36,3.35]	1.77 [1.45,2.15]*	2.55 [2.14,3.05]	1.73 [1.41,2.12]*	2.83 [2.41,3.32]	2.32 [1.91,2.82]*
Hypercholesterolaemia (Referent: Normal)	2.02 [1.81,2.26]	1.52 [1.35,1.71]*	1.68 [1.48,1.90]	1.42 [1.24,1.63]*	1.98 [1.77,2.22]	1.53 [1.34,1.74]*

Table 4.5, continued

Factors	2006		2011		2015	
	Unadjusted OR	**Adjusted OR**	**Unadjusted OR**	**Adjusted OR**	**Unadjusted OR**	**Adjusted OR**
Obesity (Referent: Normal)	3.85 [3.46,4.29]	2.12 [1.85,2.42]*	4.47 [3.92,5.10]	2.97 [2.45,3.60]*	4.66 [4.10,5.29]	2.87 [2.43,3.39]*
Abdominal Obesity (Referent: Normal)	3.23 [2.95,3.54]	2.56 [2.28,2.87]*	3.41 [2.98,3.90]	1.77 [1.44,2.19]*	3.32 [2.94,3.75]	2.05 [1.75,2.39]*

4.2 Phase III Results – Qualitative Study: In-depth Interviews

The prevalence of YOH in Malaysia remained stable throughout 2006–2015, affecting almost one fifth of young adults. Awareness, treatment, and control rates among this subpopulation were suboptimal throughout the decade, with 15% aware of their diagnosis, of which less than 50% were on treatment and less than 40% of those who were on treatment had their BP controlled. The Phase III qualitative study aimed to explain the phenomena underlying the quantitative results with regard to the low awareness, treatment, and control rates among young adults. This was achieved by exploring young adults' perceptions and experiences about living with hypertension through the use of an IPA approach.

The use of IPA enables the researcher to uncover what a lived experience means to the individual through a process of in-depth reflective inquiry, which is particularly useful for understanding under-researched phenomena or perspectives (J. A. Smith et al., 2009), such as YOH. This lived experience includes their understanding of hypertension, the impact of the disease on their life, the factors influencing their treatment and control of the disease, and their needs in managing hypertension. The findings are presented in a manner that highlights the key shared themes while also presenting the idiographic uniqueness of the individual lived experience.

As much as possible, the researcher endeavoured to purposively sample a study population with varied characteristics (Table 4.6); however, participants from the Other Bumiputeras category could not be recruited, possibly due to the location of the study site in a city in West Malaysia. Nonetheless, it was considered that this would not excessively affect the results of the qualitative phase because living with YOH is multifactorial and care was undertaken to include other demographics in the study population.

The researcher recognizes that the qualitative study was conducted in 2019 and the secondary data covered the period 2006–2015. Trends in factors such as rates of disease are often used by public health professionals to assist in healthcare needs assessments, service planning, and policy development because examining data over time makes it possible to predict future frequencies and rates of occurrence to thereby provide an impression of the overall magnitude of a health problem (Bonita, Beaglehole, & Kjellström, 2006; Carneiro & Howard, 2011). As such, while acknowledging that population age structures change with time, the age-standardized trend analysis conducted in Phase II revealed that the prevalence, awareness, treatment, and control rates of YOH remained stable throughout the ten-year period from 2006 to 2015, making it more plausible that similar rates would exist in the following decade from 2016 to 2025. Hence, Phase III of this study provides the most up-to-date evidence on the experiences and perspectives of young hypertensive adults that influence the awareness, treatment, and control rates found in Phase II.

Table 4.6 summarizes the demographics of each participant who took part in the IDIs. In this part of the study, there were 12 participants, the majority of whom were male and over 30 years of age. All 12 participants hailed from urban localities and half were Malay. The majority of the participants had a tertiary level of education, belonged to the middle 40% income group, and had a positive family history of hypertension. With regard to lifestyle factors, most did not consume alcohol, all were non-smokers, and half of the group were physically active. One third of the participants had a co-existing diagnosis of DM and one sixth had been diagnosed with hypercholesterolaemia. Other comorbidities included OSA (n = 2), asthma (n = 1), epilepsy (n = 1), and gastritis (n = 1). The majority of the participants were overweight and obese according to BMI and WC measurements, respectively.

Table 4.6: Characteristics of Participants in the Qualitative Study

Characteristics	n
Gender	
Male	8
Female	4
Age group (years)	
≤ 30	2
> 30	10
Locality	
Urban	12
Rural	-
Ethnicity	
Malay	6
Chinese	4
Indian	2
Other Bumiputeras	-
Education	
None	-
Primary	-
Secondary	2
Tertiary	10
Household income	
Bottom 40%	2
Middle 40%	8
Top 20%	2
Family history	
Yes	9
No	3
Alcohol intake	
Yes	4
No	8
Smoking status	
Yes	-
No	12
Physical activity	
Yes	6
No	6
Existence of Comorbidities	
Diabetes mellitus	4
Hypercholesterolaemia	2
Others	5
None	4
Body mass index	
Normal	4
Overweight	3
Obese	4
Severely obese	1
Abdominal obesity	
Yes	9
No	3

4.2.1 Understanding of Hypertension

The interviews began with open-ended questions to discover the participants' understanding of the disease. The following subsections explore their knowledge of YOH based on their descriptions of hypertension, perceived causes, and illness-related concerns.

4.2.1.1 Description of Hypertension

The respondents correctly described hypertension as "high blood pressure" (or its direct translation in the Malay language). Additionally, the majority of respondents managed to give a BP value (whether within the normal range of SBP/DBP values or a hypertensive value), as exemplified by the following excerpt:

> *"The normal blood pressure is 120 and 80, so, mine was 160 and 170; and then, previously I've [got] to 200 plus for the upper reading, and 160 for the lower reading" (P002, male, 34 years old)*

The one exception was a respondent with a co-existing diagnosis of DM and a secondary level of education, and described hypertension as follows:

> *"It is like a wound, isn't it? A wound on the foot?" (P006, female, 37 years old)*

One possible reason for this description could be that P006 was describing a complication of DM (diabetic foot ulcer) instead of hypertension.

4.2.1.2 Perceived Causes

Respondents could report at least one correct causation factor for their disease, such as genetics/family history, inappropriate lifestyle behaviours (lack of physical activity, unhealthy diet) and being overweight. All the young adults, whether employed or unemployed, reported stress as a major causative factor. The stressors experienced by

these young adults included issues related to work, family, and finances. The following statements pertain to the participants' work-related stress:

"It was burning the candle from both ends when it comes to work, not sleeping well, eating junk food which has a lot of sodium. And then uncontrolled weight gain." (P000, male, 37 years old)

"I think one of the main causes would be my work. I've been working 24/7, and have only had three hours of sleep every day for the past two years. Basically, it's my company because we lack resources and the project that I'm handling right now requires five to six team members but we have only two persons. So, I've been doing five persons' jobs." (P005, female, 31 years old)

"Yeah, I have been working in this profession for 14 years. It has been a very stressful job, as I'm constantly conducting high-profile cases that deal with life and death. One wrong decision might result in a disastrous [situation]; so, the stress level is quite high. Everything is on an urgent basis. Personally, I think that I developed high blood pressure or hypertension due to work." (P009, male, 38 years old)

The one unemployed participant (who had a concurrent diagnosis of DM, secondary-level education, and incorrectly described hypertension as mentioned in the previous subsection) also spoke about stress when caring for her relatives' children:

"I'm stressed because I'm a carer for my relatives' children. I'm scared that when I get angry, I will scold and hit the kids." (P006, female, 37 years old)

Other stressors included issues related to married life and problems with money, as illustrated by the following extracts:

"Marriage could have contributed mainly to the diagnosis. I mean, my marriage was an arranged marriage. So, it took a while for my partner and I to find our groove, because we were both brought up with different sets of values in life. Hence, it actually caused conflict between us." (P010, male, 33 years old)

"A contributing factor is my family situation. My mother is separated from my father, so, it's just me taking care of my family. My father already has heart disease; thus, I am responsible for my family. Perhaps, that's the cause. I need to take care of my brother and my father because I'm the older child." (P011, male, 26 years old)

"Yes, I am stressed because you know, my family just like every other family, needs money to survive." (P003, male, 21 years old)

4.2.1.3 Illness-related Concerns

Most of the young adult interviewees could describe at least one hypertension-related health complication (e.g., stroke, heart attack). Several participants also spoke of concerns about sudden death and dying too young:

"I did Google complications of hypertension [tears welling up, becoming emotional, voice breaks] and it mentions that it may cause stroke and also heart attack." (P005, female, 31 years old)

"I worry my heart function will decrease as I age. I'm 26 now, and I do not know what my situation will be like when I reach 40, whereby my heart function may be reduced. I also worry about the heart attacks and stroke." (P011, male, 26 years old)

Those young adults who had no illness-related concerns had up to a secondary level of education. When queried and probed further regarding their concerns or worries about future risk, they could not respond. Several respondents who had a concomitant diagnosis of DM expressed more concerns about their DM diagnosis over hypertension, as illustrated by the following response:

> *"Since I have diabetes as well, I'm more concerned about my diabetes than my hypertension because hypertension, I know, I can control, but diabetes, I know, down the road regardless of you controlling it or not, complications tend to occur. So, I'm a bit more concerned [about my diabetes]." (P010, male, 33 years old)*

4.2.2 Personal Experience of Living with Hypertension

The young adults with hypertension were also asked to reminisce about their initial diagnosis and given opportunities to freely express the ways in which this diagnosis has affected their lives psychologically, socially, and economically.

4.2.2.1 Impacts of the Disease

(a) ***Psychological Impact***

The respondents cited at least one emotion they had experienced in relation to their diagnosis. The most common emotions mentioned were "surprised", "scared" and "angry". Some respondents identified feelings of "self-blame" or "regret" following their preliminary diagnosis of YOH. Such respondents viewed their condition as their fault and a representation of poor lifestyle decisions:

> *"I didn't practise physical activity, exercise and perhaps my eating habits were not healthy at that time. Therefore, my BMI reflected that – I was slightly obese." (P001, female, 35 years old)*

> *"In my opinion, I believe it is because when I was younger, I loved eating fast food and all types of food. I never controlled my diet; I hardly drank plain water. Yes, I*

think it is because I didn't practise eating healthily at a young age. Therefore, now I have this problem." (P007, male, 38 years old)

Additionally, the issue of negative stigma associated with hypertension was raised by the majority of the young adults interviewed, although their responses were more inclined towards self-stigma rather than public stigma, as exemplified by the following:

"I do not tell my friends that I have hypertension. Because I am afraid that if they find out, they won't want to be friends with me. I feel that they won't be able to accept me because they are all well in themselves, unlike me." (P004, male, 36 years old)

"I don't like telling people about my diagnosis except for my best friend. The reason being I feel embarrassed. Embarrassed because I have hypertension, even before 40 years old. Usually, people say that those above 40 are the ones who fall sick, not me." (P008, female, 39 years old)

"I feel shy because being diagnosed at a young age, people will judge me. They will be wondering why I am so young yet I have this disease. So, I just want to keep it private and confidential." (P011, male, 26 years old)

All of the respondents did not expect that they would develop hypertension, especially at this young age. Nonetheless, some had previous experiences with members of their family encountering complications of hypertension (e.g., death, heart attack, stroke).

(b) ***Social Impact***

The majority of the respondents stated that having this diagnosis affected their lifestyle in positive ways such as choosing healthier foods and drinking less alcohol and fewer caffeinated drinks, as shown by the following two excerpts:

"I choose to eat healthier. I choose lower carb stuff. Also, I eat smaller portions, for example, maybe I'll take one or two bites then I'll share it, instead of having one for myself." (P001, female, 35 years old)

"Nowadays, I have stopped having coffee as it can trigger my headaches. Now, I just choose to drink plain water. I also drink fewer carbonated drinks. I have stopped eating food that contains MSG [monosodium glutamate], junk food. My wife cooks for me and she reduces the salt and sugar content of home-cooked foods." (P007, male, 38 years old)

An interesting impact of having hypertension that was mentioned by one respondent was that the diagnosis had made them step back from work-related stressors and socialize more:

"Basically, I socialize more. Before, I was working all the time. Since knowing this hypertension is caused by stress, I try not to stress myself, and I go out more often and do things that make me happy." (P005, female, 31 years old)

In contrast, another respondent admitted that the diagnosis had had no significant impact on his lifestyle:

"Oh, I haven't controlled my diet, not even the slightest bit. Everything is just the same as before." (P009, male, 38 years old)

(c) ***Economic Impact***

All of the respondents were being prescribed antihypertensive medication(s). The majority admitted that the diagnosis did not impact them financially; for these respondents, the cost of treatment (medicine and consultations) was borne by their companies or, in the case of the unemployed respondent, by their family. The other

respondents spoke of the economic impact of the medications and blood investigations, for example:

"My concern is of course the cost of the treatments. It is still affordable at this point. However, I need to set aside money for medical bills, money which could have gone to savings." (P001, female, 35 years old)

"I have to take a lot of medication, which amounts to a lot every year. Previously I used to be able to ask my mother for money when I was back in my hometown. Now that I have moved to KL, I pay for myself. I need to pay RM40 every time, which is quite expensive for me." (P003, male, 21 years old)

The economic impact of medication was a recurring theme for the above respondent P003 and also for P006 (female, 37 years old, with concurrent DM). Both of these respondents were in the bottom 40% income group and had a secondary level of education. In the above subsection 4.2.1.2 on perceived causes of YOH, P003 cited stress in relation to money issues as a contributing factor.

4.2.3 Factors Influencing Treatment Adherence

Treatment in the context of this study includes lifestyle changes and/or compliance with medication. This subsection contains the respondents' elaborations on the facilitators and barriers that influenced their treatment adherence.

4.2.3.1 Facilitators of Treatment Adherence

(a) ***Social Support***

All respondents cited strong social support from family members, peers, workplace, and physicians or medical staff as a facilitator of treatment adherence. Statements about support from family members include the following:

"My wife is there to remind me to take my medication, she is a very good support for me. My mother too advises me to control my diet and what I eat." (P002, male, 34 years old)

"My mother tells me it is very important to take my medication every day. Because, if there are any problems in the future, nobody can save me." (P003, male, 21 years old)

Statements about support from friends include the following:

"My friends help me adjust to a new diet because they are trying to eat healthy as well. They ask to go for healthier alternatives rather than the heavier foods. So, yeah, I do have good support from my friends. They're alright." (P001, female, 35 years old)

"My friends actually encourage me to eat healthier." (P010, male, 33 years old)

Statements about support from work and colleagues include the following:

"When I was admitted into Emergency, that was when my bosses became aware of my condition and then they let me take two weeks off just to recover fully. Also, they tried to reduce some of the workload. In my line of work, we have to handle a few projects; so, instead of having a lot of projects, now, I'm handling only one project. My assistants too are aware of my diagnosis and they help me a lot." (P005, female, 31 years old)

"Usually, when they (my colleagues) find out that I have this condition, they advise me to rest if I'm tired. They don't push me to do work, and ask me to rest. So far, they have been very understanding. There has not been anyone who, when they find out I am sick, ask me to continue my work." (P007, male, 38 years old)

Statements about support from doctors or medical personnel include the following:

"The doctor knows that we can read stuff up on the internet now. My GP was very good, he had this whole talk about how you can try and titrate the drugs that I'm taking now by taking care of my lifestyle. So, we had a chat about how you have to have a lifestyle change, as it's dangerous to have blood pressure so high. Then, he told me it may damage your kidneys in the long run. It may be bad for your heart. You may get a stroke, that sort of thing. He says it must be controlled. At 160/110, it must be controlled." (P000, male, 37 years old)

"My regular doctor here in RUKA referred me to the dietitian and to the Sport Medicine Clinic. By them doing so, I feel that someone cares about me and emotionally supports me." (P008, female, 39 years old)

(b) ***High Self-efficacy***

The majority of respondents displayed at least one element of "self-efficacy" and willingness to change their lifestyle for the betterment of their health and improve their knowledge about YOH, as illustrated by the following extracts:

"I read a lot about hypertension, and keep [making] notes, even Facebook or whatever, that is, any information that I can find regarding hypertension and what it will lead to." (P002, male, 34 years old)

"I change my food intake by eating foods with less salt content. I eat more oats and it's totally a 360-degree change. I don't drink sweet drinks anymore and I [eat] more fruits. Basically, more oats, less carbonated drinks, more frequent water… When I eat out, I choose foods with less calories. After all, I can't avoid going to places that serve unhealthy food, right? So, what I can do is just cut my calories." (P005, female, 31 years old)

(c) ***Perceived Threat or Severity of Disease***

Another facilitator of treatment adherence that was apparent among the respondents was their "perceived threat or severity of disease", such as fear of stroke, myocardial infarction, and death – outcomes which the participants have either read about or witnessed first-hand among friends or family members:

> *"I have a friend who died young. I don't know what exactly happened to her but what I know is that I don't want to die young. I am too young to die." (P003, male, 21 years old)*

> *"I worry about heart attacks and stroke. Previously, my father had a heart attack and I [can] see that he's suffering for it. So, I just don't want to get it. It's too early, I'm too young." (P011, male, 26 years old)*

(d) ***Experiencing Symptomatic Relief***

Respondents spoke of experiencing symptomatic relief when taking their medications, such as a decrease in frequency of headaches and an easing of their 'quick-to-anger' temperaments. The benefits motivate them to comply with the treatment regime, as illustrated by the following excerpts:

> *"I can feel the difference when I take the medications and when I don't. I feel healthier, I mean, I can feel the blood circulate better compared to when I do not comply with the medications. Also, I don't get headaches or numbness when I take them." (P005, female, 31 years old)*

> *"If I don't take my medication, I will get angry and scold the children. After taking my medication, I feel better and more in control of my emotions." (P006, female, 37 years old)*

"I know that if I don't take the medication, my condition will worsen. I have tried not taking medication for three days and I suffered from a severe headache. I was worried that I would have a stroke." (P008, female, 39 years old)

(e) ***Role-modelling***

'Role-modelling' was an interesting facilitator that emerged from the IDI analysis, where respondents spoke of exemplary people who made a change in their lifestyle and health that they would like to emulate. Two such examples are given below:

"I have a friend, my colleague, who is 20 years older than me, who does not have any disease. That's amazing, right? Furthermore, I have a colleague who is the same age as me, but has no hypertension, although he has another disease which is a fatty liver and he is also a heavy smoker. After getting his diagnosis, he changed his diet and everything. Subsequently, there were significant changes in his lifestyle and his condition improved!" (P002, male, 34 years old)

"I obtained this idea from my ex-boss. He posted up on Facebook and Instagram tips on how to achieve 10,000 steps a day. So, regardless of his work, he actually stops the car and he will walk to work and back home. I got the idea from him, and I thought, 'Why don't I try doing this?'" (P010, male, 33 years old)

4.2.3.2 Barriers to Treatment Adherence

All the recruited respondents reported receiving treatment for hypertension. There were a number of barriers to treatment adherence that were mentioned. These were attributed to personal (time constraints), treatment (side effects of medication), and disease (being asymptomatic) factors.

(a) ***Time Constraints***

Lack of time was the barrier to treatment adherence that was most often cited. The majority of respondents admitted that lack of time was mainly due to work (long hours, working two jobs to make ends meet), as exemplified by the following:

> *"I can only exercise three times a week. Actually, my doctor advised me to exercise four or five times a week, but I cannot because I do not have a lot of time. I finish work at 7 pm, then at night I actually provide Grab car services; I go around KL, providing Grab car services and then I only go back home at 11 pm or sometimes 12 am. So, after I get home, there is no time for exercise." (P004, male, 36 years old)*

However, some respondents also stated that lack of time was due to social activities (e.g., watching movies), which took precedence over healthy activities.

> *"If there is a new movie that [has been] released, I would rather go to watch a movie with my friends than exercise." (P003, male, 21 years old)*

(b) ***Side Effects of Medication***

Respondents stated that side effects acted as a deterrent to compliance with medication. Common side effects include fertility problems (in males), kidney problems (increased frequency of micturition), cough, and liver problems. Some of the concerns expressed by the respondents are illustrated below:

> *"One of the things you always see [in movies] is they tell you if you take the medication, then you may be impotent when you're a bit older. That was the first question [I put] to my GP." (P000, male, 37 years old)*

> *"When I spoke to my colleague, she told me not to take hospital medicine. She said that her father took these medications and he subsequently developed kidney disease. So, maybe it's just a minor effect as I am experiencing frequent urination*

but maybe if I take the medication [for a long time], something more will happen." (P002, male, 34 years old)

(c) ***Being Asymptomatic***

Some respondents mentioned that they did not experience any symptoms of hypertension, hence non-compliance with medication usually led to no negative health repercussions:

"I did realize my blood pressure is always on the high side but I really didn't bother to do anything about it because I think I'm coping with it quite well, and I don't have any symptoms of high blood pressure. I don't have dizziness or the so-called symptoms that they are talking about. I eat well, sleep well, everything [has been] just fine for me; so, I literally have ignored it for…I think [for] many years. I do have the blood pressure machine at home; sometimes when I check, it is on the high side. But physically, I don't feel bad [in] myself. The funny thing is, when I forget to take my medication, I feel no difference. I did accidentally skip [it] for [one] week because I was outstation and I ran out of [my] supply but physically and mentally, I didn't feel any difference." (P009, male, 38 years old)

This same respondent (P009) had mentioned earlier that having a diagnosis of YOH had no significant impact on his lifestyle, possibly because he does not experience any untoward symptoms of hypertension.

4.2.4 Needs in Managing Hypertension

The latter part of the interview delved into possible solutions to address young adults' needs in managing hypertension. These included shared decision-making with their healthcare professionals, managing their long-term expectations of treatment, prevention through increasing awareness among their peers, utilization of social media and provision of hypertension education materials during clinic consultations.

(a) ***Shared Decision-making***

The majority of respondents, from all age groups and education levels, agreed that shared decision-making was an important aspect in a doctor–patient relationship. Although some stated that they respected their doctors' decisions and advice, the majority of the respondents wanted to be more involved in choices pertaining to their health instead of being told what to do. They also wanted the doctor to spend more time listening to them during consultations instead of just "doing their job", as illustrated by the following excerpt:

> *"It would be better if the doctors could spend more time with you, talking more about your lifestyle changes. I don't have a doctor who will take a real interest. If you have a GP that you see all the time and he knows you, you can talk about things other than what ailment you have at this very moment. Then, talking to you about lifestyle changes it sort of comes through, instead of seeing a GP that you have not seen before in your life, that tells you that 'Oh, you need to lose weight'." (P000, male, 37 years old)*

Another respondent highlighted how they feel about complying with their medication instructions:

> *"The doctor will usually advise me to take the medication, and [he] can be rather insistent. Therefore, I'll [acquiesce] to appease him. However, if I don't take the medicine, when I go see him next with an improved BP reading, I will tell him what I've done." (P002, male, 34 years old)*

Earlier, the same respondent (P002) had described having side effects with his current treatment resulting in increased frequency of micturition. Additionally, this respondent was advised by his colleague not to take his medication as it could cause kidney disease; a comment which may have exacerbated his doubts. Although he was in disagreement

with his treatment, he was not entirely forthcoming about this to his doctor. In this situation, the researcher advised him that it was in his best interests to discuss any concerns he might have pertaining to his treatment with his physician during his next follow-up.

(b) ***Managing Long-term Treatment Expectations***

When asked about the most important benefits or results they would expect from treatment, some respondents wanted to be completely cured of the disease after taking the medication. They hoped to be able to stop taking medication completely and get back a sense of being "normal" again:

> *"For me, if possible, I want to be well again – just like when I was younger. I don't want to take any more medication." (P007, male, 38 years old)*

> *"That's the only reason why I am following the plan. If I follow the plan that is given then I will get rid of hypertension from my body. I won't need to rely on medication anymore." (P009, male, 38 years old)*

(c) ***Prevention through Increasing Awareness among Peers***

The respondents also spoke of the importance of increasing the awareness of YOH among other young adults so as to prevent them from going down the same path. Some respondents recommended compulsory work-sanctioned activities and/or medical check-ups to raise awareness among young working adults who were too busy to take time off for routine health checks. Some examples of the respondents' views on this issue are given below:

> *"Private practices and the GPs or the polyclinics should have enough time to counsel and convince people who are hypertensive to change their lifestyle. The doctors don't do enough of it now. They're just treating…. The population needs to*

be educated more. I feel like you should educate them to make sure that other young people don't go down the same road." (P000, male, 37 years old)

"Awareness can be improved by the hospital or health facilities implementing a clinic or a workshop on young-onset hypertension. Some pertinent topics would be how to prevent hypertension, and the causes of hypertension. You should inform the public earlier before they reach their 30s as there are already some people experiencing hypertension in their 20s." (P002, male, 34 years old)

"I would suggest organizing activities that can be broken into in several short sessions. For example, the first session would detail the participants' health conditions, then the second session would detail the adverse effects of non-compliance with medications, so on and so forth. These short sessions should be aimed at captivating the audience and leaving them wanting more information." (P003, male, 21 years old)

"My previous workplace used to encourage overweight or obese staff to utilize the staff gym. Furthermore, every Wednesday, we would have a 'healthy menu' available – where there's no salt involved, therefore it's not tasty (laughs). Also, every Wednesday we have Zumba classes for the staff. There's also a programme called Stepathlon where staff members form groups of six people who collect points by walking and cycling and other activities. The person with the most points at the end of a certain time period gets a prize." (P008, female, 39 years old)

"If there was a compulsory order from the workplace to check for a hypertension diagnosis especially with an annual health check-up then it wouldn't be an issue. But for young people to go and do voluntary health checks, I doubt they will do so. In my opinion, I might be 38 years old, but I have a group of friends who are in

their twenties, and none of them go for check-ups. So, asking them to go [for a] check-up is [tantamount to] insulting them, saying that they have problems." (P009, male, 38 years old)

(d) ***Use of Social Media***

The majority of young adults reported finding social media a helpful tool in terms of getting information and sharing lifestyle advice. Those respondents who did not use social media as a tool to gain information about YOH cited their doctors/family members as important sources of information. Therefore, education about hypertension needs to be tailored to the individual's needs.

Some recommendations made by the young adult respondents include the use of real-life persons (case studies) on social media platforms to share their life experiences about coping with YOH. This makes the disease more relatable and realistic. Also, the male respondents seem to have a predilection for videos rather than text.

"I think that social media can actually be used to inform. However, the delivery method needs to be interesting to appeal to younger audiences versus the general public. It really needs to be specific for younger audiences, that's when people will listen. If it's very general like something your mom and dad can relate to then the younger audience can't relate. Social media can influence young people who are going through the same ordeal [as we are], that's when we tend to listen even more. So, if they are making life changes too, you think, okay I can do that as well. So, you lead by example, [learn] from people who are in the public [eye] like Instagram influencers. I believe that is how you can appeal to younger audiences." (P001, female, 35 years old)

"Videos would be helpful, but they have to be short. Nowadays, people do not like to watch long videos. You can make them in segments – for example parts one, two and three – so that people will be eager to watch or wait for the next 'instalment'." (P003, male, 21 years old)

"I like to read about case studies, about how people like myself develop hypertension. I will compare and see if my life is similar to theirs, that is, if their history is similar to mine. If it is relatable, then the information can help me and is very valuable. It is more realistic this way." (P004, male, 36 years old)

"With regards to the information, don't give us too much of it. Just put the most important things in bullet points. When we are free to read further and if we are interested in knowing more, then we can click on the associated link." (P007, male, 38 years old)

(e) ***Education Materials on Hypertension***

The majority of respondents reported that they had not received any hypertension education materials from the clinic. Yet, all reported that they would benefit from reading leaflets or pamphlets with information about hypertension if they were handed some. Requested material included information in their native language (Chinese/Tamil/Malay), reasons/causes behind the development of their disease (why and how), methods to control/prevent high BP, and the outcomes of hypertension, among others:

"I just want to know what the causes of young hypertension [are]. Is it because of my lifestyle or is it because of my past problems, such as my food intake? I'm not sure? Also, I would like to know more about methods to reduce high blood pressure, as well as how to prevent heart attacks and stroke." (P011, male, 26 years old)

To summarize, the results gleaned from the participants' responses are shown in Table 4.7 below.

Table 4.7: Summary of Young Adults' Perceptions and Experiences about Living with Hypertension

Themes and Sub-Themes	Concepts	Findings
Understanding of hypertension		
• Description of hypertension	What hypertension means to young adults	Most correctly described hypertension as high blood pressure The majority provided a correct BP value
• Perceived causes	Knowledge of risk factors	All respondents reported at least one correct causation factor, such as genetics/family history, inappropriate lifestyle behaviours, being overweight and stress
• Illness-related concerns	Knowledge of future risks	Most described at least one clinical complication associated with hypertension, such as stroke and myocardial infarction
Personal experience of living with hypertension	The ways the diagnosis has impacted their lives	Psychological impact: The most common emotions experienced were feeling surprised, scared and angry. Some expressed regret/self-blame. The majority were concerned about self-stigma. Social impact: The majority reported a positive impact of a YOH diagnosis such as choosing healthier foods and drinking less alcohol/caffeinated drinks. Economic impact: The majority reported no impact as the cost of treatment was borne by the government (for civil servants) or companies (for private employees). However, the cost of medication had an effect on those from the lowest income group and lower education levels.

Table 4.7, continued

Themes and Sub-Themes	Concepts	Findings
Factors influencing treatment adherence		
• Facilitators of treatment adherence	Factors that encourage compliance with medication and lifestyle advice	Social support, high self-efficacy, perceived threat or severity of disease, experiencing symptomatic relief, and role-modelling were cited as facilitators
• Barriers to treatment adherence	Factors that discourage compliance with medication and lifestyle advice	Time constraints, side effects of medication, and being asymptomatic were cited as barriers
Needs in managing hypertension	Unmet needs based on current healthcare provision	Shared decision-making, managing long-term treatment expectations, prevention through increasing awareness among peers, use of social media, and distribution of education materials on hypertension were highlighted as possible ways in which to help manage hypertension

4.3 Summary of the Chapter

Overall, the results presented in this chapter answered research objectives two to four, which, to recap, were:

ii. To describe the prevalence, awareness, treatment, and control of YOH in Malaysia from 2006 to 2015;

iii. To measure the association of YOH with sociodemographic factors (gender, age, locality, ethnicity, education, income, family history), lifestyle (alcohol intake, smoking, physical activity), and cardiovascular risk factors (diabetes, hypercholesterolaemia, obesity, abdominal obesity);

iv. To understand the underlying experiences and perspectives of young adults' living with hypertension that influence the awareness, treatment, and control rates of YOH in Malaysia.

The results from Phase II revealed that the prevalence of YOH in Malaysia remained stable throughout the period 2006–2015, affecting almost one fifth of young adults: 17.7%, 95% CI [17.0, 18.3] in 2006, 17.0%, 95% CI [16.0, 17.9] in 2011 and 18.4%, 95% CI [17.4, 19.4] in 2015. Awareness, treatment and control rates among this subpopulation were suboptimal throughout the decade, with 15% aware of their diagnosis, of which less than 50% were on treatment and less than 40% of those who were on treatment had their BP controlled, hence leaving much to be desired.

Overall, based on the analysis of the data from the three surveys, YOH was significantly and positively associated with the following factors: male gender, increasing age, primary education level, bottom 40% income level, positive family history, DM, hypercholesterolaemia, and obesity (using both the BMI and WC measurements). Several interesting findings in this study were the increasing prevalence rate of YOH among urban residents, the lower prevalence of YOH among Chinese and Indian ethnicities, and the lack of a significant association between YOH and physical activity.

Using an interpretive phenomenological approach, four major themes were identified: (i) young adults' understanding of hypertension, (ii) personal experience of living with hypertension, (iii) factors influencing treatment adherence, and (iv) needs in managing hypertension. The majority of the respondents correctly described hypertension; and all could report at least one correct causation factor for their disease, among which stress was identified as an important contributing factor. Some respondents reported feeling surprised about receiving a YOH diagnosis at their age, Also, the majority were worried about the negative stigma linked with YOH, although their responses were more inclined

towards self-stigma rather public stigma. The facilitators of treatment adherence that were mentioned were good social support, high self-efficacy, perceived threat or severity of disease, experiencing symptomatic relief and role-modelling. On the other hand, the barriers to treatment adherence were attributed to personal (lack of time for lifestyle modification), treatment (side effects of medication), and disease (being asymptomatic) factors. The respondents also voiced out certain needs in managing their condition, namely, shared decision-making with their healthcare professional and addressing their long-term expectations of treatment, as well as the use of social media and education materials on hypertension to intensify the prevention of YOH through increasing awareness of this disease among their peers.

CHAPTER 5: DISCUSSION

The systematic literature review presented in Chapter Two appraised the available data in order to provide a broad understanding of the public health epidemic that is YOH and the variations that exist between different settings and populations worldwide. Upon conducting the review, it was apparent that the prevalence of YOH differed considerably across various populations, with levels as low as 1.6% in Singaporean men aged 17–23 years (Gan et al., 2003) and as high as 25.5% in Americans aged 24–32 years (Gooding et al., 2014). In the 20 studies collated, different hypertension classifications were used, namely, JNC 7, 2013 ESH/ESC Guidelines, WHO criteria, Task II Consensus, NCEP-ATP-III, IDF, and JSH. Only three studies took into account white coat hypertension (Ejima et al., 2006; Endo et al., 2011; Gan et al., 2003), a response which could lead to increases in BP often by as much as 30 mmHg (G. Ogedegbe & Pickering, 2010). Indeed, comparisons in YOH prevalence between countries or even within the same country are somewhat hindered by differences in the definition of hypertension, study period, methodology, standardization of BP assessment instruments, age structure, and socioeconomic factors (De Macedo et al., 2007; Polonia, Martins, Pinto, & Nazare, 2014; J. Wang et al., 2014).

This chapter contains an interpretation of the results and exploration of the study findings, which are compared and contrasted with those of the previous studies that were discussed in the systematic literature review in Chapter Two. As the systematic review findings have been discussed extensively in Chapter Two, the current chapter provides a critical appraisal of and insights into the findings of the quantitative and qualitative data. This is followed by a triangulation of the data, that is, an integration of results derived from the mixed methods employed in the study. Finally, the chapter concludes by

highlighting the strengths and limitations of this study and providing a summary of the chapter content.

5.1 Phase II Discussion – Quantitative Study: Secondary Data Analysis

5.1.1 Prevalence, Awareness, Treatment, and Control of Young-onset Hypertension from 2006 to 2015

To the best of the researcher's knowledge, this study is the first of its kind to elucidate the prevalence, awareness, treatment, and control as well as the associated risk factors of YOH in Malaysia during a ten-year timeframe. The results are different from the NHMS findings in that missing data was addressed, data was age-standardized to the 2010 National Census, and reweighted before analysis was performed. This study also provides data on the awareness, treatment, and control rates of YOH in Malaysia – information which was not published in the NHMS 2011 and 2015 reports (because only the overall prevalence of hypertension and known and undiagnosed hypertension were included).

It is of paramount importance to derive a precise estimation of YOH prevalence and its associated factors in order to establish a viable strategy for its management and prevention. The results of this study demonstrate that in a representative sample of noninstitutionalized Malaysian young adults, the age-adjusted prevalence of YOH remained unchanged from 2006 to 2015, affecting almost 20% of the study population (Table 4.2). The high prevalence rate could be explained by the low awareness, treatment, and control rates evident throughout the decade (Table 4.3). Although the results reported herein indicate that the prevalence of YOH in Malaysia remained unchanged for ten years, this disease affected nearly one fifth of the young adult population in 2015, 18.4%, 95% CI [17.4, 19.4], which equates to approximately two million young Malaysian adults being diagnosed with YOH. This means that YOH affects a considerable number of our

country's workforce, with effects that remain to be seen when complications of CVD emerge in years to come. These results indicate that public health and medical outreach programmes aimed at young adults may prevent hypertension and, possibly, later-life CVD.

The amount of comparable data on the prevalence of YOH is limited: based on the results of the systematic review in Phase I only 20 studies reported a prevalence rate (Table 2.2). The prevalence of YOH in Malaysia during the period 2006–2015 stands at 17.7%–18.4% and is therefore comparable to the rate in other developing countries such India (Das et al., 2013), Indonesia (Widjaja et al., 2013), and Greece (Bertsias et al., 2003) but higher than that in developed countries such as Japan (Ejima et al., 2006; Endo et al., 2011) and the United States (Y. Zhang & Moran, 2017).

The stable rate of YOH prevalence in Malaysia over the period of one decade – at 17.7%, 95% CI [17.0, 18.3] in 2006, 17.0%, 95% CI [16.0, 17.9] in 2011 and 18.4%, 95% CI [17.4, 19.4] in 2015 (Table 4.2) – is consistent with several studies that have investigated the trends/time-series data related to YOH for periods ranging between four and 16 years (Booth III et al., 2017; Choukem et al., 2017; Leppert et al., 2019; Y. Zhang & Moran, 2017). However, a longitudinal study by Jardim et al. (2015) among health professionals that covered a 20-year period revealed that the prevalence of YOH increased from 4.6% in 1993 to 18.6% in 2013, $p < .001$.

As elaborated in Chapter One, the unchanged prevalence of YOH in Malaysia possibly reflects the nature of the healthcare system in the country with regard to its reliance on opportunistic screening when it comes to hypertension. Young people are entitled to the best possible standards of well-being and health (United Nations, 1949), because they represent our future in which we invest our many hopes. Yet in reality, appropriate treatment, protection from known risk factors, and effective prevention of NCDs are

rarely offered by societies or health systems (Hauerslev & Allen, 2018). Since the beginning of the 21st century, the world has seen large investments in MCH, which has led to great improvements in the health of children in their early years of life (Stuckler, King, Robinson, & McKee, 2008). There have also been heavily skewed allocations of funds aimed at the control of infectious diseases (Nozaki, 2013). However, generally there has been low global investment in NCDs, a situation that is especially dire considering that NCDs account for more than 80% of all deaths in the Western Pacific Region (World Health Organization, 2014b). A similar situation exists here in Malaysia where the primary healthcare system prioritizes the provision of MCH care and the management of infectious diseases (Mustapha, Omar, et al., 2014; Ng et al., 2017), but not NCDs. Hence, with regard to YOH, the nature of Malaysia's healthcare system needs to evolve from the current emphasis on curative services (Malaysia National Health Accounts Section, 2019) to focus on preventive care.

In addition to healthcare systems overlooking the prevention of NCDs, the situation is compounded because young invincibles may not deem themselves to be at risk of developing chronic diseases (Bibbins-Domingo & Burroughs Peña, 2010), hence they do not readily seek routine screening or treatment. This decreases the likelihood that they will have accurate and up-to-date knowledge of their BP status (Everett & Zajacova, 2015) because young adults who believe they are in excellent health are less likely to be aware that they have hypertension (Gooding et al., 2014). Furthermore, a growing number of reports show that young adults generally fare worse than adolescents and older adults due to their greater levels of risky behaviours, lower perception of risks, and less frequent access to care (L. Neinstein, 2013). The combination of these two factors, that is, the lack of attention paid by healthcare systems to NCDs and young adults' insouciant attitudes towards their own health, cumulatively poses a challenge for public health professionals. This may explain the unchanged prevalence rate of YOH in Malaysia because the

attitudes and health-seeking behaviours of young adults have remained somewhat constant throughout the years in view that the current healthcare system has not allocated enough resources to highlight and address this issue.

The prevalence of YOH and its association with several sociodemographic variables has shown a statistically significant increase throughout the decade 2006–2015 (Table 4.2). Of note, the prevalence of YOH increased significantly among urban dwellers over the ten years covered by this study, from 15.6%, 95% CI [14.8, 16.5] in 2006 to 17.5%, 95% CI [16.3, 18.7] in 2015, aOR 1.15, 95% CI [1.03, 1.27]. This could be due to increasing numbers of urban–urban and rural–urban migrants during these years, where numbers evidently increased from 1955 to 2020 (Figure 3.4) with currently 77.8% of the Malaysian population now living in urban areas (Department of Statistics Malaysia, 2018). The multivariate analysis revealed that although rural residents were more likely to develop YOH in 2006, aOR 1.22, 95% CI [1.10, 1.36], the converse was evident in 2015, aOR 0.86, 95% CI [0.74, 0.99]. Young adults face health challenges that may be caused in part by rapid urbanization as cites grow to support faster-paced lifestyles, as evidenced by more available types of transportation and the proliferation of fast food outlets. Hence the selection of fast and unhealthy food options becomes normalized for young people living in cities. Indeed, research in Southeast Asia among youths living in urban environments has demonstrated that they are at greater risk of developing diabetes, heart problems, and respiratory diseases (Angkurawaranon et al., 2014).

With regard to SES, there was a statistically significant increase of YOH from 2006 to 2015 among those with primary and tertiary education levels, and among the middle 40% income group. Several studies have demonstrated that there is a relationship between lower SES and hypertension (Naidu et al., 2019; Naing et al., 2016). It has also be shown that lower educational attainment may be a proxy for low health literacy (Ma et al., 2013)

which may lead to ignorance of the complications of uncontrolled hypertension, and to inadequate access to healthcare (Naing et al., 2016). As iterated above, due to rapid urbanization, young adults who have completed their tertiary education may prefer to live in urban settings to advance their career and thus may also experience occupational stress in their corporate jobs. The workplace environment is considered to be among the most important potential environment stressors during these contemporary times (Rosenthal & Alter, 2012), which may in turn result in raised BP (Spruill, 2010).

As expected, the prevalence of YOH among the bottom 40% of earners was consistently the highest compared with the other income groups. However, interestingly from 2006 to 2015, the prevalence of YOH increased significantly among the middle 40% income group at a rate of 2.6%, 95% CI [2.7, 2.3], a result which was statistically significant, aOR 1.21, 95% CI [1.01, 1.47]. The 2018 Malaysian State of Households survey conducted by Khazanah Research Institute (2018) revealed that since the 1970s, there has been a gradual increase in the gaps between the top 20%, middle 40% and bottom 40% income groups. During the year 2000, there was a difference amounting to RM6,000, RM2,000 and RM8,000 in the estimated real mean household income between T20 and M40, M40 and B40, and T20 and B40 groups, respectively. This income gap increased to RM9,000, RM4,000 and RM13,000, by the year 2016. Based on the 11th Malaysia Plan (2016–2020), education provision, healthcare benefits, cash handouts, targeted subsidies, as well as entrepreneurship and employment opportunities, were among the regular measures aimed at easing the burden of the lowest income earners (Economic Planning Unit, 2015). As most of the financial aid goes to the bottom 40%, the middle 40% group – the majority of whom live in the city and include mostly salary earners in both the private and public sectors – may be experiencing the ongoing frustration of having to deal with a declining disposable income and the increasing costs to maintain a comfortable standard of living. Studies undertaken in middle-income

countries have demonstrated that those with lower household incomes were 60% more likely to having Stages 1 and 2 hypertension, compared to their higher income counterparts (Basu & Millett, 2013). These results indicate that both the bottom 40% and middle 40% income groups should be targeted for YOH prevention and awareness.

From 2006 to 2015, awareness of YOH among young adults in Malaysia remained stable, ranging from 14.4%, 95% CI [13.1, 15.8] in 2006 to 16.1%, 95% CI [14.3, 18.1] in 2015, p trend = .397 (Table 4.3). However, these are alarmingly low rates, with only one sixth of young adults being aware of their diagnosis. The suboptimal awareness rates revealed in this study are consistent with observations in other developing countries (Kayima et al., 2015), but they are much lower than the rates found in the developed world (Y. Zhang & Moran, 2017) (Table 2.5). Some contributory causes to these results include the following: given that both the risk perceptions of clinicians and the patients' (contingent on patient gender, age, ethnicity, or comorbidities) can impact their level of awareness, generally, young adults are less assimilated into the healthcare system (Fortuna, Robbins, Mani, & Halterman, 2010; L. Neinstein, 2013; Schiller, Lucas, Ward, & Peregoy, 2012). Further, research on young adults with repeated appointments with their health care providers showed that those aged 18–24 years were 28% less likely to have their hypertension diagnosed by their physician compared to those aged ≥ 60 years of age (Johnson et al., 2014b). This situation is compounded when young adults tend to be unaware of their vascular risk factors and have lower medication adherence (Sung, Lai, Wu, & Hsieh, 2017).

Treatment rates for YOH also remained stable for the ten-year period 2006–2015 at 46.0%, 95% CI [41.2, 50.9] in 2006 and 48.4%, 95% CI [42.6, 54.2] in 2015, p trend = .662 (Table 4.3). Hence these results indicate that less than 50% of young adults in all three NHMSs were on some form of treatment for hypertension, whether lifestyle advice

or medication. Among young adults, a trial of lifestyle modifications is commonly the initial hypertension treatment step, rather than antihypertensive medication, (Johnson et al., 2014a). Yet, despite the preference for this initial mode of intervention, there is evidence that young adults with hypertension (Valderrama, Tong, Ayala, & Keenan, 2010) and young adults in general (Ishisaka, Jukes, Romanelli, Wong, & Schiro, 2012) are less likely to receive recommendations on strategies to manage hypertension, for example healthy diet and exercise. Furthermore, a study among 500 young adults aged 18–39 years with incident hypertension revealed that only 55% had documented lifestyle education within one year (Johnson et al., 2015). The low treatment rate among young adults could be attributed to healthcare professionals concerns and doubts regarding the negative consequences and long-term advantages of early pharmacological intervention in this age demographic (Y. Zhang & Moran, 2017). As a case in point, a report by the panel members appointed to JNC 8 strongly recommended treatment of elevated DBP in adults ≥ 30 years of age, but only weakly recommended therapy in adults 18–29 years of age (James et al., 2014). Individuals with less of a disease burden may also not perceive treatment as necessary and are not used to taking several prescribed medications compared with those who have a greater disease burden (Ishisaka et al., 2012).

Paradoxically, the YOH awareness rate increased from 2006 to 2011; however, the treatment rate decreased during the same period (Table 4.3 and Figure 4.1). This could be due to the differing operational definitions for treatment that were utilized in NHMS 2006 and 2011 (Table 3.2). In 2006, medication use was the only therapy evaluated for hypertension treatment. In 2011 (and 2015), lifestyle advice was included as well. Such differentiation in definitions has been reported in other studies that have examined trends in hypertension over time (Egan et al., 2010; Sung Sug Yoon et al., 2015). In respect of this study, the decrease in the treatment rate may indicate that young adults were inadequately provided with counselling for lifestyle modification in 2011.

In Malaysia, the control rate for hypertension among young hypertensives who were on treatment ranged between 31.8%, 95% CI [25.8, 38.5] in 2006 to 39.2%, 95% CI [31.3, 47.6] in 2015. Although overall, the control rate improved over these ten years by 7.4%, 95% CI [5.5, 9.1], p trend = .179, this increase still leaves much to be desired. The low control rates observed in this analysis can be explained in part by lack of awareness or treatment. Hypertension control rates vary within countries according to age, gender, race/ethnicity, SES, and quality of healthcare (He et al., 2002). A study in the United States compared the overall control rates of hypertension between young adults and older adults, and showed that, while BP control rates were lower among young adults, this group were more likely to attain controlled BP when treatment was administered compared with older adults (80.4% vs 65.5% in 2013–2014) (Y. Zhang & Moran, 2017). As such, research proffers the view that medications that lower BP and blood cholesterol, and therefore the risk of atherosclerotic vascular disease events and deaths, are among the most cost-effective interventions available to health systems but are not being delivered effectively (Roth et al., 2018). This could be another underlying reason for the suboptimal control rates of hypertension among young Malaysian adults. These observations suggest that improving the healthcare system to better prevent and detect YOH may improve BP control in Malaysia. In addition, improving YOH awareness should result in improved treatment and control rates.

This study analysed the separate effects of several sociodemographic variables such as age, gender, and ethnicity on awareness, treatment, and control rates (Table 4.4). In general, YOH prevalence, awareness, and treatment rates were lower among those aged < 30 years as compared to their older counterparts. Nonetheless, among this younger group, awareness increased at a significant rate of 4.4%, 95% CI [3.7, 5.2], aOR 1.56, 95% CI [1.17, 2.07] over the decade 2006–2015. The reasons behind this may be due to improved health vigilance. The 2015 Nielsen Global Health and Wellness survey found

that consumers around the world are attempting to take charge of their health by making more healthful food choices by, for example, reducing their intake of sugar, cholesterol, trans and saturated fats, and sodium (The Nielsen Company, 2015). However, higher rates of controlled BP were achieved in the younger age group among those who were being treated. This is consistent with other studies (Y. Zhang & Moran, 2017) and might be due to the presence of other comorbidities and increased incidence of Stage 2 hypertension in adults as they age that reduces the effectiveness of pharmacological interventions among older adults (David A Calhoun et al., 2008; Egan et al., 2010).

The subgroup analysis revealed gender-based disparities in YOH awareness, treatment, and control, similar to those observed in other studies (Everett & Zajacova, 2015; Hajjar & Kotchen, 2003; Y. Zhang & Moran, 2017). Overall, in this study, women had a lower prevalence rate, higher awareness and treatment rates; but a lower control rate compared to men. Other studies have shown that young adult women recorded more regular healthcare visits on average compared to their male counterparts (Y. Zhang & Moran, 2017). This may be due in part to the fact that young women are more likely to see their healthcare providers for services such as regular gynaecological check-ups (Bertakis, Azari, Helms, Callahan, & Robbins, 2000), which increases the likelihood of having their BP checked as compared to young men (Schmittdiel et al., 2011). Moreover, gender norms about asking for help and seeking care reduce the likelihood that even in times of need, men will seek out healthcare services (Everett & Zajacova, 2015). Indeed, literature has shown that the healthcare utilization of men is far lower than that of women (Springer & Mouzon, 2011), especially in the younger age groups (Marcell, Klein, Fischer, Allan, & Kokotailo, 2002).

Despite having better awareness and treatment rates compared to young adult men, the BP levels of young adult women who were on treatment (whether lifestyle advice or

medication) were slightly lower than in men (30.0% vs 34.0% in 2006; 37.1% vs 41.0% in 2015), similar to other studies (Hajjar & Kotchen, 2003). However, the results of the current study contrast with those reported in some other studies that show that in general women have better overall awareness, treatment, and control rates than men (Y. Zhang & Moran, 2017). There could be several reasons for this disparity in results. First, with lifestyle modification alone, there is evidence that BP control is worse in women than in men (Wenger et al., 2018). Next, with regard to medication use, the female gender may be a risk factor for adverse effects or attenuated clinical responses to antihypertensive drugs (Ueno & Sato, 2012), which may in turn lead to poorer treatment compliance and hence poorer BP control in the long term. Guidelines recommend that beta-blockers should be considered for younger patients because such patients have increased sympathetic drive and that they should especially be considered in female patients of child-bearing potential (Malaysian Society of Hypertension, 2018). However, the incidence of adverse events associated with metabolized beta-blockers has been found to be greater in women as compared to men (Thürmann et al., 2006). A review of gender-related differences in the pharmacokinetics and pharmacodynamics of antihypertensive drugs concluded that there is mounting evidence to suggest that there are gender differences in the kinetic profiles of several antihypertensive drug classes, which are primarily due to differences in the drug transporters affecting absorption (e.g., P-glycoprotein, P-gp) or the enzymes affecting metabolism and/or clearance (cytochrome P450, CYP450) (Ueno & Sato, 2012). Gender hormones interact with metabolizing enzymes to cause differences in drug exposure, elimination, efficacy, and adverse effects. The analysis in this study also revealed gender-related disparities in BP control with women having slightly lower rates than men despite better overall awareness and treatment rates. These findings suggest that a personalized approach is needed to choose the ideal therapy that effectively lowers BP (which includes a multifaceted approach to

therapy using both lifestyle modification and pharmacotherapy), prevents CVD, and minimizes adverse effects in women. Gender-specific differences in the pathogenesis of and response to treatment of hypertension exist, and must be taken into consideration (Ahmad & Oparil, 2017).

With regard to the association with ethnicity, as compared to the Malay, Chinese, Indian, and Others groups, the prevalence of YOH was highest among the Other Bumiputeras group. However, despite having the highest awareness rates, this group had among the lowest treatment and control rates as compared with the other ethnicities. Examples of the ethnicities in the Other Bumiputeras group include the Iban and Kadazan peoples, who constitute the majority indigenous tribes in Sarawak and Sabah, respectively. Prevalence was also high among those in the "Others" category, and this group displayed the poorest awareness and control rates throughout the period 2006–2015. The Others category comprises Eurasian Malaysians (who trace their ancestry to British, Dutch and/or Portuguese colonists) and other long-term residents of Indonesian, Thai, Filipino, and Myanmar descent who have settled in Malaysia over time (Nagaraj et al., 2015).

Ethnic variations in the trends in prevalence, awareness, treatment, and control of hypertension have long been recognized (Bjertness et al., 2016; Hajjar & Kotchen, 2003; Ishisaka et al., 2012; Y. Zhang & Moran, 2017). The results of this study are consistent with another local study that found that the indigenous people from the state of Sarawak ('Sawarak Bumiputera') had a higher prevalence of hypertension compared with other ethnic groups (Rampal et al., 2008). However, the results of the current study contrast with those in Naing et al. (2016) and Naidu et al. (2019), who found that the prevalence of hypertension was higher among Malays, although it should be noted that the hypertension prevalence results in these two previous studies were for all ages, that is, the

studies did not focus on young adults specifically. Dietary intake may also play a role in influencing ethnic variations in YOH epidemiology. It is well known that the traditional foods of the Asian people contain high quantities of salt. Previous studies have consistently shown that, in Malaysia, men, the East Malaysia population, Bumiputeras (Sabah and Sarawak), and those aged 30–39 years consume the highest sodium intake as assessed using methods such as the food frequency questionnaire and 24-hour dietary recall (Institute for Public Health, 2014; Rashidah et al., 2014). Salt has long been widely used in the production of local Asian sauces, pickling, and fish fermentation (J. O. Lee & Kim, 2013), and previous studies have demonstrated that uncontrolled BP among adults can be attributed to excessive sodium intake (Polonia et al., 2014; Sacks et al., 2001).

In a study conducted in United States, hypertension awareness was found to be doubled among young adults who had regular visits to a health care provider over the last two years (Gooding et al., 2014). This could explain the difference in the YOH awareness rates between the ethnicities in 2015 whereby Sarawak and Sabah Bumiputeras had the highest outpatient care utilization rates while "Others" had the lowest (Institute for Public Health, 2015b). Frontini, Srinivasan, Elkasabany, and Berenson (2003) examined the effect of awareness of hypertension in a large population of young adults, and reported that an increase in awareness can in turn lead to a rise in the proportion of subjects undergoing medical treatment.

According to the analysis of the data in the three NHMSs, hypertension treatment rates for the Chinese ethnic group decreased from 2006–2015. This may be due in part to Chinese resorting to other modes of treatment such as T&CM; indeed, in 2015, Chinese self-reported the highest prevalence ever of the use of T&CM at 32.9%, 95% CI [29.4–36.8] (Institute for Public Health, 2015c). The usage of T&CM, including supplements and health foods, has been shown to be correlated with lower compliance to

antihypertensive medication (Krousel-Wood et al., 2010). Moreover, culturally specific beliefs may play a role in enhancing the treatment and control of YOH. As an example, culturally appropriate storytelling has been shown to be an effective tool in improving BP among black individuals with uncontrolled hypertension (Houston et al., 2011). Hence, the influence of cultural factors across ethnic populations cannot be ignored in respect of addressing the issue of adherence to medication compliance and lifestyle changes, especially in a multiracial country such as Malaysia. It would be worthwhile to undertake further research to explore how healthcare utilization uptakes and treatment adherence differ across ethnicities in the country. Socioeconomic developments, welfare policies, and improved health services may impact ethnic gradients differently (Bjertness et al., 2016) and hence also need to be considered.

5.1.2 Risk Factors Associated with Young-onset Hypertension

The previous subsection on prevalence, awareness, treatment, and control of YOH provides a clear depiction and explanation of the disease situation in Malaysia over the period 2006–2015. In the current subsection, utilization of the multilevel eco-epidemiological life course conceptual framework (Figure 2.2) aided the researcher in constructing a precise understanding of the risk factors that influence individual- and population-level health across the health continuum with regard to YOH.

5.1.2.1 Sociodemographic Factors

According to the multilevel eco-epidemiological life course framework (section 2.8.1 and Figure 2.2), distal variables (multilevel 4) include the different environmental settings that safeguard people from or subject them to various health-related consequences. These include the 1) demographic environment (such as population structures by gender and age, and urbanization); 2) cultural and social environments (such as ethnicity); 3) economic environment (such as SES); and 4) pre-conceptional and conceptional

environments (such as family history). The influences of these factors on YOH the response variable YOH (multilevel 1) are detailed in the following.

(a) ***Gender***

Disparities in gender were pronounced in this study, with men experiencing a higher prevalence of YOH compared to women throughout the decade under study. Multiple logistic regression analysis showed that men had twice the odds of developing YOH compared to women. Therefore, this finding indicates that male gender is a strong risk factor for YOH; results which are similar to the literature pertaining to YOH (Bertsias et al., 2003; Choukem et al., 2017; Das et al., 2013; Ibrahim et al., 2014; Koziarska-Rościszewska et al., 2010; Leppert et al., 2019; Nkeh-Chungag et al., 2015; Nsanya et al., 2019; Soysal et al., 2005; Widjaja et al., 2013).

Gender variations in hypertension have been widely studied. It is well recognized that young men are more likely to develop high BP and have poorly controlled hypertension as compared to premenopausal women, which has been attributed to androgen-mediated abnormalities in BP natriuresis (J. Staessen, Bulpitt, Fagard, Lijnen, & Amery, 1989; Yong, Kuller, Rutan, & Bunker, 1993).

(b) ***Age***

Consistent with the literature, this study found that there was an increasing prevalence of hypertension with increasing age (K. M. Choi et al., 2006; Kayima et al., 2015; Soysal et al., 2005). From the multivariate analysis, increasing age independently contributed to hypertension, a finding that is similar to those reported in other studies on YOH (Al-Nozha et al., 2007; K. M. Choi et al., 2006; Erem et al., 2009; Yadav et al., 2008). An established ageing mechanism that may lead to this upwards trend is stiffening of the arteries (Blacher & Safar, 2005), particularly in the case of systolic hypertension. New evidence points towards a delay in age-related increases in BP among subjects with

improved cardiorespiratory fitness (X. Liu et al., 2017), which highlights the necessity of implementing a primary prevention strategy for hypertension.

(c) ***Locality***

According to the results of the analysis in this study, YOH seemed to be significantly associated with rural residency in 2006, similar to previous studies (Adler et al., 2015; Islami et al., 2011; J. Wang et al., 2014). However, an inverse association was seen in 2011, aOR 0.95, 95% CI [0.82, 1.10] and this type of association was statistically significant in 2015, aOR 0.86, 95% CI [0.74, 0.99]. These results contrast with those of a study conducted by Mierzecki et al. (2014), who found that the proportion of YOH in urban and rural dwellers was the same at 30%. One possible reason for the finding of this study for 2006 is that, at that time, individuals from rural areas may have been characterized by a lower level of knowledge concerning hypertension and incorrect lifestyle (Krzyszycha, Szponar, & Cyran, 2009), because efforts in the areas of health promotion and education were usually lacking in rural areas, thus creating lower awareness among this population regarding the detection and treatment of high BP (Yu et al., 2008). As urbanization is a process that occurs over a number of years, the increasing rural–urban and urban–urban migration (Department of Statistics Malaysia, 2018) as a result of employment may have led to a shift in the association between awareness and locality in the studied population. This supposition is supported by evidence of a statistically significant increment in YOH prevalence among urban dwellers from 2006 to 2015 (Table 4.2).

Urbanization is expected to lead to a sedentary lifestyle due reduced physical activity which is then associated with a rise in the prevalence of obesity as well as hypertension in a linear relationship (Al-Nozha et al., 2007). A previous study which aimed to examine the risk disparity between rural and urban populations in Yangon, Myanmar,

demonstrated that the risk factors for diabetes, obesity, and other chronic diseases are higher in cities (Htet et al., 2016). In urban localities, job strain may be an important factor in the aetiology of hypertension in modern society. According to the job strain model (Karasek, Baker, Marxer, Ahlbom, & Theorell, 1981), in the case of urbanites, low decision latitude and high work demand in the workplace can elicit stressful response levels which is considered to be similar to or even greater than the influence of the more conventional occupational stressors such as chemical and physical hazards (Rosenthal & Alter, 2012; Siegrist, 2010). Interestingly, X. Wang et al. (2006) found that a strong behavioural disposition to actively handle psychosocial stress may be associated with higher BP. Therefore, the role of primary healthcare providers present in both, rural and urban environments should be emphasized

(d) ***Ethnicity***

With regard to ethnicity, this study found that YOH was most prevalent among the Other Bumiputeras group throughout the ten-year period, whereas those of Chinese and Indian descent were less likely to develop YOH. These results are similar those of longitudinal studies that observed significant ethnic differences in ambulatory BP (X. Wang et al., 2006) and other health indicators (Harris et al., 2006) as adolescents progressed into adulthood. Indeed, the racial disparity in hypertension identified in the current study is not only a well-recognized phenomenon, it is consistent with the literature (Gillum, 1979). Several underlying parameters have been studied in relation to the association between ethnicity and hypertension, including salt sensitivity, BMI, socio-environmental determinants, access to care facilities, foetal/early life origins, and differential treatment response (Jones & Hall, 2006; X. Wang et al., 2006). As such, the interaction between genetic susceptibility and environmental factors such as higher dietary salt intake, poor intake of potassium and fibre, physical inactivity, and obesity

(especially truncal) may explain the ethnic differences (Naing et al., 2016; Rao, 2012) in YOH prevalence.

(e) ***Education***

A key indicator of SES is education level. This study found that the prevalence of YOH was lowest among those who had achieved a tertiary level of education, and that subjects with no formal education and primary education had higher odds to be hypertensive compared to those with secondary and tertiary education – a finding that was consistent over the ten years 2006 to 2015. These findings corroborate those of Jardim et al. (2015), who found that, in comparison to the general population, a health professional population who had a higher level of education had lower rates of YOH. However, in contrast, Gan et al. (2003) and Gooding et al. (2014) found no significant association between hypertension and level of education.

The findings of the current study can perhaps be explained by the lower level of awareness among the less-educated participants regarding the types of dietary habit that can help to decrease the incidence of hypertension, particularly that of lowering the amount of salt intake, which has been found to play an important role in the development and control of hypertension (Sacks et al., 2001). In Thailand, those who only completed elementary school had approximately eightfold higher odds of having hypertension in comparison to their counterparts with a high school level of education (Lwin-Mm-Khin, Oranut, & Chaweewon, 2011). Similarly in Taiwan, a 36% higher chance of Stage 1 to Stage 2 progression of hypertension was found among those with lower levels of education (Chiu, Wu, Tseng, Yen, & Chen, 2006).

(f) ***Income Level***

Another key indicator of SES is income level. A study conducted among 8400 young adult respondents aged 24–32 years revealed that high financial debt relative to available

assets is associated with higher perceived stress and depression, worse self-reported general health, and higher DBP (Sweet, Nandi, Adam, & McDade, 2013); these associations remain significant when controlling for psychological and physical health, prior SES, and other demographic factors This could explain the higher prevalence of YOH among the bottom 40% income group in the current study, which remained steadily higher than that of the other income groups, that is, the middle 40% and top 20%, over the period 2006–2015. From the multivariate analysis, those in the bottom 40% income group were statistically more likely to develop YOH. These results are consistent with other YOH studies (Gan et al., 2003; Gooding et al., 2014). However, they contradict those reported by Das et al. (2013), where the proportion of hypertension was found to increase as per-capita monthly income increased, and they are also in contrast to the findings of several other studies in which it was reported that income was not a predictor for developing YOH (Al-Mohaissen et al., 2017; Nsanya et al., 2019).

The Malaysian Adults Nutrition Survey of 2014 showed that those with lower SES were more likely to eat food stalls, which are well known for selling foods with higher salt content and fairly inexpensive (Institute for Public Health, 2014). Moreover, people with lower SES have are at increased risk of experiencing mental health issues such as depression and stress, which may lead to elevated BP rates (World Health Organization, 2013).

(g) ***Family History***

This study found that YOH was more prevalent among young adults with a history of familial hypertension, which is consistent with the literature (Al-Mohaissen et al., 2017; Das et al., 2013; Ejima et al., 2006; Endo et al., 2011; Gan et al., 2003; Nsanya et al., 2019). Likewise, the multivariate analysis in the current study revealed that family history played an important role in the development of YOH. The findings of the current study

are in line with those in previous studies that revealed a positive association between YOH and family history (Al-Asmary et al., 2008; Widjaja et al., 2013), but not with the prior study by Gan et al. (2003), who reported that parental history of hypertension does not show a significant correlation in the regression model.

Although the JNC 7 report stated that the genetics of hypertension still remain unclear (Chobanian et al. (2003), a family history of CVD in first-degree relatives has since been found to be significantly associated with prevalent CVD diagnosed at or before the age of 60 years (Scheuner, Whitworth, McGruder, Yoon, & Khoury, 2006). Therefore, it is essential to promote awareness among subjects who have a positive family history that they need to have routine health checks and make appropriate lifestyle choices in order to reduce the hypertension morbidity rate among younger population.

5.1.2.2 Lifestyle Factors

In the multilevel eco-epidemiological life course conceptual framework (section 2.8.1 and Figure 2.2), intermediate variables (multilevel 3) are determined by groups of distal variables, such as those related to demographic, cultural, and social environments. For example, urbanization and rural–urban migration as distal variables can influence changes in intermediate variables such as their lifestyles, behaviours, diet, living standards, health literacy, and health care access (Kuate Defo, 2014). In the following, the influences of lifestyle behaviours such as alcohol intake, physical activity and smoking on YOH as the response/outcome variable (multilevel 1) are discussed.

(a) ***Alcohol Intake***

From the NHMS data, the prevalence of YOH in those who ingested alcohol in excess of the amount recommended in the WHO guidelines increased significantly over the 10 years to 2015, with approximately one quarter of young hypertensive adults admitting to this amount of alcohol intake, 24.6%, 95% CI [21.2, 28.5] in 2015 compared to 19.6%,

95% CI [17.5, 21.8] in 2006. These findings are in line with Jardim et al. (2015), who, in their comparative analysis among health care workers on the prevalence of CVD risk factors in 1993 and two decades later in 2013, revealed that the subjects included in both analyses demonstrated a significant increase in their alcohol intake (32.7% vs 34.9%, p = .037). Furthermore, the current study demonstrated that excess alcohol ingestion increased the risk of developing YOH by 1.2–1.4-fold, in contrast to studies by Gan et al. (2003) and Nsanya et al. (2019) in which no independent association between alcohol drinking and high BP was found. Nonetheless, other studies in China indicated that heavy drinking is associated with presence of hypertension, where the habitual drinker is 1.40 times more likely to be associated with the presence of hypertension (J. Wang et al., 2014), results that are similar to those revealed in this study. Excess alcohol intake has been demonstrated to be a risk factor for hypertension (Chobanian et al., 2003) and morbidity from CVD, including coronary heart disease, cerebral infarction and cerebral haemorrhage, was higher in heavy drinkers (Hao et al., 2004).

(b) ***Smoking***

The prevalence of current smoking among young-onset hypertensives in this study remained stable from 2006 to 2015, which is similar to Jardim et al. (2015) in which the trend in smoking was found to remain unchanged among health care workers over a period of 20 years. However, the finding of the current study was in contrast to that reported in another study which found that the smoking trend among young adults decreased over a period of 16 years (Leppert et al., 2019). Additionally, in contrast to most other YOH studies that found no association between smoking and BP (Gan et al., 2003; Kayima et al., 2015; Koura et al., 2012; Nsanya et al., 2019; Widjaja et al., 2013), an interesting result of this study was that YOH was inversely associated with smoking despite abundant evidence proving that smoking is among the main preventable causes of hypertension (GBD Risk Factor Collaborators, 2018). The same finding can be found

elsewhere; as examples, increases in BP after smoking cessation (D.-H. Lee, Ha, Kim, & Jacobs Jr, 2001; Oncken et al., 2001) and lower BP levels among smokers compared to former smokers (Green, Jucha, & Luz, 1986) have reported by several researchers. Furthermore, the results of a follow-up study among male steel workers demonstrated that in comparison with never-smokers and ex-smokers, the prevalence of hypertension was lower among continuous smokers (Okubo, Miyamoto, Suwazono, Kobayashi, & Nogawa, 2002).

However, when considering the aforementioned findings, it should be noted that most of the previous studies and the current study only utilized current smoking behaviour to analyse the effects of smoking on health (cigarette consumption classification: heavy smokers and light smokers; status classification: former smokers, current smokers, and non-smokers). As examples, Okubo et al. (2002) and Green et al. (1986) categorized smokers by the amount of cigarettes smoked daily and current smoking status, and analysed this data for a specific period of time. There may be several reasons to explain the bias in the above results on the effects of smoking: first, smoking typically impacts chronic health, therefore smokers can gradually recover from initial smoke-inflicted harm as current smoking may not immediately damage health (Jha et al., 2013; Peto et al., 2000; Slovic, 2000). In other words, the initiation of chronic diseases is gradual, therefore using current smoking to measure these conditions may not be as precise. Furthermore, current cigarette consumption or smoking status may not accurately reflect tobacco intake, because smokers may change their smoking habit (DiClemente & Prochaska, 1982; Nakamura et al., 2008). In view of the recent data and literature, there may be a delay on the effect of smoking on health, especially in relation to the development of chronic diseases. Therefore, current tobacco consumption may not be strongly associated with current health status. Results such as these indicate that irrespective of the temporary side effects of quitting, it is important to recommend that smokers stop smoking as early as

practicable, as well as to evaluate the impact of smoking from a life course perspective in future studies (Gao, Shi, & Wang, 2017).

(c) ***Physical Activity***

This study found that the trend in the prevalence of hypertension among young adults who were physically active remained stable from 2006 to 2015. This finding contrasts with that of the longitudinal study conducted by Jardim et al. (2015), whose analysis of the prevalence of CVD risk factors in the 215 subjects included in both analyses (1993 and 2013 data) showed a decrease in the prevalence of sedentary behaviours (50.2% vs 38.1%, p = .015). The multivariate regression in the current study revealed no significant association between YOH and physical activity, similar to some YOH studies (Kayima et al., 2015; Widjaja et al., 2013), but in contrast to other previous studies by Al-Mohaissen et al. (2017), Das et al. (2013), and Erem et al. (2009) which demonstrated that decreased physical activity and sedentary lifestyle are determinants for hypertension. This study's results could be explained by the fact that the measurement of physical activity in the NHMSs was self-reported, hence it was a subjective measure of activity as opposed to an objective measure such as arterial stiffness (O'Donovan et al., 2014), which may have led to a lack of uniformity in the answers.

5.1.2.3 Cardiovascular Risk Factors

In the aforementioned adopted framework (section 2.8.1 and Figure 2.2), distal and intermediate variables in turn influence proximal factors (multilevel 2). These proximal factors include the immediate factors, circumstances, and settings, that exist prior to the occurrence of an event of interest (Kuate Defo, 2014), in this case, YOH. In the context of this study, proximal variables include the general and physical health status of the respondents. This includes their associated comorbidities during a YOH diagnosis, that is DM, hypercholesterolaemia, and obesity.

(a) ***Diabetes Mellitus***

In this study, over one third of young adults with hypertension had a concomitant diagnosis of DM (36.5%, 32.4%, and 36.0% in 2006, 2011, and 2015, respectively). As expected, DM was positively associated with YOH status by 1.73 to 2.32 fold, results which correspond to studies among African (Kayima et al., 2015), Saudi Arabian (Ibrahim et al., 2008), and Indian (Yadav et al., 2008) young adults. There is substantial overlap between diabetes and hypertension in terms of aetiology and disease mechanisms. Common pathways include obesity, inflammation, oxidative stress, and insulin resistance (Cheung & Li, 2012).

(b) ***Hypercholesterolaemia***

Over one quarter of the young adults who had YOH also had a diagnosis of hypercholesterolaemia (28.2%, 22.8%, and 25.1% in 2006, 2011, and 2015, respectively). Young adults with a concurrent diagnosis of hypercholesterolaemia had 1.42 to 1.53 higher odds of developing hypertension and this association was statistically significant. This finding is in contrast to those in Kayima et al. (2015) and Al-Mohaissen et al. (2017) in which no significant association between hypertension and hypercholesterolaemia was found. It has been suggested that certain pathophysiologic pathways that link hypertension and dyslipidaemia to atherothrombosis may share common mechanisms (Tuñón et al., 2007). These include endothelial dysfunction due to reduced availability of nitric oxide and increased vascular permeability to LDL (Laufs, La Fata, Plutzky, & Liao, 1998); inflammatory cell recruitment into the vascular wall due to the expression of adhesion and chemoattractant molecules by the endothelium (Barnes & Karin, 1997); and thrombosis leading to acute coronary syndromes and ischaemic stroke (Toschi et al., 1997). Moreover, the enhanced activity of the renin-angiotensin-system, which plays an important role in hypertension, can activate similar mechanisms to dyslipidaemia in endothelial dysfunction, inflammation, and thrombosis.

(c) ***Obesity***

Approximately 40% of the young adults who had hypertension in this study were also obese (based on BMI). Furthermore, a significant positive association between BMI was found, where the odds increased by 2.12–2.97-fold during the period 2006–2015. The independent association found between BMI and hypertension is in line with previous findings (Al-Mohaissen et al., 2017; Bertsias et al., 2003; Choukem et al., 2017; Das et al., 2013; Gan et al., 2003; Lai et al., 2015; Nsanya et al., 2019; Widjaja et al., 2013; Yadav et al., 2008; Zafar et al., 2007). In a previous meta-analysis, an average weight loss of 5.1 kg was followed by a decrease in mean SBP and DBP by 4.4 and 3.6 mmHg, respectively (Neter, Stam, Kok, Grobbee, & Geleijnse, 2003). A variety of pathways have been formulated to determine the role obesity plays in developing hypertension, e.g. increased renin-angiotensin-aldosterone system activity, sodium retention as a result of increased renal tubular reabsorption, and activation of the sympathetic nervous system. (Kotsis, Stabouli, Papakatsika, Rizos, & Parati, 2010). In recent decades, a higher prevalence of hypertension among young adults may be attributed to the increased prevalence of overweight and obesity among adolescents, a pattern that is projected to continue in the future (Y. Zhang & Moran, 2017). Several studies have indicated that the increasing trend in hypertension in their countries is associated with an increasing trend in obesity during the same period (Flegal, Carroll, Ogden, & Curtin, 2010; Hajjar & Kotchen, 2003; Linhart et al., 2016).

(d) ***Abdominal Obesity***

The prevalence of YOH was higher among those whose WC was in the obese range. Furthermore, this study found that YOH was strongly associated with abdominal obesity, consistent with the literature (Choukem et al., 2017; Nkeh-Chungag et al., 2015). A study by J. Liu et al. (2010) also demonstrated that in African Americans, there was a strong association between cardiometabolic risk and WC, irrespective of BMI. However, there

are two schools of thought in regard to the use of WC as a measure. On the one hand, Després (2012) argued that it would be simplistic to assume that WC is a better indicator of CVD risk than the BMI indicator, because for every BMI value there is a broad range of WC value; especially given that WC may be influenced by visceral or subcutaneous fat. Furthermore, in the Bogalusa Heart Study, none of the central obesity indices (WC, WHpR or WHtR measurements) predicted the BP levels of young adults in multivariate models (Gustat, Elkasabany, Srinivasan, & Berenson, 2000). Other evidence suggests that central obesity indices (such as WC) contribute only slightly to be predictive value of YOH (Iwao et al., 2001). On the other hand, in comparison to the other measures of obesity, several studies have demonstrated that WC may be a more sensitive determinant of CVD risk (Czernichow, Kengne, Stamatakis, Hamer, & Batty, 2011; Klein et al., 2007). It has been reported that compared to their Western counterparts, Asian populations are more prone to low muscle mass and central obesity with increased insulin resistance (J. C. Chan et al., 2009). Hence, within the context of this study, it would seem that WC as a reflection of central obesity is a valuable indicator of the risk factors of hypertension.

5.2 Phase III Discussion – Qualitative Study: In-depth Interviews

To best of the researcher's knowledge, this is the first qualitative study to explore the perceptions and experiences of young adults living with hypertension in Malaysia using an interpretive phenomenological approach. The findings from this phase were used to explain the experiences and perspectives of young adults living with hypertension that influence the awareness, treatment and control rates found in Phase II.

5.2.1 Understanding of Hypertension

The majority of young adults in this study demonstrated good knowledge and understanding of hypertension. They were able to give a correct description of hypertension (along with hypertension-related values for abnormal and normal BP), describe the perceived causes of hypertension, and explain their illness-related concerns. In contrast, past literature has shown that many young adults are unable to grasp the definition of 'hypertension' and/or cannot correlate it to high BP (Morgan & Watkins, 1988). Also, a subsequent research conducted among young African American adults with differing rates of hypertensive risk demonstrated that they had poor comprehension of hypertension (Savoca et al., 2009). These findings further demonstrate the need for comprehensive education programmes and interventions targeted for young adults.

Interestingly, when the young adults in the current study were probed regarding the perceived causes of YOH, in addition to the traditional responses of genetics, inappropriate lifestyle (diet, lack of exercise), and being overweight, all respondents cited stress as a causative factor for their diagnosis, regardless of sociodemographic factors such as gender, age group, education or income level. There is now an immense amount of research that indicates an association between hypertension and job stress (Rosenthal & Alter, 2012). Among young adults, a considerable amount of time is spent at work; hence it is not unusual that constant job stress may have a significant effect on their health. The job strain model is the most widely studied model of occupational stress (Karasek et al., 1981), and focuses on two aspects of the work environment: decision latitude (or the degree of autonomy an employee has in conducting his or her duties) and job demands (or workload). As per this model, a high strain work setting (which is a combination of low control and high demand environments) creates the most stress. High job strain has been linked with increased left ventricular mass as well as increased ambulatory BP at

work, at home, and during sleep; consistent with the predicted impact of sustained BP elevation (Spruill, 2010).

The majority of respondents had some form of knowledge about future risks with regard to hypertension. Similar to the subjects in prior studies (Johnson et al., 2016; Savoca et al., 2009), these young adults respondents were mindful of the benefits of BP control to avoid future adverse events. Sufficient hypertension-related knowledge is said to form the basis for hypertension prevention and control because knowledge is a critical determinant of behaviour change and lifestyle practices (Almas, Godil, Lalani, Samani, & Khan, 2012; Huang et al., 2011). In the same vein, a local qualitative study on hypertension management at the community level revealed that lack of knowledge on targeted BP led to poor BP monitoring among the participants (Tan, Hassali, Neoh, & Saleem, 2017). Knowledge about the severity of the disease and perceived susceptibility may stimulate greater motivation among individuals to engage with behavioural change and treatment adherence (Barros et al., 2014).

5.2.2 Personal Experiences of Living with Hypertension

The respondents shared their feelings and thoughts on the continuous negative psychological consequences of being diagnosed with YOH, which includes elements of self-stigma, and guilt or self-blame. The results of this study aid in addressing an important research gap identified by Marshall et al. (2012) in respect of understanding young adults' experiences of living with hypertension. The views expressed by the respondents confirm that there is a need for healthcare teams to understand the negative emotional and mental health effects a hypertension diagnosis among young adults (Karnilowicz, 2011). A previous study has shown that chronic illness-related stigma has a strong negative influence on social functioning and on general health in students aged 18–25 living with a chronic illness (Nearchou et al., 2017). Nevertheless, additional

studies are required to investigate this crucial psychological issue, especially among young adults.

Although certain foods are an important part of Malaysian culture, some respondents stated that they had been able to switch to healthier menu choices. This was in line with the high rate of self-efficacy identified in the respondents, which is in contrast to the finding of another study among hypertensive Malaysian adults (of all ages) who confessed to difficulty in controlling their diet (Shima et al., 2014) due to the widespread availability of enticing but not necessarily healthy food in the country. Only one respondent in the current study reported being referred to a dietitian and taught about methods they could use to control their diet. This one respondent was severely obese and this could have been an underlying reason for their referral. However, it is of concern that the majority of the respondents were overweight and obese according to BMI and WC, respectively. Therefore, it could be argued that these respondents should have also been referred to dietitians.

On the other hand, the majority of respondents stated that the diagnosis of hypertension had no significant economic impact on their lives because most of them were government employees. Several young adults identified the cost of medication and blood investigations as rather significant, but all respondents still managed to obtain the medications prescribed by their doctors. Nevertheless, concerns on the supply of medication and affordability of drugs are common barriers to treatment compliance and have been mentioned by participants in other studies (Taylor et al., 2012).

5.2.3 Factors Influencing Treatment Adherence

Similar to other studies (Johnson et al., 2016; Shima et al., 2014), this study found that the social support received from family members, peers, workplace, and physicians or medical staff improved the respondents' adherence to treatment. The social support

received by patients has been repeatedly documented to be a key aspect that positively influences health outcomes by enhancing patient compliance to medical regimens (M. R. DiMatteo, 2004). The majority of research in this area has focused on diabetes, and self-management, while a few studies have looked at asthma, heart disease, and epilepsy management (Gallant, 2003; Strom & Egede, 2012). Therefore, it would be of benefit to develop a research agenda to further examine the mediators of the relationship between social support and health, and whether this mechanism varies by illness, type of support, and behaviour, especially with regard to hypertension among young adults.

Yet again, a considerable amount of high self-efficacy was shown by the young adults interviewed for this study, with the majority stating that they were willing to change their lifestyle, comply with medication instructions, and improve their knowledge about hypertension. These results contrast with those obtained by another local study among Malaysian hypertensive adults (of all ages) in which a lack of patient self-empowerment was identified (Shima et al., 2014). Previous research has demonstrated that sustainable lifestyle behavioural change is more likely when these modifications are integrated into one's personality and internally motivated (Barros et al., 2014; Bellg, 2003).

Most of the respondents alluded to the perceived threat or severity of disease being a facilitator of treatment adherence, similar to a study by Jolles, Padwal, Clark, and Braam (2013), who reported that patients were compelled to improve their BP control due to fear of escalating symptoms. Indeed, the idea has been put forward that patients' beliefs about their disease are central to their treatment adherence and it has been proposed that a greater disease severity threat would be associated with better adherence (Becker, 1974). Nonetheless, among these respondents the perceived threat of YOH did not translate into treatment adherence, perhaps due to the subjective nature of Phase III of this study. The results of a recent meta-analysis suggest that objective assessments of disease severity

(poor health) coupled with patient awareness of severity can predict treatment adherence (M.R. DiMatteo, Haskard, & Williams, 2007).

Some of the identified barriers to hypertension control identified in the current study (e.g., medication side effects and time constraints) overlapped with those reported by previous studies among other age groups (Marshall et al., 2012; Gbenga Ogedegbe, 2008; Oliveria, Chen, McCarthy, Davis, & Hill, 2005; Shima et al., 2014), which indicates that there is an ongoing need to improve hypertension control across populations. Another barrier reported by Johnson et al. (2014a) in a study conducted in the United States is the lower rate of medication initiation among young American adults aged 18–39 compared to those aged ≥ 60 years. In contrast, all of the respondents in this study were on some form of pharmacological intervention for YOH. The types of side effects reported by the study respondents were gender specific: men were concerned about fertility problems and erectile dysfunction; whereas women were concerned about increased frequency of micturition. These concerns expressed by the participants could potentially prevent them from adhering to treatment.

Another interesting finding of this study was that some respondents assumed that the lack of symptoms indicated the absence of hypertension or its consequences. Other studies have reported similar beliefs (Akinlua et al., 2017). This finding is quite significant because the holding of this viewpoint may have an adverse impact on adherence to prescribed medications. Research has shown that individuals only tend to take steps to manage their own disease when they encounter symptoms (Ike, Aniebue, & Aniebue, 2010). Therefore, it may not be logical to a patient to implement lifestyle changes (such as diet and exercise) or adhere to treatment when overt symptoms of a disease are not apparent. In addition, often after symptomatic patients are prescribed with medication, as soon as symptoms are resolved, they may once again avoid compliance

thereby limiting the treatment outcome (Akinlua et al., 2017; Bajorek et al., 2017). In this study there was evidence of cognitive dissonance, a finding which is similar to that reported by Bane, Hughes, Cupples, and McElnay (2007), who found that there was a dissonance among patients in respect of the chronic nature of hypertension, the need for long-term treatment, and its asymptomatic presentation. Based on the cognitive dissonance theory, individuals desire consistency among their cognitions (i.e., their opinions, beliefs), and dissonance occurs when there is inconsistency between behaviours and attitudes (Festinger, 1957). This was a recurring theme that arose from the interviews with the participants in this study.

5.2.4 Needs in Managing Hypertension

The majority of young adults in this study displayed a preference to be involved in making decisions that affected their health and they stated that they would like to have more time allocated to consultations with their doctors. These findings support prior research that has demonstrated that young adults prefer to have treatment options that align with their lifestyles, and not the wishes of their physician (Johnson et al., 2015; National Asthma Council Australia, 2007). These findings also highlight the need to increase patient–provider communication and to increase perceived autonomy support and self-management resources for young adults with hypertension (Perera et al., 2019; Pollak et al., 2011). The lack of communication between physicians and patients has been shown to significantly contribute to the poor adherence rates of antihypertensive medications and lack of awareness of the importance of taking medication (Perera et al., 2019).

Following on from this, although the respondents in this study exhibited adequate knowledge about the definition of hypertension, risk factors, and adverse outcomes, their comprehension again did not transform into consistently adhering to treatment advice.

There was discordance among the respondents in respect of comprehending the potentially dangerous outcomes of YOH, the lack of willingness to comply with medications for the long run, and the requirement for long-term treatment. Despite the respondents explicitly indicating that hypertension was a serious disease with grave consequences, some admitted to not heeding the advice of their physicians, including the recommendation to take their prescription regularly. Hence cognitive dissonance was again displayed here similar to other studies (Akinlua et al., 2017; Taylor et al., 2012).

Some young adults in this study supported the use of social media to fulfil their needs in managing hypertension in terms of spreading awareness and information about this chronic disease. This was in contrast to another study also among hypertensive young adults which found that these virtual health solutions have been seen as an intrusion into their leisure habits and have heightened their fears over friends being aware of their condition (Johnson et al., 2016). Nonetheless, social networks that use group interactions have been found to be beneficial in managing hypertension in middle-aged and older adults (Shaya et al., 2013).

The majority of respondents reported that there was a paucity of information and educational resources on the primary prevention of hypertension, a finding that is similar to other studies (Perera et al., 2019). This finding stresses the need for hypertension education materials geared explicitly to the problems and concerns of young adults, in their native language. Moreover, the delivery of hypertension education materials to young adults to promote necessary behavioural changes in order to achieve and maintain hypertension control can be conveyed using social media channels. However, for those who do not utilize social media, their healthcare provider is still an important source of information. Hence, hypertension education materials in printed form should also be used

to supplement counselling and to boost the YOH diagnosis, its risk factors and its continuous management as a chronic disease.

5.3 Integration of Quantitative and Qualitative Data

The mixed-methods sequential explanatory design of this study consisted of two distinct phases: a quantitative followed by a qualitative phase. In this design, the researcher first collected and analysed the quantitative (numeric) data and then explored the qualitative (text) data to help explain, or elaborate on, the quantitative results obtained in the initial phase (Creswell, Plano Clark, Gutmann, & Hanson, 2003). The rationale for this approach is twofold. On the one hand, an analysis of quantitative data can provide a general understanding of the research problem, that is, the magnitude of YOH epidemiology in Malaysia over a ten-year period from 2006 to 2015. On the other hand, an analysis of the qualitative data derived from IDIs can refine and explain the statistical results and provide greater depth of knowledge (Ivankova, Creswell, & Stick, 2006; Tashakkori, Teddlie, & Teddlie, 1998) in respect of understanding the experiences and perspectives of young hypertensive adults influencing the awareness, treatment, and control rates of YOH in Malaysia.

The respondents in the qualitative study were mostly male and those who were mostly aged > 30 years, which was consistent with results of the quantitative analysis that showed that there was a higher prevalence of YOH among men and among those toward the upper end of the young adult age spectrum. All the interviewees were from urban sites in view of the fact that the Department of Primary Care at UMMC is situated in the urban locality of Kuala Lumpur. This is an important study population because the secondary data analysis revealed that the rate of increase in YOH among urban residents was more significant over the course of the ten years covered by this study as compared to their

rural counterparts, possibly due to increasing rural–urban and urban–urban migration as a result of greater employment opportunities. Indeed, internal migration has contributed greatly to the restructuring of society in Malaysia and about half of the population in Kuala Lumpur were born in other states (The UN Migration Agency, 2016).

The respondents in the qualitative study had been diagnosed with YOH for at least one year. When asked to reminisce to time of initial diagnosis, all reported having initial symptoms of recurrent headaches but did not seek treatment. Other commonly reported symptoms included lethargy, tiredness, dizziness or being quick to anger. None of the respondents reported going for medical check-ups for hypertension on their own accord. Most were incidentally diagnosed with YOH after admission to the emergency unit for other reasons (e.g., fever, chest pain, dizziness, motor vehicle accident) and some only found out that they were hypertensive when diagnosed with other comorbidities, e.g., DM, OSA. These findings are similar to those in a study by Perera et al. (2019), in which a majority of patients recounted that their hypertension was inadvertently diagnosed during an unrelated healthcare visit. Participants from Phase III were diagnosed primarily through non-acute symptoms that were related to complications associated with their comorbidities, or only during opportunistic screening when visiting doctors for unrelated acute conditions including hospitalizations. These findings support the secondary data analysis of this study which revealed that awareness of hypertension was alarmingly low among young adults, thus reflecting the situation in the Malaysian healthcare system in which screening uptake for YOH is low.

Low SES, which is dependent on key factors such as level of education and income, has long been inversely associated with the health outcomes of a wide range of disease outcomes, including hypertension (Grotto et al., 2008; Krieger et al., 1997). Most of the interviewees in the current study had achieved a tertiary level of education, which could

account for their heightened understanding of hypertension. However, those with lower levels of education (up until secondary-level schooling) could not describe any complications of hypertension when probed further. These findings underscore the need to convey information about the lifetime consequences of hypertension especially to those with lower education levels. Moreover, respondents from the bottom 40% income group reported struggling to meet the costs of medication and investigations, which could explain the trend of a higher YOH prevalence among the bottom 40% income group as compared to their counterparts that was identified by the quantitative analysis. This finding chimes with past research showing that the affordability of medications and supply of drugs are common obstacles to compliance with treatment (Taylor et al., 2012).

Following on from this, the level of understanding of the perceived causes and knowledge of future risks of YOH also likely reflects the fact that the majority of the interviewees in this study reported that they had a family history of hypertension. As evidenced in Phase II of this study, YOH was more prevalent among young adults with a positive family history. However, better knowledge did not necessarily translate into practice as reflected by their low level of treatment adherence and consequently control of their disease, findings which correspond to those in other research (Jolles et al., 2013; M. Rahman, Alam, Mia, Haque, & Islam, 2018). In the current study, the qualitative results reflect and echo the suboptimal rates revealed in the quantitative analysis which, as elaborated above, could be explained by cognitive dissonance between knowledge, attitudes, and practice. Despite some prior studies finding an association between sufficient knowledge about hypertension and greater medication adherence and BP control (Almas et al., 2012; Huang et al., 2011), Jolles et al. (2013) demonstrated that knowledge by itself may not be associated with better control; rather, it is the feelings and beliefs of wellness that are the important factors in compliance. Therefore, knowledge alone may not have a significant effect on treatment compliance, but rather it is the

manner in which the acquired knowledge interacts with patients' beliefs to affect adherence. In light of the above, the patient's beliefs and perceptions of wellness could be a useful predictor of the intention to change behaviour and subsequent treatment compliance (Jolles et al., 2013). Thus, going forward, it would be useful for healthcare providers to address patients' beliefs at the same time as increasing their knowledge on YOH during patient consultations.

The results from the secondary data analysis showed that treatment (whether medication or lifestyle advice) rates among young adults who were aware of their hypertensive diagnosis remained below 50% throughout the decade 2006–2015. In the qualitative study, although all of the respondents were on some form of drug treatment, a number of them reported failing to comply due to barriers comprising treatment (side-effect of medication), personal (time constraints), and disease (being asymptomatic) factors. Therefore, doctor-patient appointments should involve a practical evaluation of patients' knowledge and comprehension of their care regimens. Several studies have shown the role that pharmacists play in providing information pertaining to adverse effects, missed doses, and increasing patients' knowledge of their treatment regimen (Lambert-Kerzner et al., 2010; Shima et al., 2014).

That another barrier to treatment compliance was the state of being asymptomatic was another useful finding of this study, not least because such views may compromise compliance with home BP assessments as well as medical advice (Brondolo, Rosen, Kostis, & Schwartz, 1999). A meta-analysis revealed that adherence is significantly positively correlated with patients' beliefs in the severity of their disease (M.R. DiMatteo et al., 2007). Patients' feelings and beliefs of wellness can impact adherence to physician recommendations regarding daily medication and lifestyle changes (Jolles et al., 2013). In other words, if patients generally feel well in themselves then they may not be

motivated to take their medication or change their behaviours. In summary, the current study found that regardless of demographics, a lot if not all of the respondents in the IDIs reported that they disliked hypertension treatment and/or had intentionally stopped treatment at some time or other. The respondents also identified barriers to hypertension treatment that were related to time constraints and side effects, similar to other studies (Jolles et al., 2013; Marshall et al., 2012). These findings highlight the barriers that need to be overcome in order to increase the treatment rates of hypertension among young adults.

In this study, the quantitative analysis revealed that the control of hypertension among young adults who were on treatment was less than 40%. However, when asked whether their BP was under control, the majority of the interviewees responded in the affirmative, thus revealing a mismatch between the statistical and qualitative evidence. This may be due to acquiescence response bias (Lavrakas, 2008) due to a health professional enquiring about their BP control. The qualitative data also revealed that there were certain unmet needs in the study population, such as a lack of management of their long-term expectations of treatment and an absence of shared decision-making with their healthcare professionals. The lack of communication between patient and physician is a significant contributor to poor adherence rates to antihypertensive treatment and the lack of understanding of the importance of taking medications (Perera et al., 2019). Through the interviews, some respondents spoke of wanting to be completely cured of the disease after taking medication. This shows that young adults may need more information to help them manage their long-term expectations about their disease. A longitudinal analysis conducted among groups who were recently diagnosed with hypertension showed that the critical period for the emergence of beliefs was the first year from diagnosis. This could therefore represent a window of opportunity that healthcare professionals could exploit to shape the emergence of beliefs (Granados-Gámez, Roales-Nieto, Gil-Luciano,

Moreno-San Pedro, & Márquez-Hernández, 2015) and thereby potentially influence treatment adherence and long-term control of BP among their patients. The findings of the current study also indicate that YOH care in Malaysia could benefit from applying team-based approaches using non-physician healthcare workers (such as pharmacists, dietitians, and physiotherapists) as well as from training healthcare providers on shared decision-making and effective communication skills (Montgomery, Harding, & Fahey, 2001; Perera et al., 2019), to complement the advice and education delivered by the physician. A summary of the data integration is provided in Table 5.1.

Table 5.1: Summary of Integration of Quantitative and Qualitative Data

Phenomenon	Quantitative (Phase II) findings	Qualitative (Phase III) findings	Explanation
Awareness of YOH	14.4%–16.1%	Respondents did not actively seek treatment despite having symptoms, e.g., recurrent headaches Despite displaying a good level of understanding of the perceived causes and knowledge of future risks of YOH, respondents had little to no awareness of or insight into the condition in themselves	This situation reflects the current Malaysian healthcare system in which screening uptake for YOH is low There appears to be cognitive dissonance between knowledge, attitudes, and practice
Treatment of YOH	46.0%–48.4%	Barriers: personal (time for exercise), treatment (side-effect of medications), disease (being asymptomatic)	The identified barriers were contributing factors to lack of or reduced treatment adherence among YOH adults
Control of YOH	31.8%–39.2%	Unmet needs of young adults: lack of shared decision-making between themselves and their health professionals and doctors, lack of managing long-term expectations of treatment, and lack of information provision	These unmet needs were contributing factors to the low and stagnant control rates

5.4 Strengths

The strengths of the systematic review include the conduct of comprehensive searches to ensure that all relevant publications were identified, the utilization of three large databases to find articles published over the past 20 years to maintain contemporary relevance, and the manual search of reference lists, as well as a search of the grey literature to ensure completeness. Potential bias in the conduct of this review was reduced because two reviewers independently scanned through the search output and extracted the data. In addition, there was reasonable coverage of evidence for all six WHO regions; all regions were well represented by a sufficient number of studies with reasonable sample sizes, which allowed for generalizability of the results across these geographic regions. The quality assessment of the 20 selected studies was performed by two independent reviewers using the JBI Critical Appraisal Checklist (Munn et al., 2015) and all of these studies were considered of an acceptable quality, scoring 66.67%–100%.

This study obtained secondary data from three NHMSs which had been conducted among a representative sample of the Malaysian adult population using standard protocols. The strengths of the NHMS include a high response rate, two BP measurements in the same visit by trained medical personnel, and detailed information on history of hypertension and pharmaceutical treatment. Strict training processes for data collectors are implemented and validated questionnaires and instruments are employed to ensure the quality of the data. There are also well-defined clinical criteria for risk factors across all surveys, so although the point estimates of risk factors in each survey may not be precise, the trend of risk factor prevalence over time remains robust. Ten years of data collected over three national surveys and the large sample size allowed high precision estimation of age-specific trends. Furthermore, weights were applied and age adjustment was performed according to the 2010 Malaysian population census. Hence, the findings of the current study are generalizable and provide the most reliable and up-to-date

information on the current trend in YOH in the Malaysian population and its association with certain sociodemographic characteristics and lifestyle and cardiovascular risk factors.

The strengths of the qualitative methods used in this study are due to the use of an interpretative phenomenological approach that was able to directly elicit young adults' perceptions and experiences about living with hypertension. The study population included a representation of views from different genders, age groups, and educational and income backgrounds. Furthermore, care was employed in the purposive sampling to ensure representation of most of the ethnic groups in Malaysia. In view of the prevalence of YOH having increased significantly among urban populations, it was important to elicit experiences and perceptions about living with hypertension from this group in particular. One-to-one IDIs rather than focus groups provided the perfect means for the respondents to communicate in private with the researcher. This approach builds doctor–patient rapport which potentially increases the credibility of the data by reducing response biases (Roller & Lavrakas, 2015). Indeed, IDIs have been widely used to elicit the experiences of patients living with chronic diseases (Audulv, 2013; Ebrahimi Belil, Alhani, Ebadi, & Kazemnejad, 2018; Jacobs, Ownby, Acevedo, & Waldrop-Valverde, 2017). During the data analysis, at least two reviewers separately analysed the data, compared the results and constructed a final thematic framework based on general consensus. Furthermore, as no new themes emerged from later interviews, data saturation was considered to have been accomplished.

In addition, the mixed-methods sequential explanatory study design that was employed in this study allowed the collection of rich, comprehensive data. It strengthened the rigour of the research and enriched the analysis and the findings (Wisdom & Creswell, 2013). Furthermore, the triangulation of the output of different data collection methods and the

integration of results increased the validity of the study findings because the phenomena under investigation were approached from a range of perspectives (Peat et al., 2019). By using a mixture of both quantitative and qualitative methods, a breadth and depth of understanding and corroboration was attained while simultaneously offsetting the weaknesses inherent in using each approach by itself.

5.5 Limitations

As with all studies, the results reported here must be viewed within the context of the investigation's limitations. One of the limitations of the systematic review conducted in Phase I of the study was that not all of the crucial data on gender, age, and other descriptive statistics was available from the selected studies, despite repeatedly contacting the corresponding authors. Hence some of these studies had to be omitted from the analyses. In addition, some study characteristics such as the study period (year(s)), study design, and classification of YOH were unavailable for two studies (despite contacting the authors for more information). Nonetheless, these two studies were included in the review because the prevalence of YOH (main outcome) was reported. Another limitation of the systematic review was that only English and English translation publications were searched; thus, the results of the quantitative analysis may not represent all of the available evidence.

As mentioned above, for Phase II of the study, the quantitative data was extracted from the NHMSs, which meant that there was limited exploration of the other possible associations with the risks of developing YOH such as dietary factors/salt intake. However, there was a sufficiently detailed examination of the known associations described above to provide a comprehensive depiction of the epidemiology of YOH in Malaysia. Another limitation of the data analysis in Phase II is that the data was obtained

from cross-sectional studies, therefore, although associations may have been found between exposures (independent variables) and an outcome (YOH), cause and effect cannot be established. However, because this study looked into trends in hypertension over a decade, and the exposure characteristics such as gender and ethnicity and the outcome developed over this period, the temporal nature of the exposure–outcome association is more plausible.

It is also recognized that missing data is an inherent problem in the analysis of secondary data. To address this drawback, a careful examination of the questionnaires and instruments was performed in order to identify skip patterns. All variables were systematically reviewed and missing data was rectified using statistical methods such as the multiple imputation technique in order to minimize as much as possible the effect of missing data on the results, in contrast to the approach used in the NHMS where complete case analysis is performed.

As regards the measures themselves, as BP was measured only during a single visit, the prevalence of hypertension may have been overestimated. According to the CPGs of both the WHO (World Health Organization (1978) and the MSH (Malaysian Society of Hypertension (2018), the definition of hypertension should be based on the average of at least two or more BP readings taken at two or more visits after an initial screening. Nonetheless, the use of BP measurements taken during one visit is a well-recognized inherent problem of large epidemiological investigations and should have minimal effects on within-sample comparisons. Also, multiple visits are impractical for large-scale studies, hence the approach adopted in this study was similar to that taken by many epidemiological studies (Aekplakorn et al., 2012; De Macedo et al., 2007; Polonia et al., 2014; Van Minh et al., 2009; J. Wang et al., 2014; Y. Wu et al., 2008).

Also in relation to the NHMS, behavioural and socioeconomic variables were self-reported and may have been influenced by social desirability and recall bias. This could have led to overestimation of these factors. Nevertheless, self-reporting has been validated as an effective method to diagnose and identify risk factors of hypertension (Thawornchaisit et al., 2014) and it seems that the method of risk factor diagnosis, whether by clinical diagnosis or self-report, is vitally important to the assessment of risk factor prevalence (Leppert et al., 2019; Nsanya et al., 2019; Y. Zhang & Moran, 2017).

As for limitations related to the qualitative study in Phase III, the young adults who participated in the qualitative study were ethnically diverse, there was a lack of representation of ethnicities categorized as Other Bumiputeras, perhaps due to the location of the sampling site. Therefore, the qualitative data may not encompass some of the views on managing hypertension among these ethnicities. Nonetheless, the goal of qualitative studies is not to generalize but rather to provide a rich, contextualized understanding of some aspect of human experience through the intensive study of particular cases (Polit & Beck, 2010).

Both patients and providers have EMs. A provider's EM is rooted in their medical training and depicts the thought processes in which clinicians comprehend and treat illnesses. Hence, both patients and healthcare providers may have dissimilar EMs of the pathogenesis and development a particular illness. Congruence between the EMs of patients' and their physicians has been found to have a positive effect on their health outcomes (M. Weiss, 1997). However, this study did not obtain healthcare providers' narratives, which may provide a one-sided perspective on the doctor–patient EM of hypertension. Nonetheless, this gap provides opportunities for future research studies to explore these different EMs.

5.6 Summary of the Chapter

Chapter Five contained a detailed discussion of the findings of this study and situated them within the existing body of research. The study findings are summarized as follows:

Phase I: The results showed that there has been considerable variability in the epidemiology and trends of YOH in Malaysia and elsewhere over the years. Most of the regional disparities in the prevalence of hypertension among young adults may be due to variations in research protocols, as well as differences in genetic susceptibility and environmental factors. Comparisons of YOH prevalence between countries or even within the same country are in some ways hindered by differences in the definition of hypertension, the study period, methodology used, lack of standardization of BP assessment instruments, the age structure employed, and socioeconomic factors.

Phase II: The prevalence of YOH in Malaysia was found to be comparable to that reported for other developing countries. However, it was higher than in developed countries such as the United States. Awareness, treatment and control rates too were suboptimal throughout the decade. Trends of YOH in association with sociodemographic, lifestyle and cardiovascular risk factors varied throughout the years. These results indicate that for the past decade, YOH has been a significant public health problem and it will only continue to remain a problem unless major strides are undertaken to address this.

Phase III: Factors such as attitudes, beliefs, and experiences, as well as the social and cultural environments of patients play significant roles in the hypertension treatment process (Shamsi, Dehghan Nayeri, & Esmaeili, 2017). The majority of young Malaysian adults in this study population have knowledge about hypertension (correctly describing the term and future risks involved). However,

knowledge did not necessarily translate into practice with some not complying with their treatment regimen. Barriers to and facilitators of treatment adherence as well as the unmet needs in the management of hypertension among this population were also identified.

The discussion of the quantitative and qualitative results was followed by a triangulation of the data, a summary of which was provided in Table 5.1. This was followed by an overview of the strengths and limitations of the study and a summary of the chapter.

CHAPTER 6: CONCLUSION

In Chapter Six, first the main conclusions of this study are summarized in relation to the research objectives. Next, the implications and significance of the results, both from the public health and clinical perspectives, are elaborated. This is followed by some recommendations for policy and practice. The chapter then concludes the thesis with some suggestions for future research directions.

In order to achieve a substantial decline in CVD prevalence and to implement successful preventive strategies, it is of the utmost importance to acquire in-depth knowledge of the epidemiology of YOH both in the international and national setting as well as the effects of sociodemographic, lifestyle, and cardiovascular risk factors. Following on from this, an understanding of young adults' experiences and perspectives of living with this disease allows researchers and healthcare providers to engage with patients in comprehensively addressing their lived illness experiences, especially in the local Malaysian context. In this regard, this study achieved all its research objectives by first providing the most up-to-date data on the worldwide prevalence of YOH, hence highlighting the pervasiveness of this public health epidemic in other populations. This was followed by an elucidation of the nationwide prevalence, awareness, treatment and control of YOH in Malaysia and its associated factors over a ten-year period from 2006 to 2015 as well as an exploration of the lived illness experiences of young hypertensive Malaysian adults.

Prior to this thesis, information on YOH was scarce and scattered. Previous studies focused on hypertension in adults as one entity, or specifically on either the older age group or adolescents, thereby side-lining the young adult subpopulation. In order to understand the burden of YOH worldwide, a systematic review was conducted in Phase I of this study. The review identified 20 articles which were analysed in depth. The results

revealed that the prevalence of YOH varied widely – with the lowest rate in Singapore (1.6%) among men aged 17–23 years and the highest in the United States (25.5%) among men and women aged 24–32 years. The international variation in prevalence may be attributed to differences in the definition of YOH, environmental factors, genetic susceptibility, and study protocols. These results justified the need to conduct a study on YOH in Malaysia to ascertain the burden in the context of an upcoming developing nation. Furthermore, the results helped in defining the appropriate age range of the young adult subpopulation investigated in this study as encompassing those aged 18–39 years as well as in synthesizing the required variables for Phase II of the study.

In Phase II, which involved a comprehensive analysis of secondary data from three NHMSs (2006, 2011, and 2015), it was revealed that the prevalence of YOH in Malaysia was comparable to that seen in other developing countries and that this prevalence had remained stable over the ten-year period, affecting nearly one fifth of the young adult population. The analysis also showed that awareness, treatment, and control rates were suboptimal throughout this decade, with 15% aware of their diagnosis, of which less than 50% were on treatment and less than 40% of those who were on treatment had their BP controlled. In addition, significant increasing prevalence trends were noted in young adults in urban localities (aOR 1.15, 95% CI [1.03, 1.27]), in those with a primary and tertiary level of educational attainment (aOR 1.37, 95% CI [1.14, 1.65] and aOR 1.29, 95% CI [1.09, 1.52], respectively) as well as in those in the middle 40% income group (aOR 1.21, 95% CI [1.01, 1.47]). Overall, the multivariate analysis conducted on data from all three NHMSs revealed significant positive associations between YOH and sociodemographic (male gender, increasing age, lower SES in terms of primary education and bottom 40% income level, and positive family history) and between YOH and existing comorbid CVD risk factors (DM, hypercholesterolaemia, and obesity). Several interesting findings in this study included the increasing prevalence rate of YOH among

urban residents, the lower prevalence of YOH among Chinese and Indian ethnicities, and the lack of a significant association between YOH and physical activity.

Furthermore, subgroup analysis on YOH awareness, treatment, and control by age, gender, and ethnicity revealed that younger adults in the 18–39 years of age group had lower awareness and treatment rates. Nonetheless, among those who were on treatment for YOH, better control was achieved in the younger age group compared to their older counterparts. Additionally, awareness and treatment rates were found to be higher in women compared to men; however, control was poorer in women. With regard to association with ethnicity, the prevalence of YOH was observed to be highest among the Other Bumiputeras category; however, this category had among the lowest treatment and control rates compared to other ethnicities. Moreover, young adults in the Others category too displayed the poorest awareness and control rates throughout the decade under study. Overall, trends in YOH prevalence, awareness, and treatment remained stable throughout the decade, with the exception of treatment rates among the Chinese ethnic group which decreased by 21.5% from 2006 to 2015.

An understanding of patients' views is critical to improving sustained treatment adherence and consequently improved BP control. By using an interpretative phenomenological approach, this study achieved its final specific objective of exploring young adults' unique perceptions and experiences of living with hypertension through the means of one-to-one IDIs. The majority of the interviewees correctly described hypertension, and all could report at least one correct causation factor for their disease, among which stress was cited as an important contributing factor. Half of the respondents reported feeling surprised when they were given a hypertension diagnosis at their age and the majority were worried about the negative stigma associated with YOH, although their responses were more inclined towards self-stigma rather than public stigma. Facilitators

of treatment adherence included good social support, high self-efficacy, perceived threat and severity of disease, experiencing symptomatic relief, and role-modelling. Barriers included time constraints, side effects of medication, and being asymptomatic. The participants also voiced out certain needs, which included shared decision-making with their healthcare professional, managing their expectations of long-term treatment, and intensifying prevention of YOH by increasing awareness among their peers through the use of social media and hypertension education materials. In combination, these findings should help in guiding the planning and implementation of effective hypertension interventions primarily aimed towards the young adult community which will likely improve the stagnant and low hypertension awareness, treatment, and control outcomes among this subpopulation.

6.1 Implications and Significance of the Findings

6.1.1 Public Health Implications

The results of this study reveal that YOH has been a significant public health problem in Malaysia since at least 2006, and will continue to remain a problem unless major strides are undertaken to address this issue. If the YOH control rate remains stagnant, the Malaysian government's target of a 25% relative reduction in the prevalence of raised BP by 2025 will not be met (Ministry of Health Malaysia, 2016). The increasing prevalence of YOH among the urban population and those of lower SES (based on education and income levels) highlights the need for interventions that target prevention at these particular groups. Furthermore, public health preventive measures should focus on those at the lower end of the young adult age spectrum (who have lower awareness and treatment rates) because evidence shows that when they are treated, they are more likely to achieve better overall control of their BP. In the case of men, the emphasis should be

placed on improving their awareness and treatment rates, whereas in the case of women, the focus should be on implementing measures to improve persistence in treatment adherence. The study results indicate that ethnic variations obviously affect the epidemiology of YOH in Malaysia. The different sociocultural beliefs and values of the country's diverse ethnic groups should therefore be considered during consultations because these factors may greatly influence YOH treatment adherence and control.

This study narrowed the knowledge gap on the epidemiology of YOH in Malaysia and its associated factors for the period 2006–2015 by providing crucial information on the extent of hypertension among young adults. Furthermore, the findings of this study underscore the importance of treating young adulthood as a separate entity in research, planning, programming, and policymaking. This study fulfilled the overarching principles of NSP-NCD 2016–2025 by first taking into account the health and social needs of people at all stages of the life course, which includes young adulthood, and second, by seeking to empower people and communities, specifically young adults, who should be empowered and involved in activities for the prevention and control of NCDs, including advocacy, policy, planning, legislation, service provision, monitoring, research, and evaluation. There are windows of opportunity to prevent and control NCDs at multiple stages in the life course. Traditionally, however, policies and plans tailored specifically for young adults have been overlooked in the Malaysian healthcare system. Hence, the results of this study can be used as an evidence base by health policymakers and relevant stakeholders to further develop Malaysia's NCD policy and to create cost-effective health promotion strategies specially targeted at this subpopulation.

Interventions must be initiated at early points in the life course to avert CVD burden in later adulthood. Targeted interventions tailored to the unique needs of the ethnically diverse population of Malaysian young adults are needed to enhance hypertension

management protocols and improve future preventive CVD healthcare delivery. For example, based on the results of this study, young adults have iterated a desire to have access to preventive cardiovascular healthcare seminars or talks as well as free health check-ups including BP examination in the workplace. They have also expressed a need for information on the signs and symptoms of YOH, the risk factors associated with the development of YOH, ways in which to avoid YOH. In addition, dissemination of such hypertension education materials in their native language would be helpful in assisting them to retain this information. Workshops on YOH could be rolled out in phases, beginning with a focus on those most at risk (based on the results of the logistic regression analysis), including males, those > 30 years of age, those hailing from urban localities, those with a positive family history, young adults with a lower SES, and those with a concomitant comorbidities such as DM, hypercholesterolaemia, and obesity.

Some identified stakeholders who may have a vested interest in this study include professional associations (e.g., the MSH), governmental bodies such as the MoH, and young adults themselves as beneficiaries of any efforts made to address the prevalence of YOH. This list is based on personal correspondence between the researcher and the chairman of the Working Group on Malaysian Hypertension CPG, prior networking opportunities with members of the MSH during national conferences, and a valuable DrPH professional internship with the Disease Control Division (specifically the NCD-CVD-Cancer-Tobacco Sector) of the MoH, Malaysia. It is hoped that through a combination of this study's evidence-based results and prior networking with relevant policy entrepreneurs, a policy window can be created to highlight and subsequently manage YOH in Malaysia.

6.1.2 Clinical Implications

Based on the focal research areas set out in the latest MSH CPGs (Malaysian Society of Hypertension (2018) (Table 1.1), the results of this study contribute to several domains that will assist those working in the clinical setting. First, this study identified the "risk factors of hypertension in the younger age group". Significant and positive associations were found with sociodemographic (male, increasing age, lower SES in terms of having a primary education and a bottom 40% income level, positive family history) and existing comorbid risk factors (DM, hypercholesterolaemia, and obesity). Additionally, significant increasing prevalence trends were noted for young adults in urban localities, for those who with a primary and tertiary level of education, and for those in the middle 40% income group. These results can assist primary care physicians and public health professionals in targeting prevention strategies at and increasing awareness among young adults who fall into those categories.

Second, the results reveal that YOH is a heterogeneous condition that requires individualized care. The researcher identified a "method of assessing cardiovascular risk in people aged under 40 years with hypertension" by conducting a trend and risk factor analysis of the secondary data from three NHMSs. This is merely the first step towards a big data analysis. Going forward, a centralized data informatics system for national surveys can be used to identify young adults at risk of YOH (as listed above). Artificial intelligence (AI) can potentially be used to classify risk of hypertension in individuals and identify mechanisms of poorly controlled hypertension. Through AI, clustering algorithms can be used to discover hidden structures in sophisticated data in order to identify subgroups of patients with poorly controlled hypertension due to multiple factors (i.e., conventional, genetics, environmental, and lifestyle) or those at risk of developing hypertension (Krittanawong et al., 2018). Information from this data can be inputted into devices with sensors (wearable technology such as watches, wrist bands, and badges)

connected to the Internet of Things, which can engage young adults in disease management and allow physicians to monitor at-risk patients. This would also allow the provision of personalized therapy to this subpopulation that is in the prime of life.

Third, this research illuminated the "barriers to good BP control" in the community, specifically those among young Malaysian adults. In order to provide appropriate and up-to-date behavioural modification programmes for young adults, it is first important to obtain a clear understanding of their hypertension beliefs and practices. As such, these results can be utilized in behavioural change models such as the health belief model to devise specific strategies to enhance self-care among these young adults with hypertension. For instance, dissemination of this study's findings can increase the individual's level of perceived susceptibility via increased awareness of YOH attained through attendance at workplace health seminars/screenings and exposure to mass media campaigns and newspapers, or even through interactions with family members with hypertension. This increase in perceived susceptibility will in turn lead to an increase the individual's level of perception regarding the severity of YOH, that is, the psychological, social, and economic impact that YOH could have on their life. The combination of perceived susceptibility and perceived severity will thus lead to an increase in the perceived threat of the disease, which includes knowledge of the risk of developing future adverse cardiovascular events such as myocardial infarction, stroke or death. Hence, when young adults can perceive that the benefits of treatment adherence outweigh the barriers (such as time constraints, side effects of medication, and being asymptomatic), this will ultimately lead to increased self-efficacy in managing and controlling the disease. By understanding these barriers to hypertension treatment among young adults, healthcare professionals can include them in health behavioural models to potentially improve their consultations and guide their patients towards successful persistence in BP control.

Lastly, through the interviews conducted in Phase III, this study succeeded in "empowering patients in BP management" by providing young adults with a platform for their voices to be heard. In a study by Jagosh, Boudreau, Steinert, MacDonald, and Ingram (2011), participants revealed that the mere act of a physician listening to them is empowering because it motivates them to take ownership of their health. Understanding how young adults view and interpret hypertension as well as their experiences of living with a chronic illness is a crucial initial step in the development of effective interventions. Each individual's EM is subjective and consists of personal constructs of their own perceptions, culture, and environment. Therefore, through exposure to new knowledge, a person's EM is potentially modifiable. The qualitative study findings revealed critical focus areas for interventions among hypertensive young adults. As evident from this study, the young adults' needs for managing YOH are unique and varied. This information can be used to create effective patient-centred education materials, both in printed form and digital form via social media, which would increase young adults' knowledge about YOH and its treatment. The types of information that young adults would like to see in these materials include the reasons behind the development of YOH (such as genetics or stress), symptoms of YOH, and methods to control/prevent YOH as well as the calamitous consequences of uncontrolled YOH (such as myocardial infarction, stroke, and death). This information needs to be presented in an interesting manner and should include a summary of the points that have the greatest relevance for young adults that takes into account the subpopulation's health literacy, that is, the material should also be provided in the native languages of Malaysia with no medical jargon.

6.2 Recommendations for Policy and Practice

In order to obtain a remarkable reduction in mortality and morbidity due to hypertension, effective prevention and management strategies are warranted. Interventions targeted towards earlier identification of raised BP and its control are expected to deliver the greatest benefit in terms of reducing the incidence of CVDs and its associated mortality (Altun et al., 2005). The WHO reported that prevention, care, and treatment of hypertension are among the key points in promoting public health (World Health Organization (2013).

Social ecological models describe the interactive characteristics of individuals and environments that underlie health outcomes and it has long been recommended that such models guide public health practice in respect of health promotion within organizations (Golden & Earp, 2012). This type of model helps healthcare professionals to understand the factors that affect a behaviour and provides guidance for developing successful programmes through social environments by emphasizing the multiple levels of influence (such as individual, interpersonal, organizational, community, and public policy) and the idea that behaviours both shape and are shaped by the social environment (Figure 6.1). The principles of social ecological models are consistent with social cognitive theory concepts (Bandura & Walters, 1977) which suggest that creating an environment conducive to change is important in order to make it easier for people to adopt healthy behaviours. Additionally, when evaluating the multiple levels of the life course eco-epidemiological conceptual framework (Figure 2.2), this study takes into consideration that although disease develops in individuals, public health efforts can be initiated at any point (including community, family, and individual levels) resulting in healthy people in healthy societies (Kuate Defo, 2014). Hence, this study's recommendations for policy and practice will be presented in the following subsections in accordance with the socio-ecological model.

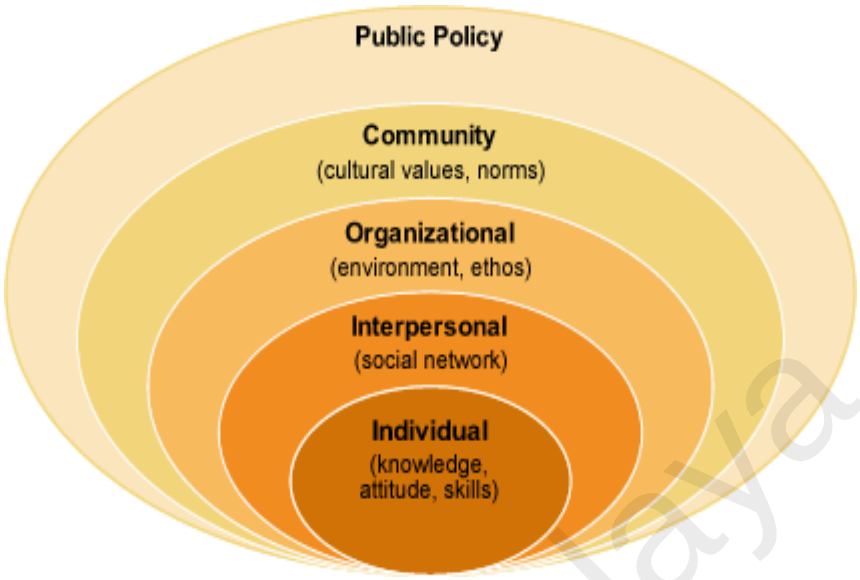

Figure 6.1: Social Ecological Model

Source: Bronfenbrenner (1977)

6.2.1 Individual Level

Individual or intrapersonal level interventions are those that the target knowledge, perceptions, intentions, or self-efficacy of the target population (Golden & Earp, 2012). At this level, the use of role models to harness the motivation of young adults (Lockwood, Sadler, Fyman, & Tuck, 2004) to increase their knowledge and improve their health behaviours may be beneficial. A role model is defined as a person whose behaviour, example, or success is or can be emulated by others, especially by younger people. Role-modelling was a term put forward by sociologist Robert K. Merton who hypothesized that individuals compare themselves with reference groups of people who occupy the social role to which the individual aspires (Holton, 2004). Several respondents in the qualitative analysis spoke of certain role models that they endeavoured to emulate in terms of managing their health and living a healthier lifestyle. On the one hand, positive role

models, that is, individuals who have achieved a high degree of success, can encourage others to pursue similar accomplishments (Lockwood & Kunda, 1997). For example, in the qualitative interviews, a respondent spoke of emulating his co-worker whose condition improved after successfully changing their diet and lifestyle. However, negative role models, that is, individuals who have experienced some kind of failure or misfortune, can also motivate others to avoid similar adversity (Lockwood, 2002). For example, respondents spoke of their desire to increase awareness among their young adult peers because they wanted to prevent the same condition from happening to them. Role models can potentially be young adult celebrities, politicians, athletes, and entrepreneurs and even healthcare workers themselves.

6.2.2 Interpersonal Level

The interpersonal level comprises the formal (and informal) social networks and social support systems that can influence individual behaviours. At this level of intervention, strategies can include the education, training, and skills enhancement of people who interact with the young adult target population (Golden & Earp, 2012). The 'whole-of-society' approach as emphasized by NSP-NCD 2016–2015 (Ministry of Health Malaysia, 2016; Mustapha, Omar, et al., 2014) can be achieved by using young adults themselves via increasing peer–peer awareness and support. This method of using young people to change sedentary and unhealthy behaviours and mindsets of other young people has indeed proven to more effective (National Research Council and Institute of Medicine, 2015). Often, it is the need for more 'appealing' and holistic solutions aimed at stimulating engagement and participation among the people who need these interventions the most rather than the lack of solutions, that makes addressing NCDs difficult. The key to increasing young adults' participation in the battle against NCDs is the provision of appropriate guidance and tools to enable them to brainstorm ways on how to get their peers to make healthier lifestyle choices. By using social media, young adults' voices can

provide a novel perspective on NCD prevention and control by sharing targeted messages on key risk factors and interventions. During Phase III, some participants recommended the use of real-life persons (case studies) on social media platforms who could share their life experiences about coping with YOH. This would make the disease more relatable and realistic. Furthermore, young adults can engage with their peers and share information about NCDs, as well as lead programmes to promote healthy behaviour, such as community exercise classes, or healthy eating programmes.

In addition, young adults' healthcare providers have an important role to play in BP management and control. This study gathered insights to identify unmet needs of hypertension management specific to young adults, for example, they voiced a preference for shared decision-making. The results indicated that in order to improve adherence, clinicians must better understand and engage with patients' ideas about causality and help them to manage their long-term expectations of disease. Healthcare professionals can work with individuals in a variety of settings to adapt their choices to develop healthy behaviours tailored to accommodate physical health, cultural, ethnic, traditional, and personal preferences, as well as personal food budgets and other issues of accessibility. Lifestyle patterns that are tailored to the individual are more likely to be motivating, accepted, and maintained over time, and thereby have the potential to lead to meaningful shifts in behavioural change, and consequently, improved health (National Research Council and Institute of Medicine, 2015). Moreover, it has been shown that comprehensive lifestyle modification is feasible and has beneficial effects on BP reduction (Cakir & Pinar, 2006).

The establishment of better BP control has been found when delivering a multifaceted approach to treatment using a combination of both lifestyle interventions and antihypertensive medication (Kayima et al., 2015). Although the best tolerated and safest

approach to controlling BP in young adults may be lifestyle modifications (such as reduced sodium intake, weight loss, and physical activity), at the same time, cost-effective pharmaceutical therapies that lower elevated BP remain important interventions (Institute for Health Metrics and Evaluation, 2018; Roth et al., 2018). The results of the current study showed that young adult men had lower rates of awareness and treatment, whereas women had poorer control. Hence, tailored advice should be at the forefront during doctor–patient consultations, that is, the aim for young men should be to increase their awareness of YOH and adherence to treatment. On the other hand, because clinically significant gender-based adverse effects of antihypertensive drugs have been identified as being more common in females, consultations with young women should not only focus on their BP medication adherence and persistence (Ahmad & Oparil, 2017; Ueno & Sato, 2012), but also enquire into whether they are experiencing any side effects from their medication and, if warranted, consider alternative pharmacological interventions.

Additionally, this study found that a number of young adults had comorbidities associated with YOH. In such cases, effective communication between multidisciplinary healthcare teams such as doctors, dietitians, nutritionists, physiotherapists, psychologists, etc. is critical in order to discuss and understand these patients' concerns and beliefs, and work closely to establish a management plan that is tailored to the individual and addresses other competing demands that the patient may face during young adulthood. In other words, a holistic approach to treatment is recommended.

6.2.3 Organizational Level

At the organizational level, modifications need to be made to institutional environments policies and services (Golden & Earp, 2012). Organizations, such as the workplace where young adults spend most of their time, play a critical role in increasing the awareness and prevention of YOH. Education to improve individual lifestyle changes

such as food selection and physical activity choices can be delivered through seminars or talks in the workplace. The analysis conducted in the current study revealed that young adult men had lower awareness and treatment rates compared to their female counterparts. In this group which infrequently accesses preventive care health services, it is likely that their hypertension awareness, treatment, and control may only be enhanced outside of conventional clinical or hospital settings, such as with the implementation of workplace-based health screening programmes which is deemed to be more efficacious in reaching young adults (Fonarow et al., 2015). Of note, there was consistent mention among the respondents in the qualitative study of experiencing occupational-related stress, which is a factor that predisposes an individual to hypertension. Kales, Tsismenakis, Zhang, and Soteriades (2009) proposed two approaches to address this type of stress. First, they suggested population-based wellness programmes to be made available at the workplace, such as promoting stress management, sleep hygiene, weight control, and encouraging aerobic exercises; as well as providing screening and individual counselling for individuals at higher risk of hypertension. Second, they suggested that the workplace could provide incentives by restricting duties or allocating time-limited work clearance to ensure that hypertensives with uncontrolled BP do not continue to work indefinitely. Siegrist (2010) recommended that the identification of and subsequently preventive measures for certain employment categories who are at increased risk of stress be developed.

Institutions such as pharmaceutical companies and development banks have the manpower, resources, and expertise necessary for harnessing, directing, and developing young adult behavioural change ideas driven by the young adults themselves and targeted towards the prevention of NCDs in ways relatable to other young adults. Such institutions can invest in creating dedicated young-adult-orientated programmes to produce impactful work that can change the national NCD discourse. For example, AstraZeneca in their

philanthropic Young Health Programme (a disease prevention programme to improve health and life chances of adolescents with particular emphasis on NCDs) has reached over three million young people and delivered health education programmes in 26 countries (AstraZeneca, 2019). It is hoped that the dissemination of the findings of the current study can garner similar interest and commitment among other such organizations to invest in the health and well-being of young adults.

6.2.4 Community Level

Community level interventions include education, training, and skills enhancement of the general community beyond the target population of young adults and immediate contacts (Golden & Earp, 2012). Under the same whole-of-society umbrella, interventions can be rolled out by utilizing respected members of the community as 'new agents of change'. Young men who have lower awareness and treatment rates, as well as those in the Other Bumiputeras and Others ethnic groups, may react more positively and connect to primary care if screening of BP is carried out by trusted and trained laypersons. In the United States, barbershop-based hypertension outreach programmes using barbers as health educators to monitor BP and promote physician referral has been shown to be an effective method in improving hypertensive control rates among black male barbershop patrons (Victor et al., 2011). This method can be employed in the local context by utilizing and training respected members of the community such as imams and pastors (of younger ages) to check BP and encourage patient referral. Additionally, young adults of different ethnicities may respond better to health education and promotion if their cultural and religious beliefs are acknowledged. In the Malaysian context, other individuals who could possibly influence and educate younger adults include personal trainers, yoga instructors, barbers, hairdressers, and nail salon artists. Future research would be required to determine the efficacy of these approaches in increasing the awareness and control of hypertension in this population.

Meanwhile, public health initiatives should increase awareness among both patients and providers that chronic NCDs such as hypertension may not cause any apparent symptoms and can occur early in the life course. Awareness campaigns need to reach young adults of different backgrounds, localities, and educational levels. This requires a strengthening of the relationships between national organizations such as the MoH and those at the community level such as local authorities, as well as academic institutions of higher education such as the University of Malaya. It also requires effective information networks within defined boundaries such as the MSH CPG Working Group. Strategies that encourage engagement and collaboration among multiple stakeholders can facilitate health-related social change and create the right climate for individual change (National Research Council and Institute of Medicine, 2015).

6.2.5 Policy Level

The results from this study reveal that for a decade, a substantial proportion of young adults have been hypertensive, with concomitant low awareness, treatment, and control rates. These findings underscore how important it is that young adulthood should be treated as a separate priority area in NCD programmes, which can only be achieved by modifying public policies. Furthermore, there is a need to reorient primary care services of the Malaysian health system from the management of infectious diseases and MCH which during the early years were the health needs of rural areas, to NCDs, which are a major health concern in the country today (Mustapha, Omar, et al., 2014). As such, local, state, and national policies should upgrade YOH as a separate entity in community health management and allocate adequate resources for programmes and interventions especially with regard to YOH-related primary prevention and health promotion, early detection and screening, as well as treatment and surveillance.

6.3 Directions for Future Research

This study has elucidated the epidemiology of YOH in Malaysia and explored the perspectives of young adults that influence the awareness, treatment, and control rates. A natural subsequent step would be utilizing these findings to formulate a strategy for preventing and managing YOH in the next decade. Future interventional studies to determine the effectiveness of a targeted YOH prevention strategy is recommended.

The literature has demonstrated that diet plays an important role in the development of NCDs (Al-Mohaissen et al., 2017; Nsanya et al., 2019). This study did not explore the association between diet and YOH. Yet, dietary patterns (e.g., potassium and sodium intake) may have changed during the period covered by this study. However, these changes were not measured in the NHMS. Therefore, further exploration is needed to better comprehend how alterations in these variables may contribute to clarifying the trend in YOH in Malaysia.

From this study, it was evident that YOH affected different ethnic groups differently. In addition to environmental factors and lifestyle behaviours, genetics could also play a role in this disparity. Several genes associated with lipoprotein metabolism (such as the cholesterol ester transfer protein gene, hepatic lipase gene, lipoprotein lipase gene, apo A1 gene, apo E gene, and apo B gene) have been found to be associated with CAD in young people (Aggarwal et al., 2016). Thus research that is focused on identifying any contributing genetic factors is essential to address the evidence gaps in respect of the link between ethnicity and susceptibility to YOH.

As regards the formulation of an integrated approach to public health policy and practice focused on young adults, this will require improvements in the data assembled for surveillance and research. It here that the role of AI in healthcare innovation can come into its own, that is, to combine, manage, and analyse big data obtained from population

surveys and thereby potentially classify the risk of hypertension in young adults, identify mechanisms of poorly controlled hypertension, and even judge treatment response in clinical trials using a multiomic approach (when the data from genetic studies as proposed above becomes available) (Krittanawong et al., 2018). Hence methods of utilizing AI in such a manner should be investigated fully to improve cardiovascular preventive care, including balancing the potential of AI with its challenges –from issues of privacy, data security and data ownership in high-income countries; to difficulty in compiling data in resource-poor countries due to lack of expertise and infrastructure requirements (Wahl, Cossy-Gantner, Germann, & Schwalbe, 2018).

The possible association between BP level and job strain has been extensively studied, as elaborated above. However, data is lacking on the association between the two in Malaysia, especially among young adults. This study highlights the necessity for such studies. Furthermore, interventional studies on effective methods to alleviate occupational stress among young adults in Malaysia who work in the private and public sectors are warranted.

In the interviews conducted for the study, the respondents shared the continuous psychological consequences of a YOH diagnosis, including self-stigma, self-blame and regret. These results address a significant research gap when examining the perspectives of young adults living with YOH and also illustrates the need for health professionals to consider the detrimental mental and emotional impact a YOH diagnosis has on young adults (Karnilowicz, 2011). Therefore, further research is necessary to investigate this crucial issue, specifically among young adults.

The majority of young adults in this study supported the use of social media to fulfil their needs in managing hypertension in terms of spreading awareness and information about this chronic disease. However, more work is needed to identify relevant support

services and resources that will better serve the needs as well as safeguard young adults' privacy.

Finally, this study elicited EMs exclusively among young adults with hypertension. It would therefore be beneficial to also undertake qualitative studies to explore healthcare providers' EMs in order to achieve concordance between patient and provider needs in managing hypertension. The outcomes of such studies can aid in strengthening communications between patients and healthcare providers, as discordance between their respective EMs may be the explanation for ineffective consultations.

In conclusion, this study provided a comprehensive analysis of YOH in Malaysia, covering the prevalence, awareness, treatment, control, and risk factors of this disease as well as exploring the lived illness experience of young hypertensive Malaysian adults. This study accomplished its research objectives by providing a clear description of the epidemiology of YOH in Malaysia and also empowered young adults by providing a means for their voices to be heard in the healthcare system. The implications of this study, which have both public health and clinical significance, are profound.

This DrPH journey has been a four-year rollercoaster ride, with moments of rapid progress when the mind was clear and the writing was fluid. However, there were also moments when simply writing one paragraph was a struggle. The production of this final thesis has taught me the importance of tenacity, patience, and perseverance, which are several valuable traits for a public health physician in-training. It has also certainly fanned the flames of my passion for public health research. Although it is finally time to bid farewell to these four memorable years at University of Malaya, I am eager to put my newfound knowledge to good use in improving the public health of Malaysia.

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LIST OF PUBLICATIONS AND PAPERS PRESENTED

Publications:

1. Yi Yi Khoo, Nik Daliana Nik Farid, Wan Yuen Choo, Azahadi Omar (2020). Prevalence, Awareness, Treatment and Control of Young-Onset Hypertension in Malaysia, 2006 – 2015. Manuscript submitted to *Journal of Human Hypertension* on 2 July 2020.

Presentations:

1. Epidemiology of Young-Onset Hypertension in Malaysia and the Future Role of Artificial Intelligence. Paper to be presented at the 6th International Conference of Public Health (ICOPH) 2020, Bangkok, Thailand on 23–24 November 2020.
2. Mixed-Methods Research: A Novel Approach to Investigate Young-Onset Hypertension in Malaysia. Paper to be presented at the 2nd International Conference on Public Health and Well-being 2020, Kuala Lumpur, Malaysia on 21–22 January 2021.