THE THIRD
NATIONAL HEALTH AND MORBIDITY SURVEY
2006
(NHMS III)

HYPERTENSION & HYPERCHOLESTEROLEMIA

INSTITUTE FOR PUBLIC HEALTH
NATIONAL INSTITUTES OF HEALTH
MINISTRY OF HEALTH
MALAYSIA
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THE THIRD NATIONAL HEALTH AND MORBIDITY SURVEY 2006 (NHMS III)

HYPERTENSION & HYPERCHOLESTEROLEMIA

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MESSAGE FROM THE DIRECTOR GENERAL OF HEALTH MALAYSIA

Since independence, Malaysia has achieved remarkable progress economically and socially, notably in the health sector, through a well planned and comprehensive health care delivery system. However, Malaysia's health care system still has to grapple with many challenges, particularly the rising costs of health care and the increasing demands and expectations for quality care by our consumers. In this respect, the Ministry of Health formed the 'National Institutes of Health' to spearhead health research that will provide the body of evidence to help formulate health policies and create new tools to measure health impacts arising from the series of interventions made in the provision of health care. This will lead to an environment of better governance.

The first National Health & Morbidity Survey (NHMS) was conducted in 1986 by the Institute for Public Health (IPH) which is currently one of the research organizations under the umbrella of the National Institutes of Health (NIH). IPH was also given the task of conducting the second NHMS II in 1996 and the current NHMS III in 2006. Data and information gathered by these surveys are consistently and extensively been used by the Ministry of Health in formulating the Malaysian Health Plans and evaluating the intervention programmes.

The publication of the current NHMS III report would generate much interest amongst of all health care stakeholders in the country as well as international health organizations. It is my sincere wish that the data and information generated by NHMS III be fully distributed, discussed and utilized to enhance further the provision of health care in this country. The date generated on the national health and health- related prevalence would be useful in assessing the national health burden as well as allowing for international comparison of health systems achievements.

I would like to take this opportunity to congratulate all those directly involved in the conduct of the survey, namely members of the National Steering Committee, the Advisory Committee, Research Groups and the Working Committee for their untiring efforts in the planning and conduct of the survey as well as publication of the reports. I would like to specially place on record the Ministry's appreciation of the excellent work done by the Principal Investigator and his team and for their dedication and tenacious efforts in spearheading this project to fruition. The Ministry of Health is committed to conduct these National Health and Morbidity Surveys on a regular basis and hope that IPH will continue to provide the leadership in conducting future National Health and Morbidity Surveys in this country.

Thank you.

Tan Sri Datuk Dr Hj. Mohd Ismail Merican
Director General of Health, Malaysia.

MESSAGE FROM THE DEPUTY DIRECTOR GENERAL OF HEALTH (RESEARCH AND TECHNICAL SUPPORT)

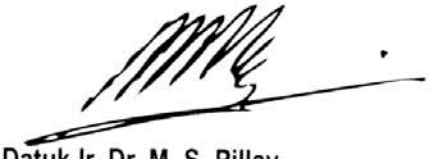
The Research and Technical Support Programme of the Ministry of Health emphasizes the need for research in supporting decision making and planning the activities in the Ministry. Only then can we ensure that every decision made either in planning resources or providing services to the people is supported by evidence based information and ensuring better results and outcome. We would certainly prefer local expertise rather than depend on foreign experts to carry out local research.

Under the umbrella of the National Institutes of Health, the Institute for Public Health has actively been involved in conducting research in public health and the National Health and Morbidity Survey is one of the major research conducted by IKU. This is the third time IKU has been given the responsibility to conduct such a mammoth task. I am very pleased that a lot of improvement have been made in the way this survey was conducted based on the experience learnt during the first and second surveys. However, due to the nature of the community survey, not all diseases and health issues were able to be covered in this survey. The research teams had to conduct an extensive literature reviews for relevant and up to date information on the health status of the Malaysian population.

I believe that the information in these reports are extremely valuable to all decision makers at the National State and district levels as well as those interested in the health of the Malaysian population. It can be a tool in providing guidance in developing and implementing strategies for the disease prevention and control programme in Malaysia.

I would like to take this opportunity to congratulate the research team members who have successfully undertaken and completed this survey. I would also like to thank all individuals and agencies who directly or indirectly made the completion of this survey possible.

The Institute for Public Health again gained a feather in its cap by successfully completing the Third National Health and Morbidity Survey.



Datuk Ir. Dr. M. S. Pillay,
Deputy Director General of Health (Research and Technical Support).

MESSAGE FROM THE DIRECTOR OF INSTITUTE FOR PUBLIC HEALTH

This is the third time the Institute for Public Health (IPH) was given the task to conduct the National Health and Morbidity Survey. The frequency of the study is every 10 years and I am proud that the Institute is able to conduct the surveys successfully since it was first initiated in 1986.

I would like to take this opportunity to thank the Director-General of Health Malaysia, Tan Sri Datuk Dr. Hj. Mohd Ismail Merican, and the Deputy-Director General of Health (Research and Technical Support), Datuk Ir Dr.M.S. Pillay, whose invaluable support and guidance were instrumental in the successful completion of the third National Health and Morbidity Survey (NHMS III). Our appreciations are also extended to all members of the Steering Committee and the Advisory Committee of NHMS III.

I would like also to take this opportunity to congratulate the Principal Investigator and his Project Team Members in completing the NHMS III study and the publication of its report. The NHMS III was made possible through the collaboration of all agencies. The meetings, workshops and conferences that were organised, met their intended objectives and the hard work put up by the field staffs, ensured the three months data collection productive and successful.

My sincere gratitude also goes to Dr.Nirmal Singh, the former Director of the Institute for Public Health, Chairman of the Advisory Committee for his continuous support and guidance which contributed towards the successful completion of the study.

I hope the documentation of this report will be beneficial for future reference.

Finally, I would like to thank all those involved in the survey for a job well done, in making the NHMS III a success and finally producing the national report of this survey.

Dr. Yahya Baba,
Director, Institute for Public Health.

MESSAGE FROM THE PRINCIPAL INVESTIGATOR NHMS III

It is indeed a challenging task when the responsibility was given to me to conduct this survey. I learned the hard way and gained a lot of valuable experience in leading the survey. The survey also taught me lots of new techniques and how it should be addressed which is not available in the textbook. In doing so, I also learned the meaning of friendship and honesty, how to manage people involved and manage properly the given budget.

I would like to take this golden opportunity to thank the Director General of Health Malaysia, Tan Sri Datuk Dr. Hj. Mohd Ismail Merican, Chairman of the Steering Committee for giving me the confidence, valuable support and guidance for the success of this survey.

I would also like to thank the Deputy Director General of Health Malaysia (Research & Technical Support), Datuk Ir. Dr. M.S. Pillay as Co-chairman of the Steering Committee for his patience in seeing through the survey until its completion the production of the national report.

My sincere appreciation to current Director of Institute for Public Health (IPH), Dr.Yahya Baba and former Directors of IPH, Dr.Nirmal Singh, Dr.Sivashamugam and Dr.Sulaiman Che Rus for their trust in me to carried out this survey. Their support for the survey has resulted the smooth conduct and success of the survey.

Special thanks to all State Directors, State Liaison Officers, Field supervisors, Scouts, Data Collection Team members for their full cooperation and efforts to ensure the success of the data collection. My appreciation is also extended to the Assistant Principal Investigator, Dr.Mohd Azahadi Omar, Main Research Group members, members of the Working Committee, Data Management group members, Statistics Consultant, Research group members , Research Officers and Research Assistants for their patience and tolerance of my behaviour to ensure the success of the study. Nevertheless I acknowledge a lot more can be done in strengthening the study.

I believe this report will serve as a useful reference for future surveys and helps in improving the local data sources and also add new valuable information for the Ministry of Health to use in the planning process. I also would like to encourage all research members to participate in further analysis of the data and publish the findings in peer review journals.

Thanks to everyone.

Dr. Hj. Ahmad Faudzi Hj. Yusoff,
Principal Investigator, The Third National Health and Morbidity Survey,
Institute for Public Health.

AUTHOR'S STATEMENT

This volume is the culmination of several months of collaborative effort by the authors who have strived to ensure the integrity of this work.

The findings in this volume have been adjusted for the differences in population composition of the survey sample and the 2006 Malaysian population.

The authors welcome any inquiries, comments and suggestions for further improvement of this volume.

ACKNOWLEDGEMENT

Chapter I:

The authors wish to acknowledge the dedication and commitment of all the field enumerators, both from the Ministry of Health and contract officers who have strived against great hardship to ensure the success of the survey. We also wish to thank the Director-General of Health and the Ministry of Health for granting us the funds and support for conducting this mammoth survey.

Chapter II:

The authors graciously express our appreciation to The Third National Health and Morbidity Survey (NHMS III) Steering Committee, the Advisory committee, Principal Investigator, NHMS III Team Members and consultants for their direction and everlasting support towards the success of this survey.

We also wish to thank the Director-General of Health and the Ministry of Health for granting us the funds and support for conducting this mammoth survey.

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ABBREVIATIONS

BP	Blood Pressure
CPG	Clinical Practice Guideline
CHD	Coronary Heart Disease
CVD	Cardiovascular Disease
DALY	Disability Adjusted Life Year
DBP	Diastolic Blood Pressure
EB	Enumeration Block
GBP	Glucose Blood Profile
HDL	Height Density Lipoprotein
LDL	Low Density Lipoprotein
LQ	Living Quarters
mmHg	Millimeter mercury
mmol/L	Milimol per Liter
MOH	Ministry of Health
NCEP ATP III	Third National Cholesterol Education Program and Adult Treatment Panel
NCEP	National Cholesterol Education Program
NGO	Non Government Organization
NHANES III	Third National Health and Nutrition Examination Survey
NHANES	National Health and Nutrition Examination Survey
NHMS I	The First National Health and Morbidity Survey
NHMS II	The Second National Health and Morbidity Survey

NHMS III	The Third National Health and Morbidity Survey
NHMS	National Health and Morbidity Survey
PPS	Probability Proportionate To Size
SES	Socio-economic Status
SBP	Systolic Blood Pressure
TG	Triglyceride
UK	United Kingdom
US	United States
USD	United States Dollar
WHO	Wealth Health Organization
YLL	Years Life Loss

CHAPTER 1

HYPERTENSION

ABSTRACT

Introduction: Hypertension is an important modifiable risk factor for cardiovascular disease. Results from periodic national surveys have shown a steady increase in its prevalence. The objective of this study is to estimate the prevalence of hypertension and its awareness, treatment and control in Malaysia.

Method: A national population based cross-sectional study was conducted in 2006. A two stage stratified cluster sampling design was employed. After consent, respondents aged 18 years and above had their blood pressure measured by trained nurses. Hypertension is defined as having a SBP ≥140mmHg and/ or DBP ≥90mmHg, or self-reported hypertension on antihypertensive medication.

Results: A total of 33,976 (response rate-98.6%) Malaysian residents aged ≥18 years was examined. The prevalence of hypertension in the overall group was 32.2% (CI: 31.6 - 32.8). Subsequent analyses are presented for those ≥30 years old to enable comparison with the Second National Health and Morbidity Survey (NHMS II). The prevalence of hypertension in the ≥30 years old (n= 24,796) was 42.6% (CI: 41.8 - 43.3). The prevalence in males; [41.7% (CI: 40.7 - 42.8)] and females; [43.4% (CI: 42.5 - 44.4)] showed no significant difference. Among the main races, the prevalence of hypertension for Malays; [45.4% (CI: 44.3 - 46.4)] was significantly higher than the Chinese: [40.6% (CI: 39.0 - 42.1)] and Indians; [40% (CI: 37.7 - 42.3)]. However, there was effect modification of the relationship between race and hypertension by sex. Among the male respondents, the prevalence of hypertension among Malays [42.3% (CI: 41.0 - 43.7)], Chinese [42.4% (CI: 40.3- 44.4)] and Indians; [40.5% (CI: 37.0 - 44.0)] were not significantly different. Whereas amongst females, the prevalence of hypertension in the Malays; [48.4% (CI: 47.1 - 49.6)] was significantly higher than the Chinese; [38.7% (CI: 36.8 - 40.7)] and Indians; [39.5% (CI: 36.7 - 42.5)].

Of all hypertensives, 35.8% (CI: 34.8 - 36.8) were aware of their hypertension. Female hypertensives; [40% (CI: 38.7 - 41.2)] were significantly more aware than the male counterparts; [31.5% (CI: 30.1 - 32.9)]. The prevalence of hypertensives under current treatment is 31.4% (CI: 30.4 - 32.3). Significantly more female hypertensives were under current treatment; [35.4% (CI: 34.2 - 36.7)] compared with male hypertensives; [27.3% (CI: 26.0 - 28.6)]. Only about 8.2% (CI: 7.7 - 8.8) of hypertensive population had their blood pressure under control. Among those under current treatment, 26.3% (CI: 24.8 - 27.8) had their blood pressure under control. There was no significant difference in blood pressure control between males and females.

Conclusion: The prevalence of hypertension has increased since the last national survey. Among those age 30 years and above, the prevalence of hypertensive has increased by almost a third over a ten-year period (NHMS II; 32.9% vs. NHMS III; 42.6%). There is an urgent need for more preventive public health interventions.

1. INTRODUCTION

Hypertension is a major public health problem in Malaysia. Hypertension is defined as systolic BP of 140mmHg or greater and/or diastolic BP of 90mmHg or greater, or the taking of antihypertensive medication (JNC VI 1997). In 1986 the First National Health and Morbidity Survey (NHMS I) showed that the percentage of adult 25 years and above with hypertension in Peninsular Malaysia were found to be 14.4%. However, in this survey, the cut off point for defining hypertension was ≥160/95mmHg. In the Second National Health and Morbidity Survey of 1996 (NHMS II), the prevalence of hypertension (cut off BP ≥140/90) amongst adults 30 years and above was estimated to be 33% (Lim & Morad 2004). In the NHMS II, it was found that the majority of patients with hypertension (67%) were unaware that they had hypertension. Of those who were aware only 23% were on treatment and of those on treatment, only 26% achieve optimum BP control. The overall rate of BP control among the hypertensive population was a miserable 6%.

The poor state of hypertension control is also seen in audits of government clinics nationwide (IHM, MOH 2006). The survey showed that only 28.5% of hypertensive attending government outpatient facilities had their BP under control. Inpatient hospital data from the Ministry of Health meanwhile showed that the number of admissions to government hospitals in Malaysia due to hypertension had increased from 26,876 cases in 1990 to 37,580 cases in 2005, an increase of 40% over a span of 15 years (Ministry of Health Malaysia 2006). In 2003 the number of patients with the diagnosis of hypertension at government outpatient health facilities in Malaysia was estimated at 393,407 (Zainal et al. 2004)

A comprehensive Cardiovascular Disease Prevention and Control Programme was formalised by the Ministry of Health in 1991 with the objectives of reducing mortality and morbidity due to coronary heart diseases, cerebrovascular disease, and rheumatic heart disease. The programme was aimed to reduce recognized modifiable risk factors such as hypertension, smoking, hypercholesterolemia, diabetes mellitus, obesity and physical inactivity in the country. A national programme for prevention and control of hypertension is one of the seven sub-programmes of the cardiovascular disease control programme. This programme was proposed to further streamline, coordinate and strengthen all existing efforts to combat hypertension by various agencies in this field. Objectives of this programme include measuring of blood pressure among those aged 20 years and above at least once every five years, offering of advice on risk factor modification for those with hypertension, provision of sustained treatment to those with hypertension and health education to the general public on the importance of hypertension as a major risk factor for coronary heart disease and stroke. Recognizing the need to provide adequate guideline for the management of hypertension, the idea for a national guideline/ consensus statement was mooted in 1993 with the aim of introducing uniformity and standardization on appropriate care for patient with hypertension. To date, there are two clinical practice guideline (CPG) of hypertension had been produced and the third edition of hypertension CPG is due for completion in 2008.

Strategies, programmes or efforts implemented thus far have to be evaluated to determine their effectiveness in reaching the target population and its impact on hypertension nationally. It is with this intention that hypertension was included in NHMS III to provide essential information such as the prevalence of and health-seeking behavior related to hypertension and related cardiovascular

risk factors. This information would enable plans to be made to further improve the prevention and control of hypertension as part of the overall strategy to combat the impending epidemic of cardiovascular disease in the developing world (Murray & Lopez 1997).

2. LITERATURE REVIEW

2.1 Epidemiology of Hypertension Worldwide

Hypertension is an important worldwide public health challenge because of its high frequency and concomitant risks of cardiovascular, cerebrovascular and kidney diseases. It has been identified as the leading risk factor for mortality, and is ranked third as a cause of disability-adjusted life-years. More than a quarter of the world's adult population, totaling nearly one billion people had hypertension in 2000, and that this proportion will increase to 29% (1.56 billion) by 2025. High prevalence of hypertension was also reported in Latin America and the Caribbean whilst the lowest prevalence occurred in Asia and Pacific Islanders (Kearney et al. 2005).

Data from the National Health and Nutrition Examination Survey (NHANES) had indicated that 50 million or more Americans have high blood pressure warranting some form of treatment (JNC VII 2003). Worldwide, approximately 7.1 million deaths per year may be attributable to hypertension (World Health Report 2002). The World Health Report (2002) revealed that suboptimal BP is responsible for 62% of cerebrovascular disease and 49% of ischemic heart disease, with little variation by sex. In addition, suboptimal blood pressure is the number one attributable risk for death worldwide.

Table 2.1 shows the most recent national survey done by few countries on the prevalence of hypertension and mean SBP of their population (WHO Global InfoBase Online 2007).

Table 2.1: Most Recent National Surveys

Country	Blood pressure, raised			Blood pressure, mean (mmHg)		
	Age group	Prevalence (Both gender)		SBP		
				Age	Male	Female
Thailand	≥35 years		22.7	≥15	119.3	117.3
United Kingdom	≥16 years		32.1	≥15	128.7	123.1
India	≥20 years		36.9	≥15	124.4	122.3
Brazil	≥18 years		12.8	≥15	123.7	119.1
Ghana	≥25 years		29.2	≥15	125.8	124.8
Singapore	≥18 years		20.1	≥18	123.9	122.3
Tunisia	≥40 years	Male	Female	≥15	124.4	122.8
		38.7	48.2			

2.2 Disease Burden

High blood pressure is usually symptomless and often not regarded as a disease in its own right. However, it is a major risk factor in a number of potentially fatal conditions and is also a precursor to several non-fatal but debilitating disorders.

The main potential consequences include:

a) Coronary heart disease
b) Stroke
c) Heart failure
d) Chronic kidney disease
e) Aortic aneurysm
f) Retinopathy
g) Peripheral vascular disease.

In terms of the numbers of people affected, the most important complication of hypertension is cardiovascular diseases (coronary heart disease, stroke, heart failure, aortic aneurysm and peripheral vascular disease).

Because of the very large numbers of people involved, those with blood pressures above 115/75mmHg contributes considerably to the overall burden of blood pressure-related disease. According to the World Health Organization (World Health Report 2002) the global disease burden attributable to a systolic blood pressure of 115mmHg or above is

a) 20% of all deaths in men and 24% of all deaths in women
b) 62% of strokes and 49% of coronary heart disease, and
c) 11% of disability adjusted life years (DALYs).

2.3 Economic Burden

Hypertension is a powerful risk factor for fatal and nonfatal cardiovascular diseases. Data from observational studies indicate that this risk is continuous, without evidence of a threshold, down to blood pressures as low as 115/75mmHg. Randomized controlled trials have convincingly shown that treatment of hypertension reduces the risk of stroke, coronary heart disease, congestive heart failure, and mortality. Based on NHMS II, 1 in 3 Malaysians above the age of 30 years have hypertension. Since it has been estimated that hypertension may affect >90% of individuals during their lifetimes, adequate control of blood pressure is of enormous public health importance.

In 1998 the health care expenditure attributable to hypertension in the United States was 108.8 billion (Hodgson & Cai 2001). In the UK the total cost burden of raised blood pressure for coronary heart disease and stroke amounts to over GBP 7 billion at 1999 prices (Maryon-Davis & Press 2005). In Malaysia, about RM215.9 million was spent on antihypertensive medicines alone in year 2005 (Sameerah & Sarojini 2007). In 2005, there were 37,580 hypertension-related admissions to government hospitals (Ministry of Health Malaysia 2005). The cost per admission of managing

hypertension was RM2,927 for those without comorbidity and complications, RM4,248 for hypertension with comorbidity and complications, and RM4,716 for hypertension with major comorbidity and complications (Amrizal et al. 2007). This amounts to at least RM110 million spent on managing hypertensive patients admitted to hospitals. The above figures are an underestimation. They do not include the many admissions due to heart failure, myocardial infarction and renal failure where hypertension was the underlying cause.

2.4 Disease Prevention

There are two broad approaches to preventing hypertension:

a) The whole population approach, and
b) The 'at-risk' individual or group approach.

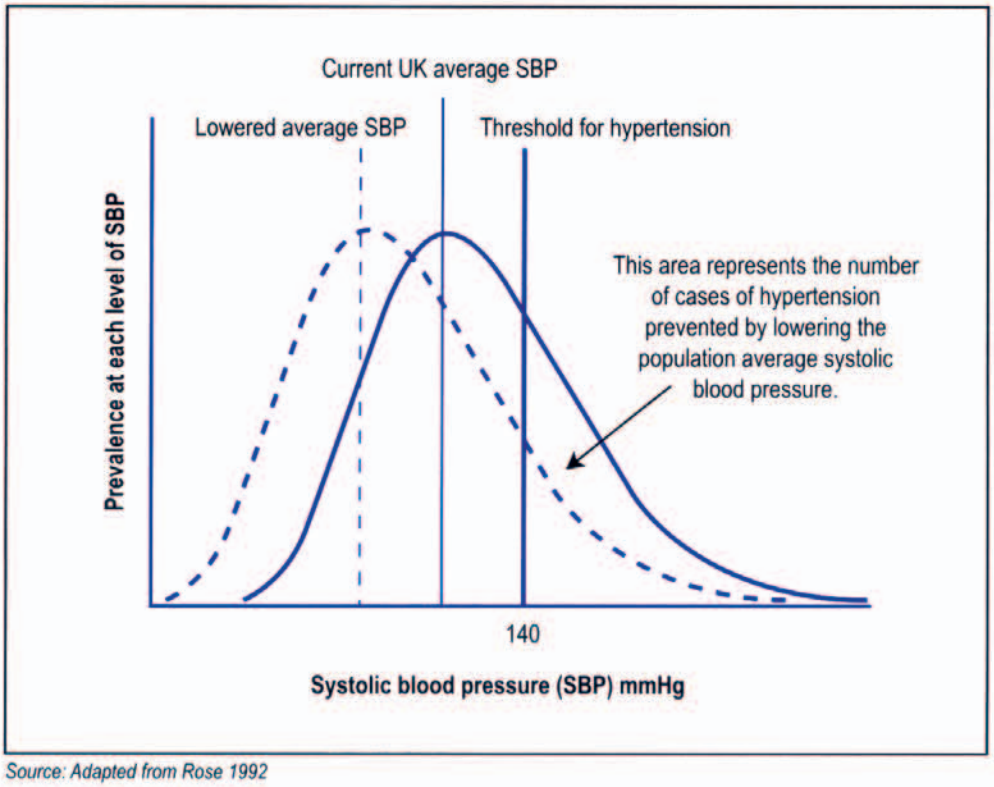
These two approaches are not mutually exclusive, and it has been argued that both are necessary in any comprehensive strategy.

2.4.1 The whole population approach

The aim of this approach is to prevent hypertension by lowering average blood pressure by a relatively small amount across a whole population. It has been estimated that a reduction as small as 2mmHg in the average adult's systolic blood pressure could save more than 14,000 UK lives per year (Maryon-Davis & Press 2005). By encouraging enough people to change their lifestyles sufficiently to lower their blood pressure, large numbers are shifted to below the threshold for hypertension (140/90mmHg) (see Figure 2.1). In other words, many cases of hypertension can be prevented.

The main lifestyle changes required to achieve this are:

a) Reducing the population average intake of salt to 6g per day as recommended by the Scientific Advisory Committee on Nutrition 3 (Maryon-Davis & Press 2005)
b) Increasing potassium intake by increasing fruit and vegetable intake to at least five portions a day
c) Controlling weight to achieve a 10% weight loss in overweight / obese people
d) Increasing habitual physical activity to a total of at least 30 minutes a day of at least moderate intensity activity, on five or more days of the week for adults, and at least 60 minutes each day for children
e) Keeping alcohol intake within recommended benchmark limits for either sex.



Source: Adapted from Rose 1992

Figure 2.1: Population approach in lowering blood pressure

Advantages of this approach include:

i. Benefiting large numbers of people.
ii. Modest and achievable lifestyle changes.
iii. Involvement of different sectors and agencies.
iv. Relatively low cost of implementation.

Barriers to this approach include:

i. Population resistance to changes in lifestyle.
ii. Factors beyond the control of the individual (e.g. as 65%-70% of salt intake is from processed foods, individuals will find it difficult to make significant reductions in salt unless there are across-the-board reductions in salt content).
iii. Benefits seen only after a long process.

2.4.2 The 'at-risk' individual or group approach

This approach focuses on people known to be at higher risk of developing hypertension than the general population. The risk factors described below can be used to identify individuals and groups in this category. For example, efforts could be focused on older people, people who are obese, those with a family history of hypertension or those with other cardiovascular risk factors.

2.4.3 Risk factors for developing hypertension

Several risk factors contribute to the development of hypertension. This can be classified as

a) **Unmodifiable risk factors:** age, gender, ethnicity and family history

b) **Modifiable risk factors:** excess dietary salt, low dietary potassium, overweight and obesity, physical inactivity, excess alcohol, smoking, socioeconomic status, psychosocial stressors, diabetes, low birth weight, being formula-fed as a baby.

2.5 Benefits of Early Detection and Optimum BP Control

There is substantial evidence that lowering blood pressure in people with hypertension is associated with a reduction in cardiovascular risk. For example, according to a relatively recent large-scale meta-analysis of observational prospective studies (Prospective Studies Collaboration 2002), among patients aged 40 to 69 years with hypertension; a 20mmHg lower systolic blood pressure is associated with reduction of stroke mortality of 50% and a reduction of coronary mortality by more than 50%. Smaller differences in blood pressure are associated with smaller differences in death rates from stroke and coronary heart disease (see Table 2.2). The difference in risk varies with age, diminishing in older people, particularly with regards to stroke.

Table 2.2: The relationship between a reduction in systolic blood pressure and cardiovascular mortality in hypertensive patients aged 40-69 years

Difference in systolic blood pressure	% difference in mortality from stroke	% difference in mortality from coronary heart disease
-20mmHg	-50%	->50%
-10mmHg	-30%	-40%
-2mmHg	-7%	-10%

Source: Prospective Studies Collaboration 2002

This data is observational in nature, and do not represent the results of intervention trials. However, a large meta-analysis of trials involving antihypertensive drugs had demonstrated significant reductions in overall cardiovascular risk with reduced blood pressure (BPLTTC 2003) and is consistent with observational study findings.

2.6 Screening for Hypertension

Periodic screening for hypertension is recommended for all persons ≥21 years of age (JNC V 1993). The optimal interval for blood pressure screening has not been determined and is left to clinical discretion. Current consensus is that adults who are believed to be normotensive should have blood pressure measurements at least once every 2 years if their last systolic and diastolic blood pressure readings were below 140 and 85mmHg, respectively, and annually if the last diastolic blood pressure

was 85-89mmHg (JNC V 1993). Blood pressure measurement should be performed in accordance with recommended technique.

The most accurate devices for measuring blood pressure (e.g., intra-arterial catheters) are not appropriate for routine screening because of their invasiveness, technical limitations, and cost. Office sphygmomanometers (the blood pressure cuff) remain the most appropriate screening test for hypertension in the asymptomatic population. Although this test is highly accurate when performed correctly, false-positive and false-negative results (i.e., recording a blood pressure that is not representative of the patient's average blood pressure) do occur in clinical practice (Tifft 1998). One study found that 21% of persons diagnosed as mildly hypertensive based on office sphygmomanometer had no evidence of hypertension when 24-hour ambulatory recordings were obtained (Pickering et al. 1988). Self-measured home blood pressure and ambulatory blood pressure monitoring may provide useful information in special circumstances (e.g., research, persistent "white-coat" hypertension), but there is insufficient evidence at present to warrant their routine use in screening.

In Malaysia, hypertension screening programme had started since 1999 through the CVD risk factor screening program. All individuals detected with SBP $\geq$140mmHg and/or DBP $\geq$90mmHg were sent to hypertension clinics for further evaluation and management.

2.7 Management of Hypertension

Once hypertension is diagnosed, it is important that prompt and effective treatment is made available to the patients. There are four major components in the management of hypertension: diet, exercise, medication and education. In addition, monitoring of blood pressure control and complication should be considered.

The ultimate public health goal of antihypertensive therapy is to reduce cardiovascular and renal morbidity and mortality. Since most persons with hypertension, especially those >50 years old, will reach the DBP goal once the SBP goal is achieved, the primary focus should be on attaining the SBP goal.

It is vital that both patients and health professionals are clear about the aims of treatment at its outset. These aims must be to prevent the complications of hypertension by reducing blood pressure to normal levels and to detect and correct other cardiovascular risk factors. The latest joint British guidelines for cardiovascular disease prevention recommended a target blood pressure of less than 140/90mmHg, or even lower in some high risk groups (NICE 2006). As far as possible, achieving this should be carried out without causing the patient adverse physical effects from medication or other interventions.

2.8 Hypertension Control Programme

Hypertension control programme has long been in the Malaysian health care service. However, prior to 1996 it was not well structured, overlapping and not well coordinated. An initial effort to improve

the program was done by Ministry of Health in 1996 by formulating a national hypertension prevention and control programme.

The national hypertension programme was further reorganised and strengthened in 2000 to provide optimal management in prevention and control of hypertension. These include strengthening the national strategies and programmes, epidemiological assessment and monitoring, improving training of health workers and promoting intersectoral collaboration.

The programme took into consideration that effective management of hypertension rests on the consistent application of preventive and clinical interventions, including efforts to detect hypertension, promote effective self-management, reduce the incidence of complications, and increase the coping skills of people with hypertension and related conditions.

To get better coverage and outcome of the hypertension prevention and control programme, more emphasis must be given to the primary health care services as the first point of contact for hypertensive patients seeking treatment. The role of paramedics in hypertension management should be given a higher priority. In empowering the paramedics in managing hypertension, they need to be trained in preventive and hypertension care, including skills in patient education and counselling. They should also be trained to work in a hypertension team.

3. OBJECTIVES

3.1 General Objective

To provide community-based estimates on the prevalence of hypertension in Malaysia to enable the Ministry of Health to review health priorities, program strategies and activities, and planning for allocation of resources.

3.2 Specific Objectives

3.2.1 To estimate the prevalence of hypertension in Malaysia by socio-demographic sub-groups.

3.2.2 To estimate the prevalence of awareness, treatment and control amongst the hypertensive population in Malaysia by socio-demographic sub-groups.

3.2.3 To make recommendations for health program managers to improve hypertension care and in so doing strengthening ischaemic heart disease (national number 1 killer) prevention programs in Malaysia.

4. METHODOLOGY

4.1 Scope of The Study

Research problems, scopes and main issues to be included in NHMS III were obtained from discussions and feedbacks from Ministry of Health state health managers, as well as experts from the local universities and individuals. The main research team members of the NHMS III reviewed and studied closely the feasibility and practicality of the suggested research topics for this community-based household survey. Extensive literature review was initiated. Technical and research experts in the field related to the identified research areas were consulted for further advise and comments. The main research group used the following criteria in considering the suggested scopes for this survey:

a) Issue/problem is current or has potential of high prevalence.
b) The issue/problem is focused on disease/disorders associated with affluence, lifestyle, environment and demographic changes.
c) The issue/problem is causing physical, mental or social disability.
d) The issue/problem has important economic implications.
e) It is feasible to implement interventions to reduce the problem.
f) The information related to the issue/problem is not available through the routine monitoring system or other sources.
g) The information is more appropriately obtained through a nation-wide community survey.
h) It is feasible to obtain through a nation-wide community-based survey.

The short-listed research topics were then presented to the Advisory Group Members for further deliberation and decisions. These topics were later refined by the research team members based on the decisions made at the Advisory Committee meeting. It was tabled to the Steering Committee and 18 research topics were approved to be included in the NHMS III.

4.2 Sampling Designs and Sample Size

In calculating the sample size, stratification and sampling design, the Methodology Division Department of Statistics Malaysia as well as several other biostatistics consultants.

4.2.1 Sampling frame

The sampling frame for this survey is an updated until 2004; an effort undertaken prior to the implementation of Labour Force Survey (LFS) 2004. In general, each selected Enumeration Blocks (EB) comprised of 8 sampled Living Quarters (LQ). The EBs was geographically contiguous areas of land with identifiable boundaries. Each contains about 80-120 LQs with about 600 persons. Generally, all EBs are formed within gazetted boundaries.

The EBs in the sampling frame was also classified into urban and rural areas. The classification into these categories was in terms of population of gazetted and built-up areas as follows:

Stratum	Population of gazetted areas and built-up
Metropolitan	75,000 and above
Urban large	10,000 to 74,999
Urban small	1,000 to 9,999
Rural	The rest of the country

For sampling purposes, the above broad classification was found to be adequate for all states in Peninsular Malaysia and the Federal Territories of Kuala Lumpur and Labuan. However, for Sabah and Sarawak, due to problems of accessibility, the rural stratum had to be further sub-stratified based on the time taken to reach the area from the nearest urban centre.

For the purpose of urban and rural analysis, Metropolitan and Urban Large strata are combined together thus referred to as 'urban' stratum, while for Urban Small and the various sub-divisions of the rural areas they are combined together to form to a 'rural' stratum.

4.2.2 Sampling design

A two stage stratified sampling design with proportionate allocation was adopted in this survey. The first stage sampling unit was the EB and within each sampled EB, the LQs were selected as second stage unit. One LQ is estimated to comprise of 4.4 individuals. All household and persons within a selected LQ were studied.

4.2.3 Sample size

The sample size was determined based on 95% confidence interval and the following factors were taken into consideration:

a) Expected prevalence rate

The prevalence rate of the health problems for Malaysia obtained from the National Health and Morbidity Survey 2 (NHMS II) were used to estimate the overall sample size. Using the previous finding of 10% prevalence rate, the initial sample size at the state level was calculated in order to come up with overall sample size. The size was further apportioned for each state using the probability proportionate to size (PPS) method.

b) Response rate of the NHMS II

The response rates, which ranged from 83 to 97% for the NHMS II of each state, were taken into consideration in the course of the determination of sample size.

c) Margin of error and design effect

As the factors of precision and efficient of the survey are paramount, the decision reached for the targeted margin of error is 1.2 and the design effect valued at 2. These values were used at the initial stages of the calculation of the sample size of each state.

The survey findings addressing the specific objectives of this survey are expected to be used for state level programmed planning. Thus, the calculation for the sample size has taken into consideration data to be analyzed at the state level.

In addition to the major factors mentioned earlier, the availability of resources, namely, financial and human resources, and the time taken to conduct this survey also becomes part of the process of the determination of sample size.

4.3 Preparation of Field Areas and Logistic Support

A number of state liaison officers were recruited in preparation for the survey proper. Strong networking with state liaison officers and District Health Officers (MOH and local authorities) from the areas sampled for the survey was established. Field scouts were mobilized from these areas to identify and tag the LQ's selected for the survey, as well as to inform the community and related government agencies of the importance and schedule of the planned survey. State liaison officers were also assisting Field Supervisors in the arrangement of transportation, accommodation and other logistics for the survey teams.

4.4 Method of Data Collections

4.4.1 The questionnaire

A bi-lingual (Bahasa Malaysia and English) pre-coded questionnaire was designed, pre-tested and piloted prior to the survey. All research topics for the questionnaire are arranged into modules ranging from A to Z. Topics that are similar area are arranged into sub-modules under a particular module. Questions comprised of both close ended and open ended. The questions in hypertension module (Module S) were tailored to the target group.

The face to face interview (FI) questionnaires consisted of two subtypes, i.e., the household questionnaire (orange) to be answered by the head of the household of the LQ selected, and the individual questionnaire, to be answered by each member of the household. One type of individual FI questionnaires were developed, to cater 18 years old and above (purple).

All the FI questionnaires have a consent form to be read and signed by the respondent. The outside cover of all questionnaires had to be filled with a unique individual identification (ID) number by the enumerator. The enumerator also had to fill his or her ID as well as the code for the outcome of the interview as part of the quality assurance process.

4.4.2 The interview

As far as possible, all adult members who qualify from the selected LQ's were interviewed by the data collection team members. Interviews commenced early in the morning and lasted till late in the evening. Where an interview had been unsuccessful due to the absence of the respondent at the selected LQ, repeat visits were conducted after leaving messages with neighbours or by other means for an appointment at a later date. A household member can only be classified as a non-responded after 3 unsuccessful visits.

4.4.3 Clinical examination

The blood pressure measurement was carried out by trained nurses:

All household members aged 18 years and above were examined for their blood pressure. Two readings of the systolic and diastolic pressure with 15 minutes apart were taken using Omron Digital Automatic Blood Pressure Monitor Model HEM-907. This instrument has been validated (Mohamed et al. 2002). Blood pressure was taken using the standard procedure and the correct cuff size.

A respondent having a systolic blood pressure of ≥140 and /or a diastolic blood pressure of ≥90mmHg was classified as hypertensive. A systolic and diastolic blood pressure below these levels respectively was classified as normotensive. The classification has been modified from the Classification of Hypertension based on JNC VII (2003).

Blood pressure results were obtained and immediately noted in the questionnaire. Respondents were informed of the results and if found to be undesirable (systolic blood pressure of ≥140 or a diastolic blood pressure of ≥90mmHg), were referred to the nearest health facility for further evaluation and management.

4.5 Field Preparations

Two main survey implementation groups were formed: the Central Coordinating Team (CCT) and the field team. The CCT's main role was to monitor and coordinate the progress of implementation and provide administrative support in terms of financial and logistic arrangement for the field survey. The Field Teams were responsible to oversee and manage the field data collection process as well as undertake quality control.

The field data collection was conducted throughout Malaysia simultaneously, spanning a continuous period of 4 months starting from the month of April 2006. Teams were organized to move into 5 regions in Peninsular Malaysia, 2 regions in Sabah and 4 regions in Sarawak for data collections.

4.5.1 Pilot study

A pilot study was conducted on a sample of EB's (not included in the NHMS III) about 2 months prior to the nationwide survey. It was conducted in three different areas in and around the Klang Valley,

namely Sepang, Klang and Bangsar. The population in these locations comprised of three distinct socio-demographic strata that are rural, semi-urban and urban respectively. The pilot study focused on the following aspects of the survey such as testing of the questionnaire, testing of the field logistic preparation, testing of the scouting activities and testing of the central monitoring and logistic support.

4.5.2 Training of data collection teams

A two weeks training course was held for field supervisors, team leaders, nurses and interviewers was to familiarize them with the questionnaire, develop their interpersonal communication skills and appreciate the need for good teamwork. Briefing on the questionnaire, mock interview in the classroom and individual practice under supervision was conducted during the training.

4.6 Quality Control

Quality control procedures for the data collection were done at two stages, field and central. Detail description of quality control process has been described in NHMS III protocol.

4.7 Data Management

4.7.1 Data screening

The following data screening exercises had been conducted at the field and central level prior to data entry:

a) Field data screened by each interviewers at the end of his/her interview
b) Field data screened for each question by peer interviewers through exchanging questionnaire booklets
c) Field data screened by team leaders and field supervisors
d) Central data screening of the questionnaire by the quality control team

4.7.2 Data entry

The data entry system was developed to record the information collected during the data collection phase. It is a web based system that allows multiple simultaneous accesses to the database. The NHMS III used a double manual data entry method and any discrepancy between both entries was verified by the supervisors. The data entry started simultaneously with data collection (first week of April 2006) and was completed at the end of January 2007. The data entered was stored in the database according to the module. The databases were designed using Structured Query Language (SQL) which is a standard language for relational database management system.

4.7.3 Data analysis

Data analysis was done by exporting the data into other analytical tools such as Microsoft Excel, SPSS and STATA. The data in database (text form) was exported to the Microsoft Excel form then to the SPSS and STATA. The raw data was cleaned and analysed according to the terms, working definition and dummy table prepared by the research groups. All the analytical process were monitored and advised by the NHMS III Statistics Consultant.

4.8 Definition of Terms / Variables

For the purpose of data analyses, the definition of hypertension was based on felt and unfelt needs of the population. Felt needs was reflected when those who reported to have been told to have hypertension by a medical doctor or paramedic in the last one year. They were classified as known *hypertensives*. Unfelt needs in the population was defined as an average of two blood pressure readings at single occasion with SBP ≥140mmHg or DBP ≥90mmHg among those who did not report as known hypertensives. They were classified as undiagnosed hypertensives.

Known hypertensives were further inquired about their treatment status (ever treated in the last one year and current treatment). They were also asked for any treatment default in the last one-year and if so, the reasons for default. For those who sought treatment, the pattern of health utilization was also inquired. Lastly, a family history of hypertension was obtained.

Further specific definition among the known and unknown hypertensives based on blood pressure measurement and / or treatment history is outlined below:

4.8.1 **Isolated systolic hypertension** was defined as having an average of two blood pressure readings at single occasion with a systolic blood pressure of ≥140mmHg and a diastolic blood pressure of <90mmHg.

4.8.2 **Isolated diastolic hypertension** was defined as having an average of two blood pressure readings at single occasion with a systolic blood pressure of <140mmHg and a diastolic blood pressure of ≥90mmHg.

4.8.3 **Systolic and diastolic hypertension** was defined as an average of two blood pressure readings at single occasion of ≥140mmHg systolic blood pressures and ≥90mmHg diastolic blood pressures.

4.8.4 **Normotensive** was defined as an average of two blood pressure readings at single occasion of <140mmHg systolic blood pressure and <90mmHg diastolic blood pressure among the unknown hypertensives (those who have never been told to be hypertensive).

4.8.5 **Awareness of hypertension** was defined as having been told to have hypertension by a medical doctor or paramedic (known hypertensives).

4.8.6 **Ever treated for hypertension** was defined as a self-report of having had any form of allopathic treatment for the condition in the last one year.

4.8.7 **Currently on drug treatment for hypertension** was defined as a self-report of respondents currently taking any form of allopathic treatment for the condition.

4.8.8 **Controlled hypertension** was defined as having a desirable blood pressure level (<140/90mmHg) among respondents who are hypertensive and among respondents who are aware of being hypertensive regardless of the current treatment status respectively.

5. FINDINGS

5.1 General Findings

The principal findings in this survey report regarding estimates for prevalence of hypertension are derived from Malaysian adult residents aged 18 years and above, who had their blood pressure examined during the Third National Health Morbidity Survey 2006. The survey was conducted by the Institute for Public Health (Institut Kesihatan Umum), Ministry of Health, Malaysia. Findings are based on the standard definition of hypertension as elevated blood pressure during examination (either SBP ≥140mmol/L and/or DBP ≥90mmol/L) using an average of two automated blood pressure measurements, or a self-reported hypertensive on current anti hypertensive medication.

From the 34,446 respondents aged 18 years and above in the NHMS III survey, a total of 33,976 subjects had their blood pressure examined; 98.6%.

On reviewing the characteristics of the survey respondents examined, it was noted that 49.4% were female and 50.6% were male. Respondents between the ages of 20 to 49 years formed 72.1% of those examined, of which 28.49 % were between the ages of 20 to 29 years. The oldest age group (70 years and above) was 3.9 % and the youngest group (18-19 years old) was 6.7% of the responders examined.

Among the respondents, 91.5% were Malaysian citizens. Among all respondents, Malays (49.0%) formed the largest ethnic group, followed by the Chinese (24.8%), Indians (7.4%), other Bumiputeras (9.7%) and others (0.6%) (Refer Appendix : Table 1).

5.2 Prevalence of Hypertension Among Malaysian Residents Aged 18 Years and Above in 2006

This study reports a prevalence of 32.2% (CI: 31.6 - 32.8) among Malaysian residents aged 18 years and above in 2006 (Refer Appendix : Table 2).

Overall the prevalence of hypertension in males; [33.3% (CI: 32.5 - 34.2)] was significantly higher than females; [31.0% (CI: 30.3 - 31.7)].

Among the main races, the overall prevalence of hypertension for Malays; [33.9% (CI: 33.1 - 34.7)] was similar to that of the Chinese; [32.4% (CI: 31.1 - 33.8)]. The prevalence of hypertension for Malays was significantly higher compared to Indians; [29.4 (CI: 27.5 - 31.2)]. As the group "other Bumis" is a very heterogenous group, no inter ethnic comparisons was performed with this group.

Among Malaysian male respondents, the prevalence of hypertension was highest in the Sabah Bumiputeras; [36% (CI: 33.0 - 39.1)] and lowest among the Indians; [30.9% (CI: 28.2 - 33.8)]. However there was no significant difference in the prevalence of hypertension between the different male ethnic groups among Malaysians.

On the other hand among females, the prevalence of hypertension was highest in the Malays; [34.1% (CI: 33.1 - 35.1)] and lowest among the Sabah Bumiputeras; [26.4% (CI: 24.1 - 28.8)]. Malay females have significantly higher prevalence of hypertension compared to all other ethnic groups except for Sarawak Bumiputeras (Refer Appendix : Table 2).

Based on the survey analysis conducted, it is estimated that there are 4.8 million (CI: 4.6 - 4.9 million) Malaysian residents who may have hypertension (Refer Appendix : Table 3). This represents 2.2 million males (CI: 2.1 - 2.2) and 2.6 million females (CI: 2.5 - 2.7) hypertensives. In terms of ethnic breakdown, it is estimated that there are 2.7 million Malays with hypertension while that for the other ethnic groups are 1.0 million Chinese, 400,000 Indians, and 500,000 other Bumiputeras.

5.3 Prevalence of Hypertension Among Malaysian Residents Aged 30 Years and Above in 2006

A total of 24,796 Malaysian residents aged 30 years old and above had their blood pressure examined in this survey. Appendix : Table 4 shows that the overall estimated prevalence of hypertension for this group is 42.6% (CI: 41.8 - 43.3).

The prevalence of hypertension in males; [41.7% (CI: 40.7 - 42.8)] was not significantly different from the prevalence of hypertension in females; [43.4% (CI: 42.5 - 44.4)].

Among the main races, the overall prevalence of hypertension for Malays [45.4% (CI: 44.3 - 46.4)] was significantly higher than that of the Chinese [40.6% (CI: 39.0 - 42.1)] and Indians [40.0% (CI: 37.7 - 42.3)]. No inter racial comparisons was performed with the "other Bumis" group due to its heterogeneity.

Among the male respondents, the prevalence of hypertension among the Malays [42.3% (CI: 41.0 - 43.7)], Chinese [42.4% (CI: 40.3 - 44.4)] and Indians [40.5% (CI 37.0 - 44.0)] were comparable with no statistical significant difference seen.

On the other hand amongst the females, the prevalence of hypertension in the Malays [48.4% (CI: 47.1 - 49.6)] was significantly higher than the Chinese [38.7% (CI: 36.8 - 40.7)] and Indians [39.5% (CI: 36.7 - 42.5)]. It is plausible that the differences in overall prevalence of hypertension seen between the different ethnic groups can be attributed to the differences seen among the female subjects.

The prevalence of hypertension seems to follow a significantly increasing trend inversely proportional to the level of education. It is lowest among those with tertiary education [19.4% (CI: 17.9 - 21.0)] followed by those with secondary education [25.7% (CI: 25.0 - 26.5)], primary education [40.9% (CI: 39.9 - 42.0)] and highest among those with no formal education [58.6% (CI: 56.7 - 60.5)]. This significant observation was seen in both males and females. A similar trend was also seen between household income and prevalence of hypertension i.e. the lower the household income the higher the prevalence of hypertension. This however was only significant at the lower end of household income (among those whose household income is less than RM 2,000 per month). There were also significantly more hypertensive in the rural area [36.9% (CI: 35.9 - 38.0)] compared to urban area [29.3% (CI: 28.5 - 30.0)]. This pattern was seen in both male and female (Refer Appendix : Table 5).

5.4 Awareness, Treatment and Control of Hypertension

For the purpose of comparing with NHMS II results, these analyses are for those Malaysian residents aged ≥30 years old.

Appendix : Table 6 shows that the overall awareness rate was 35.8% (CI: 34.8 - 36.8). A significantly higher proportion of female hypertensives were aware of their diagnosis [40.0% (CI: 38.7 - 41.2)] compared with their male counterparts [31.5% (CI: 30.1 - 32.9)]. Among the major ethnic groups, Indians [41.6% (CI: 38.0 - 45.3)] and Chinese [39.2% (CI: 37.0 - 41.4)] were more aware that they have hypertension compared to Malays [35.5% (CI: 34.3 - 36.8)]. There was no difference in awareness rates between Indians and Chinese. The difference in awareness among males showed a similar trend. Significantly more Indian males were aware of their hypertension status [41.6% (CI: 36.3 - 47.2)] compared to Malay males [30.9% (CI: 29.2 - 32.8)]. There was no significant difference in awareness between Chinese males [35.5% (CI: 32.6 - 38.6)] compared to Malay or Indian males.

Among the hypertensive population the percentage of those currently on treatment was 31.4% (CI: 30.4 - 32.3). Likewise there were significantly more female hypertensive subjects who were under current treatment [34.2% (CI: 32.7 - 36.7)] compared with the male hypertensive subjects [27.3% (CI: 26.0 - 28.6)]. Among the major ethnic groups significantly more Indians [37.8% (CI: 34.3 - 41.4)] and Chinese [36.4% (CI: 34.2 - 38.6)] were on treatment compared to Malays [30.4% (CI: 29.2 - 31.6)]. Treatment rates among Indians and Chinese showed no significant difference. The difference in treatment rates among the male of major ethnic groups also showed a similar trend. Significantly more Indian [37.4% (CI: 32.3 - 42.8)] and Chinese [32.8% (CI: 30.1 - 35.7)] male hypertensives were on treatment compared to Malay male hypertensives [26.0% (CI: 24.3 - 27.7)]. There was no difference in treatment rates among Chinese and Indian male's hypertensives. Among the female, more Chinese were on treatment [40.4% (CI: 37.4 - 43.4)] compared to Indians [38.2% (CI: 33.9 -

42.7)] or Malays [34.2% (CI: 32.7 - 35.8)]. The difference is treatment rates was significant between Chinese and Malay, but not between Malay and Indian female.

Though only about 8.2% (CI: 7.7 - 8.8) of hypertensive population had their blood pressure under control, more than one quarter [26.3% (CI: 24.8 - 27.0)] of the hypertensive population under current treatment had their blood pressure under control. Overall control was highest among Indians [12.2% (CI: 10.0 - 14.7)] followed by Chinese [11.5% (CI: 10.1 - 12.9)], Sarawak Bumiputeras [8.0% (CI: 5.9 - 10.7)], Malays [7.0% (CI: 6.4 - 7.7)] and lastly Sabah Bumiputeras [6.4% (CI: 4.8 - 8.5)]. The overall control rate is significantly lower in Malays and Sabah Bumiputeras compared to Chinese and Indians. Similar trend was seen when hypertensives on treatment was analysed. Indians had the highest rate of control [32.2% (CI: 27.1 - 37.7)] followed by Chinese [31.5% (CI: 28.3 - 34.9)], Sarawak Bumiputeras [26.1% (CI: 20.2 - 33.1)], Malays [23.0% (CI: 21.1 - 25.1)] and lastly Sabah Bumiputeras [21.8% (CI: 16.6 - 28.1)]. The difference in control rate on treatment is significantly lower in Malays compared to Chinese and Indians. This ethnic difference in BP control was also seen among males and female hypertensives with Malays significantly worse compared to Indians and Chinese.

6. DISCUSSION

The NHMS are carried out at 10-year intervals, with the first in 1986 and the second survey in 1996. The NHMS II survey presented results on prevalence of hypertension for respondents aged 30 years and above. When compared with the hypertension prevalence of 32.9% in adults aged 30 years and above reported in NHMS II (Lim & Morad 2004), this study found an overall prevalence of hypertension of 42.6% for the same age group. This rise in prevalence is consistent with another recent nation wide survey in Malaysia conducted in 2004, which recorded a prevalence of 40.5% among those older than 30 years old (Rampal et al. 2007). There is thus a clear trend of increasing prevalence of hypertension among the adult population of Malaysia.

The prevalence of hypertension was similar for males and females in the overall group, a similar observation seen in the NHMS II. However from age 40 years old onwards, more female were hypertensives compared to males. In males, comparison among the difference racial groups showed that there were no statistical differences in their prevalence of hypertension. Whereas amongst the females this survey showed that Malay women had significantly higher prevalence of hypertension compared with Chinese and Indian women.

The impact of socioeconomic status (SES) on the prevalence hypertension has been shown to be controversial. Even in Europe results were conflicting. While lower SES was weakly associated with higher blood pressures in Germany, the same was not seen in the Czech Republic (Dragano et al. 2007). Grotto et al. (2007) also showed that low SES is associated with elevated blood pressure among young adults in Israel. As regards education levels, two recent studies from Asia showed that hypertension is significantly more prevalent in the low compared with the high education group (Reddy et al. 2007; Hoang et al. 2007) which is in keeping with our observation and a recently

published study from Malaysia (Rampal et al. 2007) . A 10 year follow up study from the United States among women also demonstrated that the likelihood of developing hypertension is lower among more educated women (Albert et al. 2006).

How do data from Malaysia compare with regional figures? Data from national surveys in South East Asia are not easily available with only Thailand been quoted in a recent overview of worldwide data (Kearney et al. 2005). The overall age adjusted incidence of hypertension in Thailand is 21.7% (InterAsia Collaborative Group 2003), lower than that of Malaysia. Other published works from the region are not national surveys. A recent survey of Southern Thailand (which borders northern Peninsula Malaysia) showed a very low overall prevalence of hypertension (Yipintsoi et al. 2005). A Vietnamese survey of the Bavi district showed a prevalence of 14.1% (Van et al. 2003), while in Indonesia prevalence of hypertension among those above 40 years was 37.3% (Setia & Sustrisna 2005). The Indonesian study however excluded those already on antihypertensive treatment, which means the actual prevalence was higher. The prevalence of hypertension among those aged 40 and above in the 2004 survey in Malaysia was 51.5% (Rampal et al. 2007) while in this survey the figure was 54.3%.

The population of Malaysia comprises of three main ethnic groups. It is interesting to compare the prevalence of hypertension among similar ethnic groups in the region. The prevalence among Malay females in Southern Thailand was only 4.5% (Yipintsoi et al. 2005) while that of Malay women ≥18 years old in Malaysia was 39.6%. The difference may be due to the fact that the Malays in Southern Thailand were mainly rural folk. However interestingly enough in this present survey the prevalence of hypertension is higher among rural compared to urban populations for both genders. The China Multi Center Study of Cardiovascular Epidemiology of 1998 showed that the national prevalence of population aged from 35 to 59 years was 24% (Wang et al. 2004). Malaysian Chinese aged ≥18 years old thus have a higher prevalence (32.4%) of hypertension than those of mainland Chinese. Unlike our survey, the Chinese survey showed a 25.4% higher prevalence of hypertension among urban compared to rural populations (Wang et al. 2004). There is only one published data on hypertension among southern Indians (Chockalingam et al. 2005) as opposed to several on northern Indian (Das et al. 2005; Hazarika et al. 2004; Malhotra et al. 1999; Singh et al. 1997). The prevalence of hypertension among urban southern Indians aged 18 years and above was reported at 34.7%, higher than that of Malaysian Indians aged ≥18 years old from this survey (29.4%). The figures from northern India's urban population meanwhile ranged from 23.8% (Singh et al. 1997) to a much higher prevalence of 40.9% (Das et al. 2005).

The rates of awareness and treatment were significantly higher in the female hypertensives compared to males. The rate of overall BP control was also higher in females though not significant. However the rates of control on treatment did not show any significant difference between males and females.

Rates of awareness among the hypertensives have changed very little over the years. In 1996, 33% of the hypertensive subjects were aware that they had hypertension. In 2004 the awareness rate was 34.6% and the present study showed an awareness rate of 35.8%. One major improvement over these years is the percentage of patients who are aware and are treated. In 1996 only 23% of those who were aware were treated. In the present study the treatment rate among those who are aware has increased to 87.7%. The steady increase in treatment rates may be due to increase

awareness among doctors on the need to start pharmacotherapy early.

Population studies on secular trends of hypertension have generally speaking shown disappointing results. Even in the USA there was a period of worrying trend with regards to hypertension awareness, treatment and control rates (JNC VI 1997). The Chinese study quoted earlier (Wang et al. 2004) showed that while control rate has improved (from 12.7% to 19.9%) it is far from satisfactory. Indeed the projection made by Kearney et al. (2005), especially for the developing world, is of concern. Hypertension is projected to pose a serious public health challenge well into 2025 with the most of the socio economic burden to be shouldered by the developing world. While rates of control global is generally poor, it is even worse in the developing countries (Erdine & Aran 2004)

There have been several well-conducted randomised control trials over the last 10 years on the benefits of treating hypertensives patients with different levels of cardiovascular risk. These recent trials may convince doctors to start treatment earlier. Unfortunately despite the increasing trend of treatment rates among patients with hypertension, the control rate among treated patients has remained stagnant (26% in 1996, and 26.6% in 2004 and 26.3% in the present study). The overall control rate among all hypertensive patients has shown little improvement from 6% in 1996 to 8.6% in 2004 and 8.2% in the present study.

7. CONCLUSION

In conclusion the results from the NHMS III have not shown improvement from the previous survey almost a decade ago (NHMS II). In some respect there is even deterioration. It closely reflects the findings of a similar nationwide survey done more recently in 2004. This is particularly true with regards to the prevalence of hypertension, awareness and rate of blood pressure control in Malaysia. There was an encouraging improvement in the rate of known hypertensives on treatment. Reasons for the lack of improvement need to be explored and improvement strategies put in place. This survey serves as an important benchmark for further efforts towards better management of hypertension in our population.

8. RECOMMENDATIONS

8.1 The increasing prevalence of hypertension in the population is of serious concern. A population-based approach in reducing blood pressure is needed. Implementation of a more effective healthy lifestyle programme is required. With regards to hypertension, efforts must be made to educate the population to reduce salt intake and to get the cooperation of food manufacturer to display and reduce salt content in processed food.

8.2 The very low awareness rate calls for a few possible intervention strategies that include opportunistic screening and targeted screening. Due to a high prevalence of hypertension among the >30 years old, it is recommended that individuals above the age of 30 years should have at least a yearly BP check. As regards targeted screening, efforts must be made to measure BP on first-degree relatives of hypertensives especially those above 30 years old.

8.3 The higher treatment rate among those diagnosed to have hypertension compared to previous nation wide surveys is reassuring. However what is worrying is that the control rate among those treated is still poor. Efforts must be put in place to implement more effective continuing professional development programmes so that doctors are clear of treatment targets. The teaching of therapeutic at undergraduate and postgraduate levels should also reflect evidence based clinical practice guidelines. Since hypertension is also managed by paramedics, it is also pertinent that their continuing education programme keep pace with recent developments in therapeutics

8.4 Hypertension is the most prevalent cardiovascular risk factor in Malaysia and confers the greatest attributable risk to the population. Unfortunately the disease burden attributable to hypertension has not been captured in national surveys thus far. The WHO has recognized hypertension as the number 1 burden of disease globally. It is time that this is reflected in national strategies on health planning with clear targets set as key performance indicators.

8.5 Contributions of specific professional NGOs should be enhanced. Efforts by these NGOs must complement that of the MOH and unnecessary duplication avoided. All efforts in future must be in tandem in national strategy on hypertension.

8.6 Research on hypertension must now be more directed in light of these findings. Policy on dietary salt intake will be enhanced if the salt intake in our population is better quantified. Research on eating habits and preferences of Malaysian can assist in more practical and palatable dietary intervention programme. Studies to better profile the hypertensives phenotypes and genotypes in our population may assist in more targeted therapeutic approach towards better BP control. Behavioral studies to identify psychosocial predictors of poor BP control and poor drug compliance is needed. This will have to include both patients and doctors as study subjects.

8.7 The wealth of data generated by this survey should be utilized in prospective longitudinal studies at least in the hypertensive cohort. There have been several well-conducted cross sectional studies in Malaysia but we desperately need cohorts to better understand the natural progression of blood pressure in the community and the actual disease burden it poses to our society.

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APPENDIX

APPENDIX

Table 1: Characteristics of respondents for hypertension module of National Health and Morbidity Survey III (N=33,976)

	n	%	Adjusted* %
Sex			
Male	15,209	44.8	50.6
Female	18,767	55.2	49.4
Age Groups			
18-19	1,688	5.0	6.7
20-29	7,492	22.1	28.4
30-39	7,107	20.9	24.9
40-49	7,313	21.5	18.8
50-59	5,516	16.2	10.9
60-69	3,072	9.0	6.4
≥70	1,788	5.3	3.9
Ethnicity			
Malay	17,995	53.0	49.0
Chinese	6,771	19.9	24.8
Indian	2,685	7.9	7.4
Bumiputra Sabah	2,473	7.3	5.6
Bumiputra Sarawak	1,302	3.8	4.1
Others	586	1.7	0.6
Foreigner	2,164	6.4	8.5
Education			
No Formal Ed	3,651	10.8	8.0
Primary (1-6 yrs)	11,043	32.5	29.5
Secondary (7-13)	15,685	46.2	49.9
Tertiary (≥14)	3,284	9.7	11.5
Unclassified	313	0.9	1.0
Household Income			
<400	2,948	8.7	7.4
400 - 699	5,013	14.8	13.6
700 - 999	3,847	11.3	11.0
1000 - 1999	8,859	26.1	26.2
2000 - 2999	5,156	15.2	15.7
3000 - 3999	2,599	7.6	8.2
4000 - 4999	1,302	3.8	4.2
≥5000	2,904	8.6	9.6
Unclassified	1,348	4.0	4.0
Urban/Rural			
Urban	20,055	59.0	62.1
Rural	13,921	41.0	37.9

** Adjusted to Malaysian population by age, sex and race*

Table 2: Prevalence of hypertension by sex and race amongst Malaysian residents aged 18 years and above in 2006 (N=33,976)

Age (Years)	Sex, % (95% CI)		
	Male	Female	Both sexes
All races	33.3 (CI: 32.5 - 34.2)	31.0 (CI: 30.3 - 31.7)	32.2 (CI: 31.6 - 32.8)
Malay	33.7 (CI: 32.5 - 34.8)	34.1 (CI: 33.1 - 35.1)	33.9 (CI: 33.1 - 34.7)
Chinese	35.0 (CI: 33.2 - 36.8)	29.8 (CI: 28.2 - 31.4)	32.4 (CI: 31.1 - 33.8)
Indians	30.9 (CI: 28.2 - 33.8)	27.8 (CI: 25.6 - 30.1)	29.4 (CI: 27.5 - 31.2)
Bumiputra Sabah	36.0 (CI: 33.0 - 39.1)	26.4 (CI: 24.1 - 28.8)	31.1 (CI: 29.2 - 33.2)
Bumiputra Sarawak	35.6 (CI: 31.0 - 40.4)	33.3 (CI: 29.5 - 37.3)	34.4 (CI: 31.0 - 38.1)
Foreigner	26.4 (CI: 23.4 - 29.7)	19.6 (CI: 17.3 - 22.2)	23.5 (CI: 21.4 - 25.8)

Table 3: Estimated number of hypertensive population by sex and race amongst Malaysian residents aged 18 years and above in 2006*

Age (Years)	Sex, million population (95% CI)		
	Male	Female	Both sexes
All races	2.2 (CI: 2.1 - 2.2)	2.6 (CI: 2.5 - 2.7)	4.8 (CI: 4.6 - 4.9)
Malay	1.2 (CI: 1.1 - 1.2)	1.5 (CI: 1.5 - 1.6)	2.7 (CI: 2.6 - 2.8)
Chinese	0.5 (CI: 0.5 - 0.6)	0.5 (CI: 0.5 - 0.6)	1.0 (CI: 1.0 - 1.1)
Indians	0.2 (CI: 0.1 - 0.2)	0.2 (CI: 0.2 - 0.2)	0.4 (CI: 0.3 - 0.4)
Other Bumis**	0.2 (CI: 0.2 - 0.3)	0.2 (CI: 0.2 - 0.3)	0.5 (CI: 0.4 - 0.5)

** Rounded up to the closest 0.1 million population*

*** Comprises of all Non Malay Bumiputras*

Table 4: Prevalence of hypertension by sex and race amongst Malaysian residents aged 30 years and above in 2006 (N=24,796)

Age (Years)	Sex, % (95% CI)		
	Male	Female	Both sexes
All races	41.7 (CI: 40.7 - 42.8)	43.4 (CI: 42.5 - 44.4)	42.6 (CI: 41.8 - 43.3)
Malay	42.3 (CI: 41.0 - 43.7)	48.4 (CI: 47.1 - 49.6)	45.4 (CI: 44.3 - 46.4)
Chinese	42.4 (CI: 40.3 - 44.4)	38.7 (CI: 36.8 - 40.7)	40.6 (CI: 39.0 - 42.1)
Indians	40.5 (CI: 37.0 - 44.0)	39.5 (CI: 36.7 - 42.5)	40.0 (CI: 37.7 - 42.3)
Bumiputra Sabah	48.6 (CI: 44.7 - 52.4)	41.7 (CI: 38.3 - 45.2)	45.2 (CI: 42.6 - 47.9)
Bumiputra Sarawak	40.2 (CI: 35.3 - 45.3)	44.8 (CI: 40.2 - 49.4)	42.4 (CI: 38.6 - 46.4)
Foreigner	33.7 (CI: 29.7 - 37.8)	30.7 (CI: 27.2 - 34.4)	32.4 (CI: 29.5 - 35.4)

Table 5: Prevalence of hypertension by education, stratum and income amongst Malaysian residents aged 18 years and above in 2006

Age (Years)	Sex, % (95% CI)		
	Male	Female	Both sexes
Education			
No Formal Ed	49.7 (CI: 46.2 - 53.2)	62.7 (CI: 60.6 - 64.6)	58.6 (CI: 56.7 - 60.5)
Primary (1-6 yrs)	41.3 (CI: 39.9 - 42.9)	40.5 (CI: 39.2 - 41.9)	40.9 (CI: 39.9 - 42.0)
Secondary (7-13)	28.8 (CI: 27.6 - 29.9)	22.4 (CI: 21.5 - 23.4)	25.7 (CI: 25.0 - 26.5)
Tertiary (≥14)	26.8 (CI: 24.4 - 29.3)	11.0 (CI: 9.5 - 12.6)	19.4 (CI: 17.9 - 21.0)
Unclassified	30.6 (CI: 22.7 - 39.8)	28.5 (CI: 22.0 - 36.0)	29.6 (CI: 24.2 - 35.7)
Household Income			
< 400	40.5 (CI: 37.4 - 43.6)	44.8 (CI: 42.1 - 47.4)	42.8 (CI: 40.7 - 45.0)
400 - 999	35.1 (CI: 33.4 - 36.8)	36.0 (CI: 34.6 - 37.6)	35.5 (CI: 34.3 - 36.8)
1000 - 1999	33.2 (CI: 31.6 - 34.8)	30.1 (CI: 28.8 - 31.4)	31.7 (CI: 30.6 - 32.8)
2000 - 2999	32.9 (CI: 31.0 - 35.0)	27.4 (CI: 25.7 - 29.1)	30.2 (CI: 28.8 - 31.7)
≥ 3000	29.6 (CI: 27.9 - 31.4)	23.5 (CI: 22.0 - 24.9)	26.6 (CI: 25.4 - 27.9)
Unclassified	34.3 (CI: 29.9 - 38.9)	32.1 (CI: 28.6 - 35.8)	33.1 (CI: 30.2 - 36.1)
Urban/Rural			
Urban	31.3 (CI: 30.2 - 32.4)	27.2 (CI: 26.3 - 28.1)	29.3 (CI: 28.5 - 30.0)
Rural	36.4 (CI: 35.0 - 37.8)	37.5 (CI: 36.3 - 38.8)	36.9 (CI: 35.9 - 38.0)

Table 6: Prevalence of awareness, treatment and control of hypertension by sex amongst Malaysian residents aged 30 years and above in 2006

	Sex, % (95% CI)		
	Male	Female	Both sexes
	Hypertensives (N=11,709)		
Aware			
All ethnicities	31.5 (CI: 30.1 - 32.9)	40.0 (CI: 38.7 - 41.2)	35.8 (CI: 34.8 - 36.8)
Malay	30.9 (CI: 29.2 - 32.8)	39.5 (CI: 37.9 - 41.1)	35.5 (CI: 34.3 - 36.8)
Chinese	35.5 (CI: 32.6 - 38.6)	43.3 (CI: 40.4 - 46.2)	39.2 (CI: 37.0 - 41.4)
Indian	41.6 (CI: 36.3 - 47.2)	41.5 (CI: 37.1 - 46.1)	41.6 (CI: 38.0 - 45.3)
Bumiputra Sabah	31.5 (CI: 26.4 - 37.0)	39.2 (CI: 34.2 - 44.4)	34.9 (CI: 31.3 - 38.7)
Bumiputra Sarawak	25.7 (CI: 20.6 - 31.5)	45.2 (CI: 39.5 - 51.0)	35.7 (CI: 31.7 - 40.0)
Foreigner	11.0 (CI: 7.4 - 16.2)	20.4 (CI: 15.9 - 25.9)	14.8 (CI: 11.8 - 18.5)
Currently treated			
All ethnicities	27.3 (CI: 26.0 - 28.6)	35.4 (CI: 34.2 - 36.7)	31.4 (CI: 30.4 - 32.3)
Malay	26.0 (CI: 24.3 - 27.7)	34.2 (CI: 32.7 - 35.8)	30.4 (CI: 29.2 - 31.6)
Chinese	32.8 (CI: 30.1 - 35.7)	40.4 (CI: 37.4 - 43.4)	36.4 (CI: 34.2 - 38.6)
Indian	37.4 (CI: 32.3 - 42.8)	38.2 (CI: 33.9 - 42.7)	37.8 (CI: 34.3 - 41.4)
Bumiputra Sabah	25.8 (CI: 21.2 - 31.1)	33.3 (CI: 28.7 - 38.1)	29.2 (CI: 25.9 - 32.7)
Bumiputra Sarawak	19.3 (CI: 14.8 - 24.8)	41.0 (CI: 34.9 - 47.4)	30.5 (CI: 26.5 - 34.8)
Foreigner	7.8 (CI: 4.7 - 12.5)	15.7 (CI: 11.6 - 20.8)	11.0 (CI: 8.3 - 14.4)
Controlled			
All ethnicities	7.7 (CI: 7.0 - 8.6)	8.7 (CI: 8.0 - 9.5)	8.2 (CI: 7.7 - 8.8)
Malay	6.8 (CI: 5.8 - 7.9)	7.2 (CI: 6.4 - 8.1)	7.0 (CI: 6.4 - 7.7)
Chinese	10.6 (CI: 8.9 - 12.5)	12.5 (CI: 10.7 - 14.5)	11.5 (CI: 10.1 - 12.9)
Indian	12.7 (CI: 9.7 - 16.5)	11.6 (CI: 9.1 - 14.6)	12.2 (CI: 10.0 - 14.7)
Bumiputra Sabah	5.1 (CI: 3.3 - 7.9)	7.9 (CI: 5.6 - 11.0)	6.4 (CI: 4.8 - 8.5)
Bumiputra Sarawak	5.4 (CI: 3.2 - 8.8)	10.4 (CI: 7.3 - 14.7)	8.0 (CI: 5.9 - 10.7)
Foreigner	1.2 (CI: 0.4 - 3.7)	1.3 (CI: 0.5 - 3.5)	1.2 (CI: 0.6 - 2.7)

Table 6: Prevalence of awareness, treatment and control of hypertension by sex amongst Malaysian residents aged 30 years and above in 2006 (continue)

	Sex, % (95% CI)		
	Male	**Female**	**Both sexes**
Currently treated hypertensives, (N=3,927)			
Aware			
All ethnicities	86.5 (CI: 84.7 - 88.1)	88.7 (CI: 87.3 - 89.9)	87.7 (CI: 86.6 - 88.7)
Malay	84.0 (CI: 81.3 - 86.4)	86.6 (CI: 84.8 - 88.3)	85.6 (CI: 84.0 - 87.0)
Chinese	92.4 (CI: 89.4 - 94.6)	93.3 (CI: 90.7 - 95.2)	92.9 (CI: 90.0 - 94.4)
Indian	89.8 (CI: 83.7 - 93.8)	92.0 (CI: 87.5 - 95.0)	90.9 (CI: 87.1 - 93.6)
Bumiputra Sabah	82.1 (CI: 73.1 - 88.5)	84.9 (CI: 78.5 - 89.7)	83.5 (CI: 78.2 - 87.7)
Bumiputra Sarawak	75.1 (CI: 61.9 - 84.9)	90.8 (CI: 84.4 - 94.7)	85.3 (CI: 79.5 - 89.7)
Foreigner	70.6 (CI: 50.8 - 84.8)	76.7 (CI: 62.8 - 86.6)	74.0 (CI: 62.5 - 83.0)
Controlled			
All ethnicities	28.4 (CI: 26.0 - 30.9)	24.7 (CI: 22.9 - 26.5)	26.3 (CI: 24.8 - 27.8)
Malay	26.2 (CI: 22.9 - 29.7)	21.0 (CI: 18.9 - 23.3)	23.0 (CI: 21.1 - 25.1)
Chinese	32.1 (CI: 27.4 - 37.2)	30.9 (CI: 27.0 - 35.2)	31.5 (CI: 28.3 - 34.9)
Indian	34.0 (CI: 26.9 - 41.9)	30.4 (CI: 24.3 - 37.2)	32.2 (CI: 27.1 - 37.7)
Bumiputra Sabah	19.8 (CI: 13.3 - 28.4)	23.7 (CI: 17.2 - 31.9)	21.8 (CI: 16.6 - 28.1)
Bumiputra Sarawak	27.9 (CI: 16.9 - 42.2)	25.4 (CI: 18.5 - 33.8)	26.1 (CI: 20.2 - 33.1)
Foreigner	15.0 (CI: 4.8 - 38.2)	8.3 (CI: 3.0 - 20.7)	11.1 (CI: 5.1 - 22.6)

CHAPTER II

HYPERCHOLESTEROLEM

ABSTRACT

Prevalence, Awareness, Treatment and Control of Hypercholesterolemia in adult Malaysian residents, 2006

Introduction: An elevated total cholesterol value is an important risk factor for cardiovascular disease. The objective of this study is to determine the prevalence, awareness, treatment and control of hypercholesterolemia in adult Malaysian residents.

Method: A population based cross-sectional study was conducted in 2006 involving the whole of Malaysia. A stratified 2 stage cluster sampling design was used. The study population for this module is limited to subjects aged ≥18 years old. Capillary blood cholesterol was measured with Accutrend GC-Roche Diagnostics gluco-photometer. We used the US-NCEP ATP III to classify cholesterol values. For comparison purposes, we have defined cholesterol values as Hypercholesterolemia ≥5.2mmol/L and Hypercholesterolemia ≥6.2mmol/L.

Results: Among Malaysian residents aged ≥18 years, the prevalence of hypercholesterolemia (≥5.2) is 20.7% (CI: 20.1 - 21.3). Females [22.8% (CI: 22.1 - 23.5)] have significantly higher prevalence of hypercholesterolemia (≥5.2) compared with males [18.6% (CI: 17.9 - 19.4)]. Malays have significantly higher prevalence of hypercholesterolemia (≥5.2mmol/L) at 24.8% (CI: 24.1 - 25.6) compared with the Indians [21.1% (CI: 19.2 - 23.1)] and Chinese [19.3% (CI: 18.2 - 20.5)]. The Sabah Bumiputras [9.8% (CI: 5.6 - 11.2)] have significantly lower rates compared with other ethnicities.

Using 6.2mmol/L as the cut off, the overall prevalence of hypercholesterolemia (≥6.2mmol/L) is 7.1% (CI: 6.8 - 7.5). Females [8.0% (CI: 7.6 - 8.4)] have significantly higher prevalence of hypercholesterolemia (≥6.2mmol/L) compared with males [6.3% (CI: 5.9 - 6.7)]. Malays [9.0% (CI: 8.5 - 9.4)] have significantly higher prevalence of hypercholesterolemia (≥6.2mmol/L) compared with the Chinese [6.7% (CI: 6.0 - 7.4)]. The prevalence amongst the Indians [7.7% (CI: 6.6 - 9.0)] are similar to that of the Malays and Chinese. Compared with the other ethnicities, Sabah Bumiputras [2.5% (CI: 2.0 - 3.2)] and Sarawak Bumiputras [3.8% (CI: 2.8 - 5.0)] have significantly lower prevalence.

This prevalence of hypercholesterolemia is positively associated with age, female sex, family history of hypercholesterolemia, lower levels of attained education. No relationship was found with household income and urban/rural status.

Among those who were found to be hypercholesterolemic, 19.7% (CI: 18.6 - 20.8) were aware of their hypercholesterolemic state. Among those aware of their hypercholesterolemia, 44.1% (CI: 41.5 - 46.8) were currently on treatment. And among those currently treated, 69.0% (CI: 65.3 - 72.4) were found to have their blood cholesterol controlled (TC <5.2mmol/L). There was no gender difference for the awareness and treatment of hypercholesterolemia. Males [75.5% (CI: 70.3 - 80.0)] had significantly better cholesterol control compared with females [62.4% (CI: 57.4 - 67.2)].

Conclusion: The prevalence of hypercholesterolemia in Malaysia is high. However, the awareness and treatment of hypercholesterolemia is relatively low. Amongst those who are aware of their hypercholesterolemia, less than half are on treatment. And of those under current treatment, approximately 70% have controlled their hypercholesterolemia under treatment.

1. INTRODUCTION

Heart disease is the leading cause of mortality in Malaysia. Cardiovascular disease was responsible for almost a fifth of the total burden of disease (measured as Disability Adjusted Life Years- DALYs) in Malaysia in year 2000 (Ministry of Health Malaysia 2004). Almost 90% of this DALY is due to mortality (measured as Years Life Lost- YLL). Ischemic heart disease and cerebrovascular disease are the major contributors accounting for 50% and 32% of the cardiovascular burden respectively. These two diseases cause an enormous public health burden on the society.

Major modifiable risk factors for coronary heart disease include smoking, hypercholesterolemia, hypertension, insulin resistance, obesity, and physical inactivity. In the US, population campaigns have led to decreases in the prevalence of smoking, hypertension, and cholesterol levels (Burt et al. 1995). Data from Lim et al. (2000) showed that the mean blood cholesterol level of the adult Malaysian population is 4.5mmol/L but little is known about the prevalence of hypercholesterolemia.

In addition, little is known about the awareness, treatment, and control of hypercholesterolemia. Therefore, our objectives were (1) to describe the mean total cholesterol level in the adult Malaysian population and (2) to establish the proportions of adults with hypercholesterolemia who were aware of their condition, who took medications to treat the condition, and who had their cholesterol level in the desirable range.

2. LITERATURE REVIEW

Cardiovascular disease (CVD), particularly coronary heart disease (CHD), is the leading cause of medically certified deaths in Malaysia. Risk factors that contribute to the pathogenesis of this disease include smoking, hypertension, dyslipidaemia, diabetes and a family history of premature CHD. Numerous clinical studies have also shown that aggressive cholesterol reduction is associated with a reduction in morbidity and mortality of CHD.

There is a paucity of data on the prevalence of hypercholesterolemia locally. Nawawi et al. (2002) noted a prevalence rate of 67.3% amongst rural Malays (total cholesterol $\geq$5.2mmol/L). Almost a third (30.5%) of the subjects has total cholesterol of $\geq$6.5mmol/L and 11.8% have total cholesterol ($\geq$7.8mmol/L). In the National Heart Week survey (Khoo et al. 2000) noted that the mean total cholesterol of the urban population is 5.3mmol/L and 22% of those surveyed had total cholesterol ($\geq$6.2mmol/L). This result is quite similar to the mean total cholesterol of the adult Singaporean population who share a multiethnic population like Malaysia. Ministry of Health Singapore (2004) noted mean total cholesterol of 5.3mmol/L among their adult population.

Lim et al. (2000) also found that there were ethnic differences in mean cholesterol levels. The Malays had the highest blood cholesterol levels, followed by Indians, Chinese and other indigenous ethnic groups. However Zaraihan et al. (1994) found that the cholesterol levels were statistically

higher in the Indians than in the Malays and the Chinese. Various literatures have linked the different rates of CHD between the various racial groups to the differing cholesterol levels.

Dyslipidemia is very common among the diabetics and this contributes to the high prevalence of CHD amongst diabetics. Ismail et al. (2001) found that among diabetics, 73.2% had total cholesterol >5.2mmol/L and 90.9% had LDL >2.6mmol/L. More than half (52.6%) of the diabetic population studied had HDL <1.2mmol/L and 27.3% had TG >2.5mmol/L.

Little is known about the awareness, treatment, and control of hypercholesterolemia in Malaysia. To our knowledge this is the first study to assess this. Local data revealed that despite the high - prevalence of hypercholesterolemia only 12.4% and 52.8% of the diabetics with hypercholesterolemia received lipid lowering drugs in private and public hospitals respectively (Mafauzy 2005 & Mafauzy 2006). Equally poor results were seen in other developed countries. In NHANES III (1999-2000) conducted in US, amongst those with total cholesterol >5.2mmol/L only 12.1% receive lipid lowering medications. While only 5.4% of the population with hypercholesterolemia was controlled.

Population based health study is important to gather information on the health status of the public at large. The information gained can be used to guide decisions on the distribution of health care treatment resources and help plan budget requirements as well as to formulate policies. This is the third survey in Malaysia.

3. OBJECTIVES

3.1 General Objective

To provide population-based estimates of the mean serum cholesterol in Malaysia and to estimate the prevalence, awareness, treatment and control of hypercholesterolemia among the different sub-groups in Malaysia.

3.2 Specific Objectives

3.2.1 To determine the mean serum cholesterol values in Malaysia by socio-demographic sub-groups.

3.2.2 To estimate the prevalence of hypercholesterolemia in Malaysia by socio-demographic sub-groups.

3.2.3 To determine the awareness, control and treatment rates among those who are classified as having hypercholesterolemia.

3.2.4 To compare the awareness, control and treatment rates among those who are classified as having hyper cholesterolemia in the different sexes.

3.2.5 To make recommendations for health program managers to strengthen ischemic heart disease prevention programs in Malaysia.

4. METHODOLOGY

4.1 Scope of The Study

Research problems, scopes and main issues to be included in NHMS III were obtained from discussions and feedbacks from Ministry of Health state health managers, as well as experts from the local universities and individuals. The main research team members of the NHMS III reviewed and studied closely the feasibility and practicality of the suggested research topics for this community-based household survey. Extensive literature review was initiated. Technical and research experts in the field related to the identified research areas were consulted for further advise and comments. The main research group used the following criteria in considering the suggested scopes for this survey:

a) Issue/problem is current or has potential of high prevalence.
b) The issue/problem is focused on disease/disorders associated with affluence, lifestyle, environment and demographic changes.
c) The issue/problem is causing physical, mental or social disability.
d) The issue/problem has important economic implications.
e) It is feasible to implement interventions to reduce the problem.
f) The information related to the issue/problem is not available through the routine monitoring system or other sources.
g) The information is more appropriately obtained through a nation-wide community survey.
h) It is feasible to obtain through a nation-wide community-based survey.

The short-listed research topics were then presented to the Advisory Group Members for further deliberation and decisions. These topics were later refined by the research team members based on the decisions made at the Advisory Committee meeting. It was tabled to the Steering Committee and 18 research topics were approved to be included in the NHMS III.

4.2 Sampling Designs and Sample Size

In calculating the sample size, stratification and sampling design, the Methodology Division Department of Statistics Malaysia as well as several other biostatistics consultants.

4.2.1 Sampling frame

The sampling frame for this survey is an updated until 2004; an effort undertaken prior to the implementation of Labour Force Survey (LFS) 2004. In general, each selected Enumeration Blocks (EB) comprised of 8 sampled Living Quarters (LQ). The EBs was geographically contiguous areas of land with identifiable boundaries. Each contains about 80-120 LQs with about 600 persons. Generally, all EBs are formed within gazetted boundaries.

The EBs in the sampling frame was also classified into urban and rural areas. The classification into these categories was in terms of population of gazetted and built-up areas as follows:

Stratum	Population of gazetted areas and built-up
Metropolitan	75,000 and above
Urban large	10,000 to 74,999
Urban small	1,000 to 9,999
Rural	The rest of the country

For sampling purposes, the above broad classification was found to be adequate for all states in Peninsular Malaysia and the Federal Territories of Kuala Lumpur and Labuan. However, for Sabah and Sarawak, due to problems of accessibility, the rural stratum had to be further sub-stratified based on the time taken to reach the area from the nearest urban centre.

For the purpose of urban and rural analysis, Metropolitan and Urban Large strata are combined together thus referred to as 'urban' stratum, while for Urban Small and the various sub-divisions of the rural areas they are combined together to form to a 'rural' stratum.

4.2.2 Sampling design

A two stage stratified sampling design with proportionate allocation was adopted in this survey. The first stage sampling unit was the EB and within each sampled EB, the LQs were selected as second stage unit. One LQ is estimated to comprise of 4.4 individuals. All household and persons within a selected LQ were studied.

4.2.3 Sample size

The sample size was determined based on 95% confidence interval and the following factors were taken into consideration:

a) Expected prevalence rate

The prevalence rate of the health problems for Malaysia obtained from the National Health and Morbidity Survey 2 (NHMS II) were used to estimate the overall sample size. Using the previous finding of 10% prevalence rate, the initial sample size at the state level was calculated in order to come up with overall sample size. The size was further apportioned for each state using the probability proportionate to size (PPS) method.

b) Response rate of the NHMS II

The response rates, which ranged from 83 to 97% for the NHMS II of each state, were taken into consideration in the course of the determination of sample size.

c) Margin of error and design effect

As the factors of precision and efficient of the survey are paramount, the decision reached for the targeted margin of error is 1.2 and the design effect valued at 2. These values were used at the initial stages of the calculation of the sample size of each state.

The survey findings addressing the specific objectives of this survey are expected to be used for state level programmed planning. Thus, the calculation for the sample size has taken into consideration data to be analyzed at the state level.

In addition to the major factors mentioned earlier, the availability of resources, namely, financial and human resources, and the time taken to conduct this survey also becomes part of the process of the determination of sample size.

4.3 Preparation of Field Areas and Logistic Support

A number of state liaison officers were recruited in preparation for the survey proper. Strong networking with state liaison officers and District Health Officers (MOH and local authorities) from the areas sampled for the survey was established. Field scouts were mobilized from these areas to identify and tag the LQ's selected for the survey, as well as to inform the community and related government agencies of the importance and schedule of the planned survey. State liaison officers were also assisting Field Supervisors in the arrangement of transportation, accommodation and other logistics for the survey teams.

4.4 Method of Data Collections

4.4.1 The questionnaire

A bi-lingual (Bahasa Malaysia and English) pre-coded questionnaire was designed, pre-tested and piloted prior to the survey. All research topics for the questionnaire are arranged into modules ranging from A to Z. Topics that are similar area are arranged into sub-modules under a particular module. Questions comprised of both close ended and open ended. The questions in hypercholesterolemia module (Module Q) were tailored to the target group. There were a total of 8 questions in this module including the blood cholesterol measurement.

The face to face interview (FI) questionnaires consisted of two subtypes, i.e., the household questionnaire (orange) to be answered by the head of the household of the LQ selected, and the individual questionnaire, to be answered by each member of the household. One type of individual FI questionnaires were developed, to cater 18 years old and above (purple).

All the FI questionnaires have a consent form to be read and signed by the respondent. The outside cover of all questionnaires had to be filled with a unique individual identification (ID) number by the enumerator. The enumerator also had to fill his or her ID as well as the code for the outcome of the interview as part of the quality assurance process.

4.4.2 The interview

As far as possible, all adult members who qualify from the selected LQ's were interviewed by the data collection team members. Interviews commenced early in the morning and lasted till late in the evening. Where an interview had been unsuccessful due to the absence of the respondent at the selected LQ, repeat visits were conducted after leaving messages with neighbours or by other means for an appointment at a later date. A household member can only be classified as a non-responded after 3 unsuccessful visits.

4.4.4 Clinical examination

All household members 18 years old and above who had verbally consented to the test were examined for their cholesterol level using using the Accutrend GC - Roche Diagnostic's battery operated gluco-photometer. The results of the tests were made known to the respondents. Finger prick capillary blood pressure was taken once only and simultaneously tested for blood glucose level but using a different blood glucose strip. The respondent could either be fasting or not fasting when the finger prick capillary blood was taken and tested. This depended on whether the responded had agreed to fast for the capillary blood glucose level test.

A respondent with a blood cholesterol reading of $\geq$5.2mmol/L was classified as having hypercholesterolemia (regardless of fasting status). A blood cholesterol level of <5.2mmol/L was classified as desirable (regardless of fasting status). The classification was based on the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (2001)

The blood cholesterol results were obtained immediately and noted in the questionnaire by the trained public health nurse. The respondent was informed of the results and if found to be undesirable ($\geq$5.2mmol/L), were referred to the nearest health facility for further evaluation and management.

4.5 Field Preparations

Two main survey implementation groups were formed: the Central Coordinating Team (CCT) and the field team. The CCT's main role was to monitor and coordinate the progress of implementation and provide administrative support in terms of financial and logistic arrangement for the field survey. The Field Teams were responsible to oversee and manage the field data collection process as well as undertake quality control.

The field data collection was conducted throughout Malaysia simultaneously, spanning a continuous period of 4 months starting from the month of April 2006. Teams were organized to move into 5 regions in Peninsular Malaysia, 2 regions in Sabah and 4 regions in Sarawak for data collections.

4.5.1 Pilot study

A pilot study was conducted on a sample of EB's (not included in the NHMS III) about 2 months prior to the nationwide survey. It was conducted in three different areas in and around the Klang Valley, namely Sepang, Klang and Bangsar. The population in these locations comprised of three distinct socio-demographic strata that are rural, semi-urban and urban respectively. The pilot study focused on the following aspects of the survey such as testing of the questionnaire, testing of the field logistic preparation, testing of the scouting activities and testing of the central monitoring and logistic support.

4.5.2 Training of data collection teams

A two weeks training course was held for field supervisors, team leaders, nurses and interviewers was to familiarize them with the questionnaire, develop their interpersonal communication skills and appreciate the need for good teamwork. Briefing on the questionnaire, mock interview in the classroom and individual practice under supervision was conducted during the training.

4.6 Quality Control

Quality control procedures for the data collection were done at two stages, field and central. Detail description of quality control process has been described in NHMS III protocol.

4.7 Data Management

4.7.3 Data screening

The following data screening exercises had been conducted at the field and central level prior to data entry:

a) Field data screened by each interviewers at the end of his/her interview
b) Field data screened for each question by peer interviewers through exchanging questionnaire booklets
c) Field data screened by team leaders and field supervisors
d) Central data screening of the questionnaire by the quality control team

4.7.2 Data entry

The data entry system was developed to record the information collected during the data collection phase. It is a web based system that allows multiple simultaneous accesses to the database. The NHMS III used a double manual data entry method and any discrepancy between both entries was verified by the supervisors. The data entry started simultaneously with data collection (first week of April 2006) and was completed at the end of January 2007. The data entered was stored in the database according to the module. The databases were designed using Structured Query Language (SQL) which is a standard language for relational database management system.

4.7.4 Data analysis

Data analysis was done by exporting the data into other analytical tools such as Microsoft Excel, SPSS and STATA. The data in database (text form) was exported to the Microsoft Excel form then to the SPSS and STATA. The raw data was cleaned and analysed according to the terms, working definition and dummy table prepared by the research groups. All the analytical process were monitored and advised by the NHMS III Statistics Consultant.

4.8 Definition of Terms / Variables

4.8.1 Definition of cholesterol levels based on NCEP ATP III

Desirable cholesterol level is defined as <5.2mmol/L
Borderline high cholesterol level is defined as 5.2 - <6.2mmol/L
High cholesterol level is defined as ≥6.2mmol/L

4.8.2 Definition of hypercholesterolemia based on NCEP ATP III

For the purpose of data analyses, the definition of hypercholesterolemia was based on felt and unfelt needs of the population. Felt needs was reflected by those who had reported to have been told to have hypercholesterolemia by a medical doctor or paramedic in the last one year. They were classified as known *hypercholesterolemics*. Unfelt needs in the population were defined as having a blood cholesterol level of ≥5.2mmol/L among those who did not report as known hypercholesterolemia. They were classified as undiagnosed hypercholesterolemics.

Known hypercholesterolemics were further inquired about their treatment status (ever treated in the last one year and current treatment). They were also asked for any treatment default in the last one year and if so, the reasons for default. For those who sought treatment, the pattern of health utilization was also inquired. Lastly, a family history of hypercholesterolemia was obtained.

Further specific definition among the known and unknown hypercholesterolemia based on blood cholesterol measurement and / or treatment history is outlined below:

'Awareness of hypercholesterolemia' was defined as having been told to have hypercholesterolemia by a medical doctor or paramedic.

'Ever treated for hypercholesterolemia' was defined as a self-report of having had any form of allopathic treatment for the condition in the last one year.

'Currently on drug treatment for hypercholesterolemia' was defined as a self-report of respondents currently taking any form of allopathic treatment for the condition

'Controlled hypercholesterolemia' was defined as having a desirable blood cholesterol level among respondents who are hypercholesterolemic and among respondents who are aware of being hypercholesterolemic regardless of the current treatment status respectively.

5. FINDINGS

5.1 General Findings

From the 34,539 survey subjects aged 18 years and above, 31,716 subjects underwent blood cholesterol measurement, giving a response rate of 91.8%.

Appendix : Table 1 describes the sociodemographic characteristics of respondents examined for blood cholesterol level. It shows the number of respondents for each group along with the unadjusted and adjusted proportions. Based on the number of respondents, this sample comprised of 55.4% females and 44.6% males. The adjusted mean age of the respondents were 38 years old with a 95% CI and ranges from 18 to 110 years old.

A large majority of the respondents were Malaysian citizens (93.8%). Among the different ethnicities, Malays (53.4%) formed the largest group, followed by the Chinese (19.2%), Indians (7.7%), Sabah Bumiputeras (7.7%), Sarawak Bumiputeras (4.1%) and others (1.7%). As the 'others' ethnic group represent a very small proportion of the study population, analysis of this group will not be mentioned in this report.

Most of the respondents had either primary or secondary education (between 1-13 years of formal education). The monthly household income of the respondents showed that the majority (52.5%) earned between RM400 - RM1,999.

On comparing the adjusted stratified proportions between the different sub groups, the distribution of the study population is similar to that of the Malaysian population.

5.2 Prevalence

5.2.1 Prevalence of hypercholesterolemia (≥5.2 mmol/L) among those aged 18 years old and above

Appendix : Table 2 shows the prevalence of hypercholesterolemia by the different socio-demographic factors. This study reports a prevalence of hypercholesterolemia of 20.7% (CI: 20.1 - 21.3) among Malaysian residents aged 18 years and above in 2006. Among those aged 30 years and above the prevalence is 26.9% (CI: 26.2 - 27.7) while in those aged 60 years and above it is 36.9% (CI: 35.3 - 38.5).

The prevalence of hypercholesterolemia consistently increases with age from 5.0% in the 18-19 years age group up to 40.3% in the 60-69 years age group.

Among the different ethnicities, Malays has significantly higher prevalence of hypercholesterolemia; [24.8% (CI: 24.1 - 25.6)] compared with the Indians; [21.1% (CI: 19.2 - 23.1)] and Chinese; [19.3% (CI: 18.2 - 20.5)]. Compared with all the other Malaysian ethnic groups, the Sabah Bumiputras have

significantly lower prevalence of hypercholesterolemia; [9.8% (CI: 5.6 - 11.2)].

Comparing the prevalence of hypercholesterolemia among the different educational levels, there is an inverse relationship between the prevalence rates and highest educational level achieved. The prevalence of those with no formal education [28.2% (CI: 26.5 - 30.0)] and those with primary education [25.1% (CI: 24.2 - 26.1)] are significantly higher than those with secondary [17.8% (CI: 17.1 - 18.6)] and tertiary [16.9% (CI: 15.4 - 18.6)] education.

The prevalence of hypercholesterolemia is significantly lower in the urban areas; [19.9% (CI: 19.2 - 20.6)] compared with the rural areas; [21.9% (CI: 21.1 - 22.8)].

5.2.2 Prevalence of hypercholesterolemia based on NCEP ATP III classification (≥5.2 mmol/L)

Prevalence of hypercholesterolemia based on NCEP ATP III among those aged ≥18 years old is 20.7% (CI: 20.1 - 21.3). Of those studied, 79.3% have desirable cholesterol level, 13.6% are classified as borderline high and 7.1% are classified as high (Refer Appendix : Table 2). For those aged ≥30 years old, the prevalence is 26.9% (CI: 26.2 - 27.7). Of those studied 73.1% are classified as desirable, 17.0% are classified as borderline high and 9.9% are classified as high. Among those aged ≥60 years old, 63.1% have desirable total cholesterol, 20.1% are classified as borderline high and 16.8% are classified as high.

5.2.3 Prevalence of hypercholesterolemia based on cut of level of ≥6.2 mmol/L

When using 6.2mmol/L (240mg/L) as the cut off, the prevalence of hypercholesterolemia is 7.1% (CI: 6.8 - 7.5) among those aged ≥18 years. The prevalence of hypercholesterolemia (≥6.2) among those aged ≥30 is 9.9% (CI: 9.5 - 10.3) and in those aged ≥60 years is 16.8 % (CI: 15.7 - 18.0). It can be seen that the prevalence rates steadily increases with age.

5.2.4 Prevalence of hypercholesterolemia according to ethnicity

The prevalence of hypercholesterolemia in Malays; [24.8% (CI: 24.1 - 25.6)] is significantly higher than the Chinese; [19.3% (CI: 18.2 - 20.5)] and the Indians; [21.1% (CI: 19.2 - 23.1)]. There is no significant difference in prevalence between the Indians and Chinese. The prevalence of hypercholesterolemia is significantly lower in the Sabah Bumiputras; [9.8% (CI: 8.6 - 11.2) and the Sarawak Bumiputras; [16.0% (CI: 13.8 - 18.4)] compared to the other three ethnic groups.

5.2.5 Prevalence of hypercholesterolemia according to educational level

There is an inverse relationship between the prevalence of hypercholesterolemia and highest education achieved. The prevalence of those with no formal education; [28.2% (CI: 26.5 - 30.0)] and those with primary education; [25.1% (CI: 24.2 - 26.1)] are significantly higher than those with secondary; [17.8% (CI: 17.1 - 18.5)] and tertiary; [16.9% (CI: 15.4 - 18.6) education.

5.2.6 Prevalence of hypercholesterolemia according to monthly household income

Hypercholesterolemia is highest among those earning monthly household income of RM1000-1999; [22.3% (CI: 21.2 - 23.3)] and the lowest among those earning monthly household income ≥RM3000; [19.6% (CI: 18.4 - 20.8)].

5.2.7 Prevalence of hypercholesterolemia according to locality

The prevalence is significantly higher in the rural area; [21.9% (CI: 21.1 - 22.8)] compared to the urban area; [19.9% (CI: 19.2 - 20.6)].

5.3 Mean of Blood Cholesterol Levels

Among Malaysian residents 18 years and above in 2006, the mean age adjusted blood cholesterol level was 4.5mmol/L (CI: 4.5 - 4.6) (Refer Appendix : Table 2). Mean blood cholesterol level increases with increasing age group categories and peaks at age group 60-69 with a mean cholesterol level of 4.9mmol/L (CI: 4.9 - 5.0) and decreases thereafter. Females recorded higher mean blood cholesterol level; [4.6mmol/L (CI: 4.6 - 4.7)] at all age group categories compared to males; [4.5mmol/L (CI: 4.5 - 4.6)] (Refer Appendix : Table 3). Among the ethnic groups, Malay females has the highest mean blood cholesterol level at 4.8mmol/L (CI: 4.7 - 4.8) followed by Indian females at 4.6mmol/L (CI: 4.6 - 4.7).

5.4 Awareness, Treatment and Control of Hypercholesterolemia

We assessed the awareness, treatment and control of hypercholesterolemia in respondents aged 30 years and above. Among responders examined, 19.7% (CI: 18.6 - 20.8) were aware of having hypercholesterolemia (Refer Appendix : Table 5).The proportion of responders with hypercholesterolemia who were treated in the past 12 months was 11.4% (CI: 10.6 - 12.3) and of these 9.3% were controlled.

Among those respondents who were aware, [44.1% (CI: 41.5 - 46.8)] were on treatment and of those who were treated [69.0% (CI: 65.3 - 72.4)] were controlled.

Among respondents whose total cholesterol levels were ≥6.2mmol/L, [43.6% (CI: 41.4 - 45.8)] were aware. Of this, 71.5% (CI: 68.5 - 74.4) were on treatment and 89.4% (CI: 87.0 - 91.5) of those treated were controlled.

6. DISCUSSION

Our results revealed that the mean total cholesterol of the Malaysian adults in 2006 was lower than that published (Khoo et al. 2000) which was 5.3mmol/L. However, the study by Khoo et al. (2000) was confined to several urban populations in major towns. The sampling done was also non random where subjects were people who volunteered in shopping malls. Our mean total cholesterol level of 4.5mmol/L (for respondents ≥18 years of age) is comparable to that of some Asia Pacific regions for example in Mainland China where the mean cholesterol level is 4.8mmol/L (Jiang et al. 2004). The mean cholesterol level from the present survey is lower than that of the Western adults. The age adjusted mean blood cholesterol level of the adult US population (≥20 years old) was 5.3mmol/L (NHANES III (1999-2000). There is a slight increase in the mean total cholesterol level compared to the data from NHMS II (Lim et al. 2000). The mean total cholesterol level in NHMS II was 4.5mmol/L. Both national surveys (NHMS II & III) showed the Malays have the highest mean total cholesterol level followed by Indians and Chinese. However Khoo et al. (2000) found that Indians had the highest mean total cholesterol level among the three ethnic groups in Malaysia. The limitations of Khoo et al. (2000) study have been mentioned earlier.

The increasing mean cholesterol among Malaysian is disturbing as most data in the developed world showed a decreasing trend in blood cholesterol level. The US data showed a decreasing trend of blood cholesterol level from 5.31mmol/L in NHANES III (1988-1994) to 5.27mmol/L in NHANES III (1999-2000). Similar trend was noted in the Ministry of Health Singapore (2004). The blood cholesterol level dropped from 5.5mmol/L in 1998 to 5.3mmol/L in 2004. Several factors may have contributed to this increasing trend in Malaysia. Poor nutrition, inadequate physical activity, poor awareness of hypercholesterolemia and the increase in the incidence of obesity are all factors which may contribute. Inadequate treatment though cited as one of the contributory factors in some studies does not appear to be a major risk factor here as a commendable 69% of those treated were controlled.

Our study revealed that among Malaysian residents aged 18 years and above in 2006 the overall prevalence of hypercholesterolemia (≥5.2mmol/L) is 20.7%. This is much lower than that recorded in NHANES III (1999-2000) which studied respondents aged 20 and above where the prevalence was 50.4%. Using a total cholesterol level of ≥6.2mmol/L, the prevalence was 7.1%. In comparison the prevalence using the same cut off was 17.2% in NHANES III (1999-2000) and 18.7% in Singapore (Ministry of Health Singapore 2004). Various factors may have contributed to the large differences in the prevalence rates between Malaysia, Singapore and the US. Genetic, cultural and other environmental factors may contribute to this. The difference in prevalence with Singapore data is much less than US data. The difference in prevalence with Singapore is interesting because even after comparing Malaysia urban population, the prevalence is higher among Singaporean (7.0% vs. 18.7%) for total cholesterol level ≥6.2mmol/L. The higher prevalence in Singapore is also seen across all three ethnic groups. Similar to our survey, Malays have the highest prevalence (22.8%) in Singapore.

The prevalence of hypercholesterolemia increases with age and peaks at 40.3% in those aged 60-69 years. Malays has the highest prevalence of hypercholesterolemia; 24.8% followed by Indians; 21.1% and Chinese; 19.3%. The Sabah bumiputras has the lowest prevalence of

hypercholesterolemia; 9.8%. Dietary factors and differences in lifestyle may have contributed to the low prevalence of hypercholesterolemia in Sabah bumiputras.

There was a difference in the prevalence of hypercholesterolemia among the various ethnic groups in Malaysia. Our study revealed a prevalence of 24.8% in Malays which is significantly higher than the Chinese (19.3%) and the Indians (21.1%). There is no significant difference in prevalence between the Indians and Chinese. An earlier study on a smaller sample size done predominantly on urban population (Zaraihan et al. 1994) showed that Indian ethnicity has the highest prevalence of hypercholesterolemia.

There is an inverse relationship between the prevalence of hypercholesterolemia and the level of education achieved and monthly household income. Respondents with no formal education or primary education had higher total cholesterol level, so do respondents with lower monthly income. This may be related to poor awareness on health in general on hypercholesterolemia amongst this group of respondents.

This survey also assessed the awareness, treatment, and control of hypercholesterolemia in the Malaysian adult population. This analysis was only performed for those 30 years old and above because the number of respondents between ages 18 - 29 years who were on treatment was small. Only 19.7 % of respondents with hypercholesterolemia were aware of their condition. Of those with hypercholesterolemia, only 11.4% were on treatment and 9.3% were controlled.

In contrast the results from similar survey in China (Jiang et al. 2004) revealed that among all respondents who had an elevated total cholesterol concentration ($\geq$5.2mmol/L), the proportion of those who were aware of their condition was 8.8% in men and 7.5% in women, the proportion of those who were treated was 3.5% in men and 3.4% in women, and the proportion of those who were controlled (total cholesterol level $\geq$5.2mmol/L) was 1.9% in men and 1.5% in women. Data from the US population in NHANES III (1999-2000) revealed that among participants who had a total cholesterol concentration $\geq$5.2mmol/L or who reported using cholesterol-lowering medications, 69.5% reported having had their cholesterol checked, 35.0% were aware that they had hypercholesterolemia, 12.0% were on treatment, and 5.4% had a total cholesterol concentration <5.2mmol/L after age adjustment. Increase awareness of hypercholesterolemia was seen in the Minnesota Heart Survey over a ten years period of 1980/82 and 1990/92 (Pieper et al. 1997). This demonstrates the importance of creating health strategies to create awareness among the general public. Data from the Behavioral Risk Factor Surveillance System from the US (Centers for Disease Control and Prevention 2001) from 1991 through 1999 showed an increase in the proportion of participants who reported having been told that their blood cholesterol was high. However results from NHANES III (1999-2000) showed similar rates for awareness (12.0%) but interesting enough lower control rates (5.4%) compared to our study.

Our findings have public health implications. This study showed that a large proportion of our population with hypercholesterolemia is not treated and control is poor. This is most likely because a large proportion of survey population (80.7%) was not aware that they had an elevated blood cholesterol level and hence not treated. Urgent steps must be taken to strengthen existing screening programme and an awareness campaign to reduce the subsequent risks of cardiovascular diseases and stroke.

Among those respondents who were aware of being hypercholesterolemic, 44.1% were on treatment and of those who were treated 69.0% were controlled. In NHANES III (1999-2000) the results were 36.8% and 47% respectively. In a German study (Ruof et al. 2002), 65.5% of patients eligible for cholesterol-lowering medications received them. Findings from our study revealed that a relatively high proportion of respondents who are aware of their hypercholesterolemic received treatment. This could reflect current medical practice where lipid lowering drugs are started early based on consistent findings of early treatment benefits from many randomized trials. The control rate in our study is commendable. This could reflect the fact that pharmacological treatment for lipid lowering (eg. statins) has been very effective.

Our study also showed that awareness and control rates were better among those whose total cholesterol level was $\geq$6.2mmol/L; 43.6% and 89.4% respectively.

7. CONCLUSION

There has been a rapid change in lifestyles accompanied by unprecedented economic development. This has led to an increase in CHD prevalence and mortality due in part to increasing life expectancy and in part to increasing levels of CHD risk factors. Non-insulin-dependent diabetes is of increasing concern, and its prevalence is rising rapidly in tandem with the exponential rise of obesity.

Cholesterol is one of the important modifiable risk factor for CHD and is increasing with industrialization. Mean total cholesterol levels of Malaysian adult population at 4.53mmol/L though lower in comparison to Western standards (mean 5.27 in NHANES) needs to be reduced further to minimize cardiovascular risks. The level of awareness of hypercholesterolemia at 19.7% is low and this certainly can be improved with health education. Of those patients with hypercholesterolemia who were treated and controlled the rate is commendable at 69% (5.4% in NHANES III (1999-2000).This indirectly reflects the easy access and affordable health care available in Malaysia.

In conclusion, mean total cholesterol has increased from the previous survey. No prevalence data on hypercholesterolemia was available from previous survey for comparison. Though awareness is less than NHANES III (1999-2000), we were comparable in terms of treatment and fare better than them in terms of control.

8. RECOMMENDATIONS

Based on the findings of this survey, there is a need for continued effort through health promotion program to promote awareness and educate the public on the ill effects of hypercholesterolemia. Renewed efforts are necessary to lower total cholesterol concentrations. These efforts should

include aggressive promotion of heart-healthy lifestyles to prevent and control hypercholesterolemia and a sustained public health commitment at the national and state levels towards screening, primary and secondary prevention, treatment, and control of hypercholesterolemia.

Priorities should be focused on education of the public with appropriate recommendations on diet and healthy lifestyle.

Malaysia with its vast network of public health facilities and well complemented by private health care facilities can be mobilized to perform cholesterol screening. Some NGO are already actively promoting screening for cholesterol levels. The National Heart Foundation conducts Heart Awareness Week and encourages the public to come forward for health screening including that for cholesterol. The MOH can work together with these NGO to increase public awareness of hypercholesterolemia.

Specific intervention programs should be develop to target women as this survey showed that women has much higher mean cholesterol levels across all age group compared to men. Inter-ministerial approach between MOH and Ministry of Women Affairs should be considered to ensure high success level at controlling hypercholesterolemia. Other specific intervention programs should focus on urban Malays.

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APPENDIX

APPENDIX

Table 1: Characteristic of respondents (N=31,716)

	*n	%	Adjusted* %
Sex			
Male	14,153	44.6	50.6
Female	17,563	55.4	49.4
Age Groups			
18-19	1,562	4.9	6.7
20-29	6,861	21.6	28.4
30-39	6,601	20.8	24.9
40-49	6,870	21.7	18.8
50-59	5,227	16.5	10.9
60-69	2,928	9.2	6.4
≥70	1,667	5.3	3.9
Ethnicity			
Malay	16,940	53.4	49.0
Chinese	6,095	19.2	24.7
Indian	2,453	7.7	7.4
Bumiputra Sabah	2,426	7.7	5.6
Bumiputra Sarawak	1,285	4.1	4.1
Others	541	1.7	0.6
Foreigner	1,976	6.2	8.5
Education			
No Formal Ed	3,452	10.9	7.9
Primary (1-6 yrs)	10,403	32.8	29.7
Secondary (7-13)	14,583	46.0	49.9
Tertiary (≥14)	2,995	9.4	11.6
Unclassified	283	0.9	1.0
Household Income			
< 400	2,825	8.9	7.4
400 - 699	8,428	26.6	24.8
1000 - 1999	8,227	25.9	26.1
2000 - 2999	4,785	15.1	15.7
≥ 3000	6,241	19.7	22.1
Unclassified	1,210	3.8	3.9
Family h/o Hypercholesterolemia			
No	28,583	90.1	89.5
Yes	3,133	9.9	10.5
Urban/Rural			
Urban	18,293	57.7	61.5
Rural	13,423	42.3	38.5

** Adjusted to Malaysian population by age, sex and race*

Table 2: Overall prevalence of hypercholesterolemia by sex, age, ethnicity, education, income, family history of hypercholesterolemia and urban/rural status

	Mean Cholesterol (SE)	≥5.2mmol/L	≥6.2mmol/L
Age ≥ 18	4.5 (<0.1)	20.7 (CI: 20.1 - 21.3)	7.1 (CI: 6.8 - 7.5)
Age ≥ 30	4.7 (<0.1)	26.9 (CI: 26.2 - 27.7)	9.9 (CI: 9.5 - 10.3)
Age ≥ 60	4.8 (<0.1)	36.9 (CI: 35.3 - 38.5)	16.8 (CI: 15.7 - 18.0)
Age Groups			
18-19	4.1 (<0.1)	5.0 (CI: 4.0 - 6.2)	0.9 (CI: 0.5 - 1.5)
20-29	4.3 (<0.1)	10.1 (CI: 9.3 - 11.0)	2.4 (CI: 2.0 - 2.8)
30-39	4.5 (<0.1)	17.7 (CI: 16.7 - 18.7)	4.4 (CI: 3.9 - 5.0)
40-49	4.7 (<0.1)	28.0 (CI: 26.8 - 29.2)	9.5 (CI: 8.8 - 10.3)
50-59	4.9 (<0.1)	36.8 (CI: 35.4 - 38.3)	16.5 (CI: 15.4 - 17.6)
60-69	4.9 (<0.1)	40.3 (CI: 38.4 - 42.3)	19.4 (CI: 17.9 - 21.0)
≥ 70	4.7 (<0.1)	31.4 (CI: 29.0 - 33.9)	12.6 (CI: 10.9 - 14.4)
Ethnicity			
Malay	4.7 (<0.1)	24.8 (CI: 24.1 - 25.6)	9.0 (CI: 8.5 - 9.4)
Chinese	4.5 (<0.1)	19.3 (CI: 18.2 - 20.5)	6.7 (CI: 6.0 - 7.4)
Indian	4.6 (<0.1)	21.1 (CI: 19.2 - 23.1)	7.7 (CI: 6.6 - 9.0)
Bumiputra Sabah	4.1 (<0.1)	9.8 (CI: 8.6 - 11.2)	2.5 (CI: 2.0 - 3.2)
Bumiputra Sarawak	4.5 (<0.1)	16.0 (CI: 13.8 - 18.4)	3.8 (CI: 2.8 - 5.0)
Foreigner	4.2 (<0.1)	9.7 (CI: 8.3 - 11.4)	2.2 (CI: 1.6 - 3.1)
Education			
No Formal Ed	4.7 (<0.1)	28.2 (CI: 26.5 - 30.0)	10.1 (CI: 9.1 - 11.2)
Primary (1-6 yrs)	4.6 (<0.1)	25.1 (CI: 24.2 - 26.1)	9.1 (CI: 8.6 - 9.8)
Secondary (7-13)	4.5 (<0.1)	17.8 (CI: 17.1 - 18.5)	5.9 (CI: 5.5 - 6.3)
Tertiary (≥ 14)	4.5 (<0.1)	16.9 (CI: 15.4 - 18.6)	5.8 (CI: 5.0 - 6.6)
Unclassified	4.3 (0.2)	15.0 (CI: 11.2 - 19.7)	4.6 (CI: 2.7 - 7.8)
Household Income			
< 400	4.5 (<0.1)	21.9 (CI: 20.0 - 23.9)	7.7 (CI: 6.7 - 8.7)
400 - 999	4.5 (<0.1)	20.1 (CI: 19.1 - 21.2)	6.9 (CI: 6.4 - 7.5)
1000 - 1999	4.6 (<0.1)	22.3 (CI: 21.2 - 23.3)	7.3 (CI: 6.8 - 8.0)
2000 - 2999	4.5 (<0.1)	19.9 (CI: 18.6 - 21.2)	6.8 (CI: 6.1 - 7.6)
≥ 3000	4.5 (<0.1)	19.6 (CI: 18.4 - 20.8)	7.2 (CI: 6.5 - 7.8)
Unclassified	4.5 (<0.1)	21.0 (CI: 18.4 - 23.8)	7.5 (CI: 6.1 - 9.2)
Urban/Rural			
Urban	4.5 (<0.1)	19.9 (CI: 19.2 - 20.6)	7.0 (CI: 6.7 - 7.4)
Rural	4.6 (<0.1)	21.9 (CI: 21.1 - 22.8)	7.3 (CI: 6.9 - 7.8)

Table 3: Prevalence of hypercholesterolemia by age and ethnicity

	Males		
	Mean Cholesterol (SE)	**≥5.2mmol/L**	**≥6.2mmol/L**
Age ≥ 18	4.5 (<0.1)	18.6 (CI: 17.9 - 19.4)	6.3 (CI: 5.9 - 6.7)
Age ≥ 30	4.6 (<0.1)	24.7 (CI: 23.8 - 25.6)	8.9 (CI: 8.4 - 9.5)
Age ≥ 60	4.6 (<0.1)	29.3 (CI: 27.2 - 31.4)	13.3 (CI: 11.8 - 14.9)
Age Groups			
18-19	4.0 (<0.1)	2.9 (CI: 1.9 - 4.4)	0.3 (CI: 0.1 - 1.4)
20-29	4.2 (<0.1)	8.4 (CI: 7.3 - 9.5)	1.8 (CI: 1.4 - 2.4)
30-39	4.5 (<0.1)	17.3 (CI: 15.9 - 18.8)	4.5 (CI: 3.8 - 5.3)
40-49	4.7 (<0.1)	27.5 (CI: 25.8 - 29.3)	9.4 (CI: 8.4 - 10.6)
50-59	4.8 (<0.1)	32.4 (CI: 30.4 - 34.5)	14.1 (CI: 12.7 - 15.6)
60-69	4.7 (<0.1)	31.8 (CI: 29.3 - 34.4)	15.2 (CI: 13.3 - 17.2)
≥ 70	4.5 (<0.1)	24.9 (CI: 21.7 - 28.4)	10.0 (CI: 7.8 - 12.7)
Ethnicity			
Malay	4.6 (<0.1)	22.2 (CI: 21.2 - 23.2)	7.7 (CI: 7.1 - 8.3)
Chinese	4.5 (<0.1)	17.8 (CI: 16.3 - 19.4)	5.9 (CI: 5.1 - 6.9)
Indian	4.5 (<0.1)	20.9 (CI: 18.4 - 23.8)	8.4 (CI: 6.7 - 10.5)
Bumiputra Sabah	4.0 (<0.1)	9.5 (CI: 7.9 - 11.5)	2.5 (CI: 1.7 - 3.6)
Bumiputra Sarawak	4.4 (<0.1)	13.7 (CI: 11.0 - 16.9)	3.1 (CI: 1.9 - 4.8)
Foreigner	4.1 (0.4)	8.4 (CI: 6.5 - 10.9)	2.4 (CI: 1.5 - 3.9)

Table 3: Prevalence of hypercholesterolemia by age and ethnicity (continue)

	Females		
	Mean Cholesterol (SE)	**≥5.2mmol/L**	**≥6.2mmol/L**
Age ≥ 18	4.5 (<0.1)	22.8 (CI: 22.1 - 23.5)	8.0 (CI: 7.6 - 8.4)
Age ≥ 30	4.8 (<0.1)	29.2 (CI: 28.4 - 30.1)	10.9 (CI: 10.3 - 11.5)
Age ≥ 60	5.0 (<0.1)	43.8 (CI: 41.7 - 46.0)	20.0 (CI: 18.4 - 21.8)
Age Groups			
18-19	4.2 (<0.1)	7.1 (CI: 5.5 - 9.2)	1.5 (CI: 0.8 - 2.7)
20-29	4.3 (<0.1)	11.9 (CI: 10.8 - 13.0)	3.0 (CI: 2.4 - 3.6)
30-39	4.5 (<0.1)	18.1 (CI: 16.9 - 19.4)	4.4 (CI: 3.7 - 5.1)
40-49	4.8 (<0.1)	28.5 (CI: 27.0 - 29.9)	9.6 (CI: 8.6 - 10.6)
50-59	5.0 (<0.1)	41.6 (CI: 39.7 - 43.6)	19.0 (CI: 17.5 - 20.6)
60-69	5.1 (<0.1)	48.4 (CI: 45.7 - 51.1)	23.5 (CI: 21.4 - 25.8)
≥ 70	4.9 (<0.1)	36.9 (CI: 33.7 - 40.2)	14.7 (CI: 12.5 - 17.3)
Ethnicity			
Malay	4.8 (<0.1)	27.5 (CI: 26.5 - 28.5)	10.3 (CI: 9.6 - 10.9)
Chinese	4.5 (<0.1)	20.9 (CI: 19.4 - 22.4)	7.5 (CI: 6.6 - 8.4)
Indian	4.6 (<0.1)	21.3 (CI: 19.1 - 23.7)	7.1 (CI: 5.9 - 8.4)
Bumiputra Sabah	4.1 (<0.1)	10.1 (CI: 8.5 - 12.0)	2.5 (CI: 1.9 - 3.4)
Bumiputra Sarawak	4.5 (<0.1)	18.2 (CI: 15.3 - 21.5)	4.5 (CI: 3.1 - 6.4)
Foreigner	4.3 (<0.1)	11.5 (CI: 9.6 - 13.6)	1.9 (CI: 1.3 - 3.0)

Table 4: Prevalence of hypercholesterolemia by family history, education, income, urban / rural status and sex

	Males		
	Mean Cholesterol (SE)	**≥5.2mmol/L**	**≥6.2mmol/L**
Family h/o Hypercholestremia			
No	4.44 (<0.1)	17.7 (CI: 16.9 - 18.4)	5.6 (CI: 5.2 - 6.0)
Yes	4.59 (0.3)	27.1 (CI: 24.6 - 29.8)	13.2 (CI: 11.4 - 15.1)
Education			
No Formal Ed	4.4 (<0.1)	17.5 (CI: 15.0 - 20.3)	5.6 (CI: 4.0 - 7.6)
Primary (1-6 yrs)	4.5 (0.2)	22.1 (CI: 20.8 - 23.4)	7.8 (CI: 7.0 - 8.6)
Secondary (7-13)	4.4 (<0.1)	16.6 (CI: 15.7 - 17.6)	5.5 CI: (5.0 - 6.1)
Tertiary (≥ 14)	4.5 (<0.1)	19.4 (CI: 17.3 - 21.8)	6.7 (CI: 5.6 - 8.0)
Unclassified	4.2 (0.8)	13.6 (CI: 8.9 - 20.0)	3.8 (CI: 1.6 - 8.9)
Household Income			
< 400	4.3 (<0.1)	15.9 (CI: 13.6 - 18.5)	5.2 (CI: 3.9 - 6.8)
400 - 999	4.4 (<0.1)	16.2 (CI: 15.0 - 17.6)	5.4 (CI: 4.7 - 6.1)
1000 - 1999	4.5 (<0.1)	21.0 (CI: 19.6 - 22.4)	6.5 (CI: 5.8 - 7.4)
2000 - 2999	4.5 (<0.1)	18.3 (CI: 16.6 - 20.0)	6.2 (CI: 5.2 - 7.2)
≥ 3000	4.5 (<0.1)	20.0 (CI: 18.3 - 21.7)	7.6 (CI: 6.7 - 8.6)
Unclassified	4.4 (0.1)	15.8 (CI: 12.6 - 19.6)	6.2 (CI: 4.3 - 8.9)
Urban/Rural			
Urban	4.5 (<0.1)	18.4 (CI: 17.5 - 19.4)	6.6 (CI: 6.1 - 7.2)
Rural	4.5 (<0.1)	18.9 (CI: 17.8 - 20.0)	5.9 (CI: 5.3 - 6.6)

Table 4: Prevalence of hypercholesterolemia by family history, education, income, urban/rural status and sex (continue)

	Females		
	Mean Cholesterol (SE)	**≥5.2mmol/L**	**≥6.2mmol/L**
Family h/o Hypercholestremia			
No	4.6 (<0.1)	22.4 (CI: 21.6 - 23.1)	7.5 (CI: 7.1 - 7.9)
Yes	4.6 (<0.1)	26.3 (CI: 24.3 - 28.5)	12.2 (CI: 10.9 - 13.7)
Education			
No Formal Ed	4.8 (<0.1)	32.9 (CI: 30.9 - 35.1)	12.1 (CI: 10.8 - 13.5)
Primary (1-6 yrs)	4.7 (<0.1)	28.3 (CI: 27.0 - 29.6)	10.6 (CI: 9.8 - 11.4)
Secondary (7-13)	4.5 (<0.1)	19.1 (CI: 18.2 - 20.1)	6.2 (CI: 5.7 - 6.8)
Tertiary (≥ 14)	4.4 (<0.1)	14.0 (CI: 12.2 - 16.1)	4.7 (CI: 3.7 - 5.9)
Unclassified	4.5 (0.1)	16.7 (CI: 11.3 - 24.1)	5.5 (CI: 2.8 - 10.5)
Household Income			
< 400	4.7 (<0.1)	26.8 (CI: 24.4 - 29.3)	9.7 (CI: 8.3 - 11.2)
400 - 999	4.7 (<0.1)	24.2 (CI: 22.9 - 25.6)	8.6 (CI: 7.8 - 9.4)
1000 - 1999	4.6 (<0.1)	23.6 (CI: 22.3 - 25.0)	8.2 (CI: 7.4 - 9.0)
2000 - 2999	4.6 (<0.1)	21.6 (CI: 20.0 - 23.3)	7.5 (CI: 6.5 - 8.6)
≥ 3000	4.5 (<0.1)	19.1 (CI: 17.7 - 20.6)	6.7 (CI: 5.9 - 7.5)
Unclassified	4.7 (<0.1)	25.0 (CI: 21.7 - 28.6)	8.6 (CI: 6.8 - 10.8)
Urban/Rural			
Urban	4.6 (<0.1)	21.3 (CI: 20.5 - 22.3)	7.5 (CI: 7.0 - 8.0)
Rural	4.7 (<0.1)	25.2 (CI: 24.1 - 26.4)	8.9 (CI: 8.2 - 9.6)

Table 5: Awareness, treatment and control of hypercholesterolemia (≥5.2mmol/L and ≥6.2mmol/L) by sex in Malaysia in year 2006 (Age ≥30 years), N =23,293

	Percentage, % (95%CI)		
	Female	**Male**	**Both sexes**
Hypercholesterolemia (≥5.2)			
Hypercholesterolemic being Aware	18.3 (CI: 17.0 - 19.6)	21.3 (CI: 19.7 - 23.1)	19.7 (CI: 18.6 - 20.8)
Hypercholesterolemic being treated	10.6 (CI: 9.7 - 11.7)	12.4 (CI: 11.1 - 13.8)	11.4 (CI: 10.6 - 12.3)
Control among Hypercholesterolemic *	7.8 (CI: 6.9 - 8.8)	11.0 (CI: 9.8 - 12.4)	9.3 (CI: 8.5 - 10.2)
Current treatment among aware Hypercholesterolemic	44.4 (CI: 41.1 - 47.8)	43.9 (CI: 40.2 - 47.6)	44.1 (CI: 41.5 - 46.8)
Control among those on medication *	62.4 (CI: 57.4 - 67.2)	75.5 (CI: 70.3 - 80.0)	69.0 (CI: 65.3 - 72.4)
Hypercholesterolemia (≥6.2)			
Hypercholesterolemic being Aware	40.8 (CI: 38.1 - 43.5)	47.0 (CI: 43.7 - 50.3)	43.6 (CI: 41.4 - 45.8)
Hypercholesterolemic being treated	28.6 (CI: 26.2 - 31.1)	34.3 (CI: 31.2 - 37.5)	31.2 (CI: 29.2 - 33.3)
Control among Hypercholesterolemic **	21.0 (CI: 18.8 - 23.4)	30.6 (CI: 27.6 - 33.8)	25.4 (CI: 23.4 - 27.4)
Current treatment among aware Hypercholesterolemic	70.1 (CI: 66.0 - 73.8)	73.0 (CI: 68.5 - 77.2)	71.5 (CI: 68.5 - 74.4)
Control among those on medication **	86.9 (CI: 83.0 - 89.9)	92.0 (CI: 88.4 - 94.5)	89.4 (CI: 87.0 - 91.5)

** Control defined as Cholesterol Values <5.2*

*** Control defined as Cholesterol Values <6.2*