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

DIABETES MELLITUS

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ISBN 978-983-3887-17-0

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ISBN: 978-983-3887-17-0

Suggested citation:

Institute for Public Health (IPH) 2008. The Third National Health and Morbidity Survey (NHMS III) 2006, Diabetes Mellitus. Ministry of Health, Malaysia

Produced and Distributed by:

The Third National Health and Morbidity Survey Project,
Institute for Public Health,
National Institutes of Health,
Ministry of Health,
Jalan Bangsar, 50590 Kuala Lumpur,
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Published by Institute for Public Health, Ministry of Health, Malaysia

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

DIABETES MELLITUS

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This research project was sponsored by Ministry of Health
[Project Code : (P42-251-170000-00500(005000099) Sub code project : 42005000990001)]
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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 to strive to ensure integrity of this work. In the process of preparing this volume, close collaboration was established between the authors and relevant Health Programme Managers especially Institute of Public Health to facilitate the use of the research findings.

The findings in this volume were weighted for the 2006 projected population in Malaysia.

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

ACKNOWLEDGEMENT

We, the researchers, wish to express sincere gratitude and appreciation to the National Health and Morbidity Survey Steering Committee and the Advisory Group, Principal Investigator and NHMS III Team Members for their guidance and support in the preparation and implementation of this survey.

Our utmost gratitude goes to The Director of all State Health Departments, the Senior Officers and their staff, Local Authorities for their cooperation and support that enabled this survey to be carry out successfully.

Our deepest gratitude goes to those who were directly or indirectly involved in the data collection as well as data editing process. Their invaluable input made the preparation of this report possible.

ABSTRACT

Diabetes is an important public health concern. The third National Health and Morbidity Survey (NHMS III) included the diabetes module in the survey on subjects ≥18 years old. A total of 34,539 study subjects responded to the diabetes questionnaire. Known diabetes was by self-administered of respondent. A total of 31,943, who claimed they were not diabetic underwent finger-prick glucose test following at least 8 hours of fasting. A subject was classified as a newly diagnosed diabetes when the glucose level was equal to or more than 6.1mmol/L.

The overall prevalence of diabetes mellitus was 11.6%. There was an increasing trend of prevalence with age; from a low 2% in the 18-19 years age group to high prevalence ranging between 20.8% to 26.2% among 50-64 years age group. The prevalence in the urban areas (12.1%) significantly higher than rural areas (10.5%).

No gender difference in prevalence was observed. The Indians had the highest prevalence of 19.9% followed by Malays (11.9%) and Chinese (11.4%). Those with primary education or less, had a higher prevalence. Income status did not show any difference in the prevalence reported.

From this survey, the prevalence of people with known diabetes was 7.0%. The prevalence of newly diagnosed diabetes was 4.6%.

Impaired fasting glucose (IFG) was defined as whole blood capillary glucose level between 5.6 - 6.1mmol/L. In this survey, the national prevalence of IFG amongst Malaysians of ≥18 years old was found to be 4.2%.

Despite differences in diagnostic methods (2 hours post glucose load in NHMS II versus fasting glucose), the prevalence of known and newly diagnosed diabetes among adults above 30 years has increased from 8.3% in NHMS II to 14.9% in NHMS III. Similarly, the prevalence of known diabetes were 5.7% and 9.5% in NHMS II and NHMS III respectively. Among newly diagnosed diabetes, the prevalence also increased from 2.5% in NHMS II to 5.5% in NHMS III.

NHMS III revealed only 45.1% of known diabetics ever had their eyes examined, significant lowest percentages were among the young, those who self-treat, treated by private doctors, and those who did not seek treatment.

In conclusion, the prevalence of diabetes in Malaysia has almost doubled in magnitude over the last decade. In view of this serious trend, efforts in prevention and control of this chronic disease should be stepped up.

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ABBREVIATIONS

2Hpg	2h post-glucose
ACE	Angiotension-Converting-Enzyme
ADA	American Diabetes Assosiation
BMI	Body Mass Index
CDC	Centers for Disease Control and Prevention
CPG	Clinical Practice Guidelines
CVD	Cardiovascular Disease
DCCT	The Diabetes Control and Complications Trial
DM	Diabetes Mellitus
DR	Diabetes Programme
DALYs	Disability Adjusted Life Years
EBs	Enumeration Blocks
FBG	Fasting Blood Glucose
FPG	Fasting Plasma Glucose
HbAIc	Glycated Hemoglobin
HMIS	Health Management and Information System
i.e	Example
IDDM	Insulin - Dependant Diabetes Mellitus
IDF	International Diabetes Federation
IFG	Impired Fasting Glucose
IGT	Impaired Glucose Tolerance

KKM	Kementerian Kesihatan Malaysia
LQ	Living Quarters
mmol/L	Milimol per Liter
MOH	Ministry of Health
NCD	National Council Disability
NGO	Non Government Organization
NHMS I	First National Health and Morbidity Survey
NHMS II	Second National Health and Morbidity Survey
NHMS III	Third National Health and Morbidity Survey
NIDDM	Non-Insulin-Dependent Diabetes Mellitus
OGGT	Oral Glucose Tolerance Test
PIBG	Persatuan Ibu Bapa dan Guru
PPS	Probability Proportionate to Size
PTA	Parents Teachers Association
SMBG	Self-Monitoring of Blood Glucose
UKPDS	United Kingdom Prospective Diabetes Study
Vs	Versus
WHO	World Health Organization
YLD	Years Lived with Disability
YLL	Years of Life Lost

1. INTRODUCTION

Diabetes is a global health problem (King & Rewers 1993). The number of people with diabetes is increasing. This is evident from findings of a series of global estimates of current and predicted future prevalence of diabetes, (Amos et al. 1997; IDF, Diabetes Atlas 2003; King et al. 1998) and the latest update in 2004 as in Table 1.1 (Wild et al. 2004). This rising trend is due to many factors such as population growth, aging, urbanization and increasing prevalence of obesity and physical inactivity (Wild et al. 2004).

Table 1.1: Estimates of current and projected global prevalence of diabetes

	Amos et al. (1997)		King et al. (1998)		IDF (2003)		Wild et al. (2004)	
	Current (Yr)	Projected (Yr)	Current (Yr)	Projected (Yr)	Current (Yr)	Projected (Yr)	Current (Yr)	Projected (Yr)
Prevalence (adults)	NA	NA	4.0% (1995)	4.2% (2000) 5.4% (2025)	5.1 % (2003)	6.3% (2025)	2.8% (2000)	4.4% (2030)
Numbers (adults)	124 million (1997)	221 million (2010)	135 million (1995)	150 million (2005) 300 million (2025)	151 million (2000)	194 million (2003) 334 million (2025)	171 million (2000)	366 million (2030)
Prevalence Type 1 (0-14 years old)	NA	NA	NA	NA	<0.1% (2003)	NA	NA	NA
Numbers Type 1- cases	NA	NA	NA	NA	430,000 (2003)	NA	NA	NA

(NA: not available)

The Diabetes Atlas (2003) showed that the European region (48 million) and Western Pacific Region with (43 million) currently have the highest number of people with diabetes. However, by 2025 the region with the largest number of diabetes will be South East Asia Region, with a projected prevalence of 13.5% and some 145 million cases (IDF 2003).

Similar trend is observed in Malaysia. From the earliest studies carried out in 1960 (Pillay and Lim) and in 1966 (West and Kalbfleisch), followed by two decades later, in 1986 1st National Health & Morbidity Study (NHMS I) and in 1996 2nd National Health & Morbidity Study (NHMS II), Malaysia experienced similar to the global rising trend. As shown in Table 1.2, diabetes prevalence in NHMS II was 8.3% (7.8 - 8.7) where 5.7% (5.4 - 6.1) were known diabetes and 2.5% (2.3 - 2.7) were newly diagnosed based on 2 hours post-glucose load. The rising trend was further confirmed in several other small local studies (Table 1.3).

Table 1.2: Estimates of diabetes prevalence in Malaysia

Parameters	*NHMS I (1986)	#NHMS II (1996)
Prevalence of diabetes (overall)	6.3 %	8.3 %
Prevalence of known diabetes	4.5 %	5.7 %
Prevalence of undiagnosed diabetes	1.8 %	1.8 %
Impaired Glucose Tolerance (IGT)	4.8 %	4.3 %

* ≥ 35 years old adults; # ≥ 30 years old adults

Table 1.3: Local studies on prevalence of diabetes mellitus in Malaysia

Authors / year	Year of Study	Prevalence of Diabetes Mellitus
Khebir et al. (1996)	1994	12.2%
MyNCDS-1 (2006)	2005/6	11.0%

The importance of quantifying the prevalence of diabetes and the number of people affected by diabetes, i.e. burden of disease, both at present and future projections, is important to allow rational planning and allocation of resources (Wild 2004). Taking cognizance of this, the Advisory Committee of the NHMS III decided to again include the Diabetes Module as one of the scopes in the national survey in 2006. The main objective is to quantify the current prevalence of diabetes and impaired fasting glucose in the Malaysian population.

2. LITERATURE REVIEW

2.1. Definition

Diabetes Mellitus (DM) is a metabolic disorder of multiple etiologies characterized by chronic high blood glucose levels with disturbance of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action or both (WHO Report 1999). It is a chronic disease with several complications such as retinopathy, nephropathy and macro vascular diseases such as coronary artery and cardiovascular diseases.

There are two main types of diabetes namely; Type I and Type II diabetes mellitus (Shafrir 1997). Type I DM is an autoimmune-mediated destruction of pancreatic ß-cell islets causing an absolute insulin deficiency in genetically susceptible individuals (Harrison et al. 1999). As such, people with Type I DM need to take exogenous insulin to prevent the development of ketoacidosis. The frequency of Type I DM is low as compared to Type II DM. Type II DM is a multifactorial disease that shows heterogeneity in many aspects (Groop 1997). Globally, Type II DM accounts for more than

90% of cases. It is characterized by insulin resistance and/or abnormal insulin secretion. People with Type II DM are not dependent on exogenous insulin, but may require insulin if diet control or oral hypoglycemic agents fail to control blood glucose level.

2.2 Epidemiology of Diabetes Mellitus

The varying rates of diabetes observed in different parts of the world reflect underlying differences in behavioural, environmental and social risk factors, such as diet, level of obesity and physical activity (McCarty & Zimmet 1997). Highest were among migrant populations that might experienced a greater degree of westernization. Lowest rates were often found in rural areas within the country of origin, where people were living closer to their traditional life-styles (ADA 2000; Thai et al. 1987).

2.2.1 Age distribution

The 40-59 years old age group currently has the largest number of people with diabetes. By 2025, because of the aging world population, there will be 146 million people of age group 40-59 years and 147 million of age group 60 years and older (IDF 2003).

2.2.2 Gender distribution

The estimates for both year 2003 and 2025 showed a female predominance in the number of people with diabetes. The number of females were about 10% higher than males (IDF 2003).

2.2.3 Urban rural distribution

In 2003, the number of people with diabetes in urban areas were 78 million compared to 44 million in the rural areas for many countries. By 2025, it is expected that the number of people with diabetes will increase to 182 million for urban and 61 million for rural (IDF 2003).

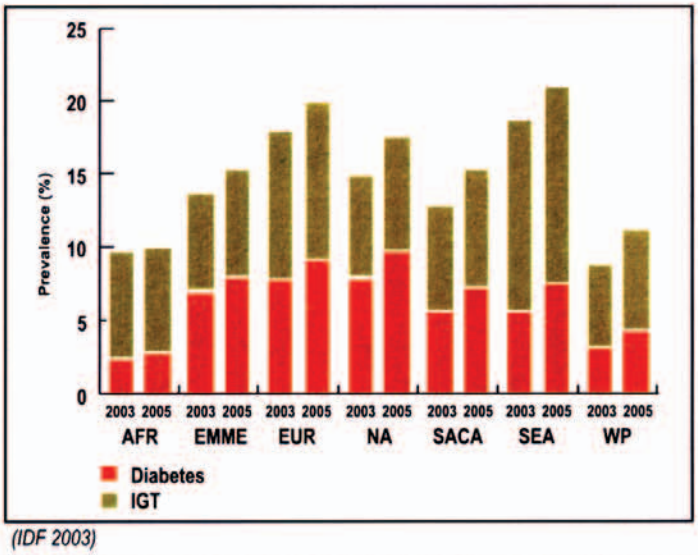
The demographic, behavioural and environmental causes of Type 2 DM have been inclusively well described (Zimmet et al. 2000). Table 2.1 shows proposed determinants of Type 2 DM. From the table, having high body mass index (BMI) and increased central obesity seemed to be highly correlated with Type 2 DM.

Table 2.1: Proposed behavioural and environmental determinants of type 2 diabetes based on findings from cross-sectional or longitudinal studies

Determinant	Strength of association	Control for confounding factors
High BMI	High	Adequate
Increased central obesity	High	Adequate
Physical inactivity	Intermediate	Not complete
Excessive intake of:		
• Energy	Intermediate	Not satisfactory
• Simple carbohydrates	Weak	Not satisfactory
• Saturated trace element	Intermediate	Not satisfactory
• Alcohol	Weak	Not satisfactory
Low intake of:		
• Dietary fibre	Intermediate	Not satisfactory
• Certain trace element	Weak	Not satisfactory
Use of some antihypertensive drugs	Intermediate	Not complete

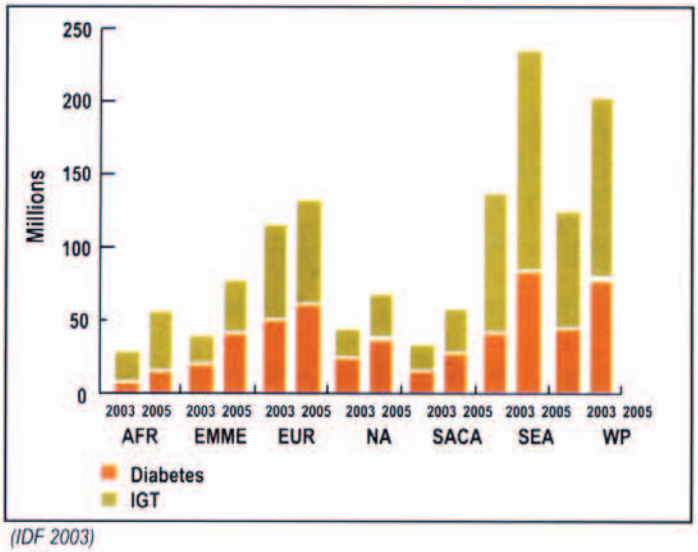
2.3 Disease and Economic Burdens

The global estimates for diabetes in 1994 to 2010 are presented in Figs 2.1 and 2.2 (IDF 2003). In Asia alone, the total number affected by DM could reach more than 138 million and it is estimated that by 2010, the disease could become 2.5 to 3.0 times more common in Asia and Africa (McCarty & Zimmet 1997).



(IDF 2003)

Figure 2.1: Estimated prevalence of diabetes and impaired glucose tolerance (IGT) for 20–79 years old age group by region



(IDF 2003)

Figure 2.2: Estimated of people with diabetes and IGT for 20–79 years age group by region

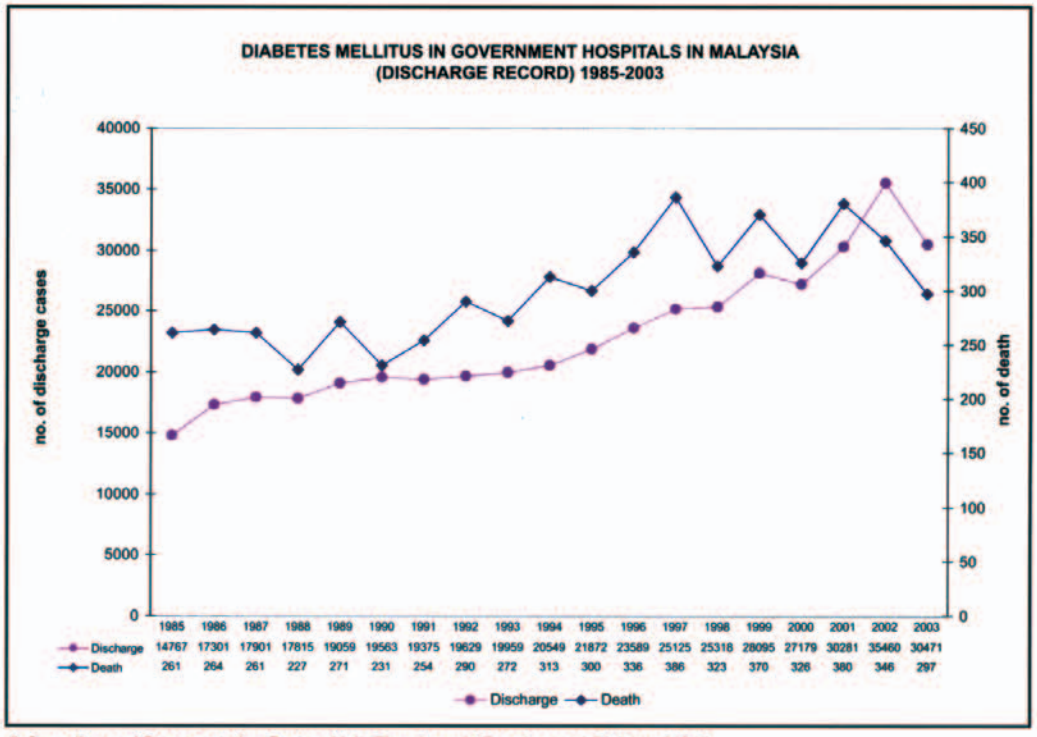
The Malaysian Burden of Disease and Injury Study (Faudzi et al. 2004) estimated that in the year 2002, there were 2,261 deaths attributed to DM (857 men and 1404 women). Although DM was not in the top 10 causes of highest Years of Life Lost (YLL) in men, the disease incurred huge burden morbidity measured as Years Lived with Disability (YLD). DM ranked third at 34,750 years in the men. The scenario is worst for women; scoring higher for both indices; 18,759 years for YLL and 37,631 years for YLD. This means, in Malaysia, women with diabetes had shorter life spent and amongst those who survived, they endured more suffering.

The sum of YLL + YLD yields the index Disability Adjusted Life Years (DALYs). DALYs is a composite measure of burden of premature mortality and non-fatal health outcome (morbidity) (Table 2.2). Based on DALYs, DM was ranked sixth for men and fifth for women among the top 10 total burden of disease in the country. Despite its lower ranking, DM probably contributed significantly to the causality of the higher ranking diseases with the exception of unipolar major depression. As shown in Fig 2.3, there is increasing correlation between number of admission and death due to diabetes between the years 1985 to 2003.

Table 2.2: Top 10 causes of DALYs by sex, Malaysia 2000

Rank	Disease	Males		Disease	Females	
		DALYs	%		DALYs	%
1	Ischaemic heart disease	164,846	10.0	Ischaemic heart disease	113,887	9.2
2	Road traffic accidents	133,789	8.2	Cerebrovascular disease	86,372	7.0
3	Cerebrovascular disease	94,059	5.7	Unipolar major depression	67,211	5.4
4	Septicemia	70,232	4.3	Septicemia	57,483	4.6
5	Acute lower respiratory tract infections	49,649	3.0	Diabetes mellitus	56,390	4.6
6	Diabetes mellitus	47,060	2.9	Hearing loss	38,994	3.1
7	Chronic obstructive pulmonary disease	45,459	2.8	Acute lower respiratory tract infections	37,890	3.1
8	Hearing loss	44,566	2.7	Asthma	32,815	2.6
9	Unipolar major depression	42,259	2.6	Road traffic accidents	28,946	2.3
10	Cirrhosis	37,902	2.3	Osteoarthritis	26,925	2.2
Total (111 disease)		**1,646,896**	**100**	**Total (111 disease)**	**1,240,997**	**100**

(Malaysian BOCD, MOH 2004)



(Information and Documentation System Unit, Planning and Development Division, MOH)

Fig 2.3: Total number of discharge and death due to diabetes in Ministry of Health hospitals (1983-2003)

2.4 Early Detection and Screening

Most people were not aware that they had diabetes. UKPDS Group (1990) showed that about 50% of those newly diagnosed with type 2 DM had chronic complications at diagnosis. In view of the chronic nature of diabetes, severity of complications and the cost to treat and manage, it is therefore imperative to prevent diabetes in all aspects and levels of prevention, and to detect diabetes cases at very early stage.

Three general approaches to reducing the complications of diabetes are to prevent the occurrence, screening asymptomatic people for diabetes and improving care for people with diabetes (Clark et al. 2000). Screening is the process of identifying those individuals who are at sufficiently high risk of a specific disorder to warrant further investigation or direct action (WHO 2003). Early identification of type 2 DM through screening will subsequently identify individuals with impaired glucose tolerance (IGT) and/or impaired fasting glucose (IFG).

2.5 Diagnostic Criteria for Hyperglycemia

The diagnostic criteria for diabetes and abnormal glucose states have evolved over the last three decades.

Prior to the late 1970s, diagnostic criterias for diabetes were variable, and were established by different research groups and clinicians using individual clinical experiences and supported by limited evidence. Accumulation of epidemiological research on diabetes and evidence-based reports were published in 1979 by the National Diabetes Data Group in the United States and by the World Health organization (WHO) in 1980; both addressing diabetes diagnostic criteria with similar conclusions (WHO 1980; National Diabetes Data Group 1999). Impaired glucose tolerance (IGT) was first established and defined as glucose level of 7.8 - 11.0mmol/L at 2-hour post 75g OGTT. IGT was recognized as a state of abnormal glucose metabolism with increased risk of developing diabetes.

In 1997, the American Diabetes Association (ADA) and later in 1999, WHO sponsored and published two new reports on diabetes diagnostic criteria following review and consideration of the accumulated evidence (WHO 1999). Both these reports recommended the lowering of fasting glucose diagnostic criteria for diabetes from ≤7.8mmol/L to ≤7.0mmol/L. The 2-hour post glucose load criteria of ≤11.1mmol/L was unchanged. A new category of IFG was established and defined as fasting level between 6.1 - 6.9mmol/L. The ADA-sponsored report favoured the use of fasting glucose as the preferred diagnostic test whereas the WHO-sponsored report highlighted that a percentage of cases diagnosed with diabetes following 2-hour glucose post OGTT, were not detected by simply measuring fasting glucose only.

Subsequently in 2003, the ADA Expert Committee on the Diagnosis and Classification of Diabetes re-examined the criteria for IFG (Genuth et al. 2003) and recommended that the cut-of point for IFG should be lowered to fasting plasma glucose (FPG) of 5.6 - 6.9mmol/L. This report also highlighted that the HbA1c value should not be used as a criteria for diagnosis of diabetes. The change in IFG criteria has been estimated to increase the population of the affected group by 2 to 5 fold depending on demographic subgroups (Davidson et al. 2003). The diagnostic criteria for diabetes mellitus and other categories of hyperglycemia are as stated in the Table 2.3.

For epidemiological or population study purposes however, screening for DM can be done either by glucose measurement after an overnight fast, or, glucose measurement on sample taken at 2-hour post 75g oral glucose load following an overnight fast.

The Malaysian Type 2 Diabetes Clinical Practice Guidelines (CPG) 2004 and Asian- Pacific Type 2 Diabetes Policy Group Guidelines, 4th edition 2005 have both incorporated the ADA 2003 recommendations (MOH 2004; Asian-Pacific Type 2 Diabetes Policy Group 2005). Diagnosis for diabetes should, wherever possible, use venous plasma sample and not capillary (IDF 2005). However, for screening programmes, either a fasting or random glucose measurement could be used as the first step. When fasting blood glucose falls between 5.6 - 6.9mmol/L or random blood glucose falls between 5.6 - 11.0mmol/L, an oral glucose tolerance test (OGTT) should be performed to confirm diagnosis. For clinical purposes, the diagnosis of diabetes should always be confirmed by repeating the fasting test on another day unless there is unequivocal hyperglycemia with acute metabolic decompensation or obvious symptoms.

Table 2.3: Values for diagnosis of diabetes mellitus and other categories of hyperglycemia

	Glucose concentration (mmol/L)		
	Whole blood		Plasma[a]
	Venous	Capillary	(Venous)
Diabetes Mellitus			
Fasting	≥6.1	≥6.1	≥7.0
or			
2-h post glucose load	≥10.0	≥11.1	≥11.1
or both			
Impaired Glucose Tolerance (IGT):			
Fasting (if measured)	<6.1	<6.1	<7.0
and			
2-h post glucose load	≥6.7 and <10.0	≥7.8 and <11.1	≥7.8 and <11.1
Impaired Fasting Glucose or Glycemia (IFG):			
Fasting (if measured)	≥5.6 and <6.1	≥5.6 and <6.1	≥6.1 and <7.0
and			
2-h post glucose load	<6.7	<7.8	<7.8

[a]Corresponding values for capillary plasma are: for DM, fasting ≥7.0, 2-h ≥12.2; for IGT, fasting <7.0 and 2-h ≥8.9; and IFG ≥6.1 (≥110) and <7.0 (<126) and if measured, 2-h <8.9 (<160).

(Source - WHO/NCD/NCS/99.2; Part 1: Diagnosis and Classification of Diabetes Mellitus)

2.6 Management of Diabetes Mellitus

Diabetes mellitus is a chronic, multi-factorial metabolic disease that requires continuing medical care and patient self-management education to monitor and maintain good glycemic control towards preventing acute complications and to reducing the risk of long-term complications. Diabetes care is complex and requires that many additional issues, beyond glycemic control, such as obesity and cardiovascular risk factors be addressed.

Glycemic control is fundamental to the management of diabetes. The gold standard for assessment of long-term glycemic control is glycated hemoglobin (HbA1c), and this should be measured every 3-6 months. Self-monitoring of blood glucose (SMBG) levels is essential to improve the safety and quality of treatment for those treated with insulin, and during pregnancy. SMBG is also widely used in the care plans of many people with Type 2 DM to complement HbA1c measurement to assess blood glucose control. Current local (Malaysian Management of Type 2 Diabetes Mellitus CPG 2004), regional (Asian-Pacific Type 2 Diabetes Policy Group 2005) and international (Global Guidelines for Type 2 Diabetes-IDF 2005) guidelines recommend an optimal glycemic target of <6.5%.

Prospective randomized clinical trials such as the DCCT in Type 1 Diabetes (The Diabetes Control & Complications Trial Research Group 1993) and the U.K. Prospective Diabetes Study (UKPDS) in Type 2 Diabetes (UKPDS 1998; UKPDS 34 1998) have shown that improved glycemic control is

associated with sustained decreased rates of retinopathy, nephropathy, and neuropathy (The Diabetes Control and Complications Trial 2000). In these trials, treatment regimens that reduced average HbA1C to ~7% (~1% above the upper limits of normal) were associated with fewer long-term microvascular complications; however, intensive control was found to increase the risk of severe hypoglycemia and weight gain (Lawson et al. 1999; Stratton 2000). The potential of intensive glycemic control to reduce cardiovascular disease (CVD) is supported by epidemiological studies (The Diabetes Control and Complications Trial Research Group 1993; UKPDS 34 1998; Lawson et al. 1999; The Diabetes Control and Complications Trial 2000; Stratton et al. 2000) and recent meta-analyses (Selvin et al. 2004; Stettler et al. 2006) but this potential benefit on CVD events has not yet been demonstrated in a randomized clinical trial.

Management of diabetes mellitus requires both a lifestyle, non-pharmacological approach in combination with the use of pharmacological agents to address the multiple pathophysiological defects which includes oral anti-diabetic agents as well as insulin therapy. This most importantly incorporates the principles of self-management through patient education and patient self-empowerment. Diabetes mellitus, in hospital or primary care setting is best managed by a multidisciplinary team, which includes not only healthcare professionals (physicians and specialists, primary care doctors, nurse educators, dieticians, pharmacists), but also the patient and their families. The team-based approach allows flexibility in delivery of care, and improves communication between healthcare professionals.

2.6.1 Lifestyle management

Diet, exercise and weight optimization are at the centre of any therapeutic programme for the management of patients with both Type 1 and Type 2 DM. These lifestyle modifications lower blood glucose concentrations and improve many of the frequently co-existing risk factors for CVD. Unfortunately most patients with Type 2 DM are unable to achieve adequate glycemic control with lifestyle interventions alone.

2.6.2 Pharmacological therapy

a) Type 1 diabetes mellitus

Insulin remains the main treatment in patients with Type 1 DM. Intensive insulin therapy is required, aiming to provide physiological insulin replacement. This is most commonly prescribed by using both quick-acting insulin to provide mealtime cover in combination with long-acting insulin to provide basal or background cover commonly referred to as a "basal-bolus" insulin regimen. However, the commonly used conventional insulin and delivery methods have not been able to approximate physiological insulin secretion well. The availability of new insulin analogues and alternative delivery methods (insulin pump) offer the potential to mimic physiological insulin secretion more closely.

The use of metformin treatment alongside insulin has increased in patients with Type 1 DM. Recent studies have suggested that metformin might benefit Type 1 DM patients who are overweight, are receiving large doses of insulin, or have HbA1c >8%. The co-existence of insulin resistance in patients with Type 1 DM is a new area of therapeutic interest (Meyer & Guerci 2003).

b) Type 2 diabetes mellitus

The pharmacological treatment of hyperglycemia is based on the two key metabolic abnormalities in Type 2 DM - insulin resistance and impaired insulin secretion. The current locally available groups of oral antidiabetic agents include sulphonylureas and metiglinides which act as insulin secretagogues to directly stimulate insulin secretion; biguanide (such as metformin) and thiazolidinediones which act to improve insulin sensitivity and alpha glucosidase inhibitors which delay intestinal carbohydrate absorption, hence reducing the need for post-prandial insulin secretion.

Type 2 DM is a progressive disease. Data from the UKPDS showed that only 50% of pancreatic beta cell function remained when Type 2 diabetes was first diagnosed, and after 6 years, only 25% of beta cell function remained regardless of therapeutic agents used (Holman 1998). The UKPDS demonstrated that after 3 years, only 50% of Type 2 DM patients were adequately controlled with a single drug and after 9 years, this figure decreased to 25% (Turner et al. 1999 UKPDS Group 1998). In the recent ADOPT trial, comparing the durability of monotherapy in newly diagnosed patients with Type 2 DM, it was found that monotherapy failure at 5 years was least for rosiglitazone compared to metformin and sulphonylurea (15%, 21% and 34% respectively) (Kahn et al. 2006). However in these studies, treatment with rosiglitazone was associated with more weight gain and edema as well as increased cost in comparison to metformin and sulphonylurea.

Metformin is a weight neutral anti-diabetic agent and is universally recommended as first-line therapy in both the obese/overweight and non-obese patients with Type 2 DM. Sulphonylureas usually lead to weight gain and can cause hypoglycemia, thus should usually be used as second or third-line agents (Asian-Pacific Type 2 Diabetes Policy Group 2005). The thiazolidinediones have also been recommended as second and third-line agents. More than one medication will be needed for the majority of patients with Type 2 DM over time. In view of the multiple pathophysiological defects in Type 2 DM, early combination therapy using oral antidiabetic agents with different mechanisms of action and subsequently, the addition of insulin with aggressive intensification of treatment regimens is the current recommended approach to optimize glycemic management in Type 2 DM (Nathan et al. 2006).

The goal of glycemic management is to achieve HbA1C levels as close to normal as possible in the absence of hypoglycemia. However, this goal is difficult to achieve with present therapies. The failure of clinicians and their patients with diabetes to implement currently available interventions aggressively and effectively, the so-called "therapeutic inertia", is the major barrier to good care.

Patients with Type 1 and Type 2 DM have an increased prevalence of cardiovascular risk factors, cardiovascular morbidity and mortality. Cardiovascular risk factors should be assessed at leas annually. These risk factors include dyslipidemia, hypertension, smoking, a positive family history of premature coronary disease, and the presence of micro or macroalbuminuria. Patients at increased cardiac risk should receive aspirin and may warrant an angiotensin-converting-enzyme (ACE) inhibitor therapy. Multifactorial interventions to simultaneously address these risk factors aggressively have been shown to reduce macrovascular disease (Goede et al. 2003) and mortality in patients with Type 2 DM, particularly in those who have had prior cardiovascular events.

The targets for glycemic, blood pressure and blood lipid control are shown in Table 2.4 with reference to Clinical Practice Guidelines Management of Type 2 Diabetes 2004, MOH (MOH 2004).

Table 2.4: The targets for glycemic, blood pressure and blood lipid control (CPG Diabetes 2004)

Determinant	Levels
Glycemic control	
Fasting	4.4 - 6.1 mmol/L
Nonfasting	4.4 - 8.0 mmol/L
HbA1c	<6.5%
Lipids	
LDL-Cholesterol	≤2.6 mmol/L
HDL- Cholesterol	≥1.1 mmol/L
Triglycerides	≤1.7 mmol/L
BMI	<23 kg/m2
Blood Pressure	
Normal Renal Function	≤130 / 80 mmHg
Renal Impairment / Gross Proteinuria	≤120/ 75 mmHg

2.6.3 Disease prevention and diabetes mellitus control program

Diabetes programme has long been implemented in the health care service. However, prior to 1996 it was less comprehensive and coordinated. Effort to improve the programme was taken by the Ministry of Health in 1996 by formulating a National Diabetes Prevention and Control Program with the mission to promote health and quality of life by preventing and controlling diabetes, its risk factors, and complications (National Action Plans and Strategies 1998).

This programme needs to be further streamlined, coordinated and strengthened in all existing efforts to combat diabetes. The objectives include to prevent or to delay the onset of diabetes, to detect diabetes early and to prevent and minimise complications. Training of healthcare personnel is an essential component to improve diabetes management outcomes. With the renewed approach of diabetes programme, greater emphasis is focused on training of medical personnel in order to establish and expand the pool of skilled paramedical as well as medical personnel at all levels of care. Diabetes guidelines such as Clinical Practice Guidelines (CPG) and protocols are developed to assist health care providers with evidence-based recommendation in management of diabetes at their local levels.

In order to effectively target prevention and control efforts of the diabetes programme, it is essential to understand how the disease is distributed in the population. The Ministry of Health uses multiple sources of data to track diabetes, including surveys, diabetes register and NCD Risk Factor Surveillance Survey, which provide information on risk factors. Through the Health Management and Information System (HMIS), it maintains a national system that provides data about hospital admissions and death due to diabetes in the country. This information is widely disseminated and also available on the web.

Information collected in this NHMS III survey would enable policy makers and programme planners in the Ministry of Health to further improve the prevention and control of Diabetes Mellitus.

Diabetic retinopathy (DR) is one of the commonest causes of blindness among working age group world wide (Fong et al. 2003). In the USA, the prevalence of retinopathy of any level was 40.3% for NIDDM and 86.4% for IDDM. As for vision threatening DR in USA, the prevalence was 8.2% for NIDDM, 42.1% for IDDDM (The Eye Disease Prevalence Research Group among adults 2004 & The Eye Disease Prevalence Research Group among Type 1 diabetic person 2004). The prevalence of DR is closely linked to the duration and control of the diabetes. At diagnosis, less than 5% will have retinopathy while after 10 years the prevalence rises to 40% - 50%. After 20 years, almost all patients with IDDM and more than 60% patients with NIDDM have some degree of retinopathy, (Klein 1991). Most patients with diabetic retinopathy may not have any visual symptoms at the early stage and when visual symptoms developed, the retinal damage may be irreversible and patients end up with permanent visual impairment. Thus early detection and prompt laser treatment of diabetic retinopathy can prevent sight loss.

Since assessment of DR requires special skill and instrumentation such as ophthalmoscope, DR may be least assessed by doctors who treat diabetic patients as compared to urine analysis done to screen for diabetic nephropathy and testing of sensation for neuropathy. However, the presence of DR is a strong indicator of suboptimal diabetic control and co-existence of other diabetic complications. Undetected early stage of DR will progress to more advanced state that requires costly surgical intervention and irreversible visual impairment.

Clinical Practice Guideline in the Management of Diabetic Retinopathy, published in 1996 by MOH and Academy of Medicine, Malaysia, stated that for all DM aged 30 years and younger, the first eye examination should be within 5 years of diagnosis and then once a year if normal; and for those aged 30 years and older, they should have their eye examined at the time of diagnosis and then once a year if normal (Clinical Practice Guidelines in the Management of diabetic retinopathy, 1996). The National Diabetes Programme in 2002 has recommended the use of DM out-patient green cards where vision and fundus examination at diagnosis and at a yearly interval have to be recorded. However, the actual adherence to CPG and National Diabetes Programme is not known.

3. OBJECTIVES

3.1. General Objective

To determine the prevalence of diabetes in the Malaysian population

3.2. Specific Objectives

3.2.1 To determine the prevalence of known diabetes mellitus

3.2.2 To determine the prevalence of newly diagnosed diabetes and impaired fasting glucose

3.2.3 To determine the percentage of known diabetes who have complications

3.2.4 To determine the health seeking behaviour among diabetes

3.2.5 To determine the association of risk factors with diabetes mellitus

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) The 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, and

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 Design 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 were roped in for advice.

4.2.1 Sampling frame

The sampling frame for this survey is an updated 2004 version; 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 was estimated to comprise of 4.4 individuals. All households 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 each module 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 types 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 Blood glucose level measurement

Blood glucose level was only tested among those who admitted that they were not diabetics and who gave verbal consent. They underwent glucose level testing of finger prick blood after a period of 8-10 hours of fasting. The tests were carried out by trained nurses using the Accutrend GC, Roche Diagnostic, a battery-operated gluco-photometer.

A small droplet of blood was put onto a glucose test strip which was then measured by the meter. The meter was portable and easy to use. The meter produced the reading for blood glucose within 12 seconds. The visual measuring range for the meter was 1.1mmol/L to 33.3mmol/L. Readings

below and above this range were recorded as 'Lo' and 'Hi' respectively by the meter. The results were obtained immediately and recorded in the appropriate boxes in the questionnaire forms. Respondents were informed of their results and those with abnormal results (≥6.1mmol/L) were referred to the nearest health facilities for further investigation. Respondents who were eligible for the glucose test but refused to be examined were classified as "refused to be examined".

4.4.4 History of eye examination

The NHMS III survey included questions on history of past eye examinations among known diabetes, which aimed to determine the proportion of known diabetes who had eye examinations and the time of last eye examination. The questions were accompanied by photograph of instruments used for examination of the fundus of the eyes such as slit lamp, fundus camera, direct opthalmoscope or indirect opthalmoscope.

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 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 were 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

4.8.1 **Normal Fasting Blood Glucose** (FBG) is defined as fasting blood glucose <5.6mmol/L detected on the Accutrend GC (Roche Diagnostics) glucometer, whole blood calibrated.

4.8.2 **Impaired Fasting Glucose** (IFG) is defined as fasting blood glucose >5.6mmol/L and ≤6.1mmol/L detected on the Accutrend GC (Roche) glucometer, whole blood calibrated.

4.8.3 **Newly diagnosed diabetes** is defined as fasting blood glucose >6.1mmol/L detected on the Accutrend GC (Roche) glucometer, on whole blood.

4.8.4 **Known diabetes** is defined as self-admission to have diabetes which is confirmed by any medical personnel or taking anti-diabetic medication.

4.8.5 **All diabetes** is defined as all types of diabetes i.e. combination of known diabetes and newly diagnosed diabetes.

4.8.6 **Ever treated** is defined as self-reporting of being on diabetic treatment (defined as either anti-diabetic medication or herbal medication) both currently or at any one time previously.

4.8.7 **Currently on anti-diabetic treatment** is defined as on regular anti-diabetic medication in the recent 4 weeks prior to date of interview.

4.8.8 **Lower limb amputation** is defined as amputation of toes, parts of the leg, above or below knee arising from diabetes.

4.8.9 **Stroke** is defined as paralysis / weakness of half or full body including those who have recovered all of which arise from diabetes.

4.8.10 **Dialysis** is defined as treatment of kidney failure i.e. peritoneal dialysis and haemodialysis

4.8.11 **Kidney transplant** is defined as the implantation of a healthy kidney into a patient with kidney failure through surgery.

4.8.12 **Family history** is defined as self-reporting of having either parent or sibling who has diabetes confirmed by any medical personnel.

4.8.13 History of **eye examination** is defined as self-reporting of having been tested using any of these equipments, i.e. slit lamp, fundus camera, direct ophthalmoscope or indirect ophthalmoscope.

4.8.14 **Last eye examination** is defined as self-reporting of estimated time interval between date of interview and year of last eye examination.

4.8.15 **Modern treatment** is defined as medication and treatment that is provided by medical doctors or health personnel, either in public or private hospitals or clinics.

4.8.16 **Traditional treatment** is defined as medication or treatment that is other than modern treatment such as homeopathy, massage, herbal therapy, acupuncture and others.

4.8.17 **Place of treatment** is defined as self-reporting of places where they get their treatment at most times such as government hospitals/clinics, private hospitals/clinics, medicine shops, pharmacy and direct selling.

4.8.18 **Exercise** is defined as any regular repeated physical activities including sports that are performed for at least 20 minutes each session, at least three times a week.

4.8.19 **Diet control** is defined as practicing diet control or types of diet to control diabetes mellitus including reducing intake of specific types of foods.

4.8.20 **Oral medication** is defined as medicine that is taken orally such as Daonil, Diamicron, Metformin/glucophage and others.

4.8.21 **Insulin therapy** is defined as medicine that is taken through subcutaneous injection.

5. FINDINGS

5.1 National Prevalence on Diabetes Mellitus

5.1.1 General findings

In this survey, the age group surveyed were ≥18 years and above. A total of 34,539 study subjects responded to the diabetes questionnaire. Known diabetes was by self-report. A total of 31,943 who claimed that they were not diabetics, underwent finger-prick glucose tests following at least 8 hours of fasting.

The national prevalence of diabetes mellitus was 11.5% (CI: 11.2 - 12), where 7.0% (CI: 6.7 - 7.3%) were people with known diabetes and 4.5% (CI: 4.3 - 4.8) were those newly diagnosed with diabetes (Table 5.1). The national prevalence for impaired fasting glucose (IFG) was 4.2% (CI: 4.0 - 4.6).

The prevalence of diabetes in age group of 18-30 years was 2.4% of which 0.4% were known diabetes and 2.0% newly diagnosed diabetes. Impaired fasting glucose was 3.1% in this age group as compared to 4.7% in adults above 30 years age group.

Table 5.1: Status of diabetes mellitus in Malaysia 1986 - 2006

	1986 NHMS I	1996 NHMS II	2006 NHMS III	2006 NHMS III	2006 NHMS III
Age group (years)	≥35	≥30	≥18	18 - <30	≥30
Diabetes Prevalence	6.3%	8.3%	11.6%	2.4%	14.9%
Known diabetes	4.5%	6.5%	7.0%	0.4%	9.5%
Newly diagnosed	1.8%	1.8%	4.5%	2.0%	5.4%
Impaired Glucose Tolerance (IGT) / Fasting Glucose (IFG)	*4.8%	*4.3%	#4.2%	#3.1%	#4.7%

*based on IGT; #based on IFG,

@ Estimated population in 2006:
≥18 = 12,923,504
≥18 - <30 = 3,496,060
≥30 = 9,424,769

Based on this prevalence, the projected number of people of age 18 years old and above affected by diabetes in Malaysia is estimated at 1,492,665.

Compared to the NHMS II (1996) among adults of age ≥30 years old, there was an increase in the prevalence of diabetes from 8.3% to 14.9%, an increase in the prevalence of known diabetes from 6.5% to 9.5% and a 3-fold increase in the newly diagnosed diabetes from 1.8% to 5.4% (Fig 5.1).

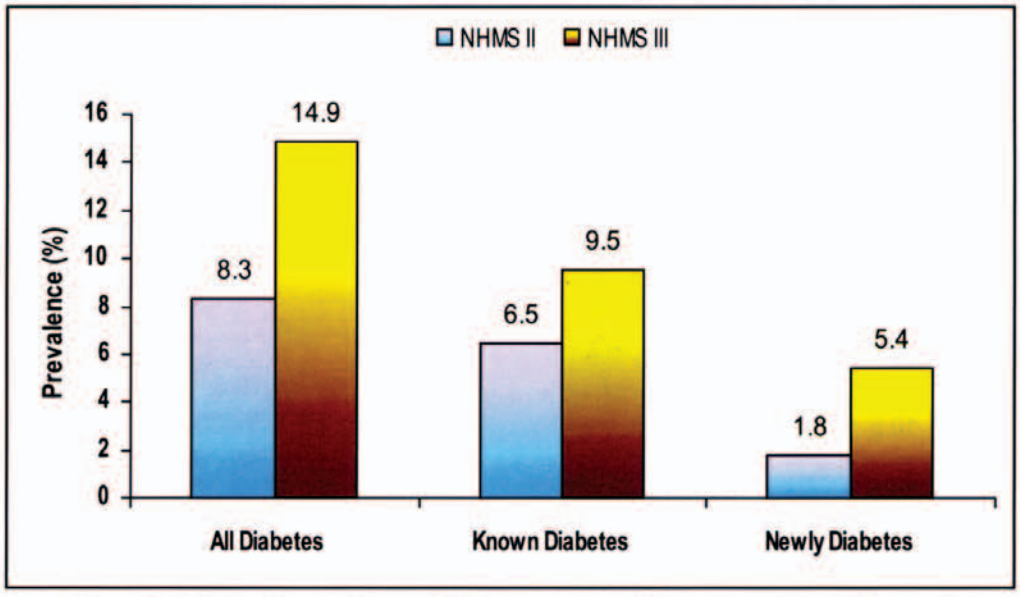


Figure 5.1: National prevalence of diabetes among Malaysian adults (≥30 years) in NHMS II (1996) and NHMS III (2006)

Diabetes prevalence also increased with age; from 2% in the 18-19 years age group to an alarming prevalence ranging between 20.8% to 26.2% among the 50-64 years age groups (Fig. 5.2).

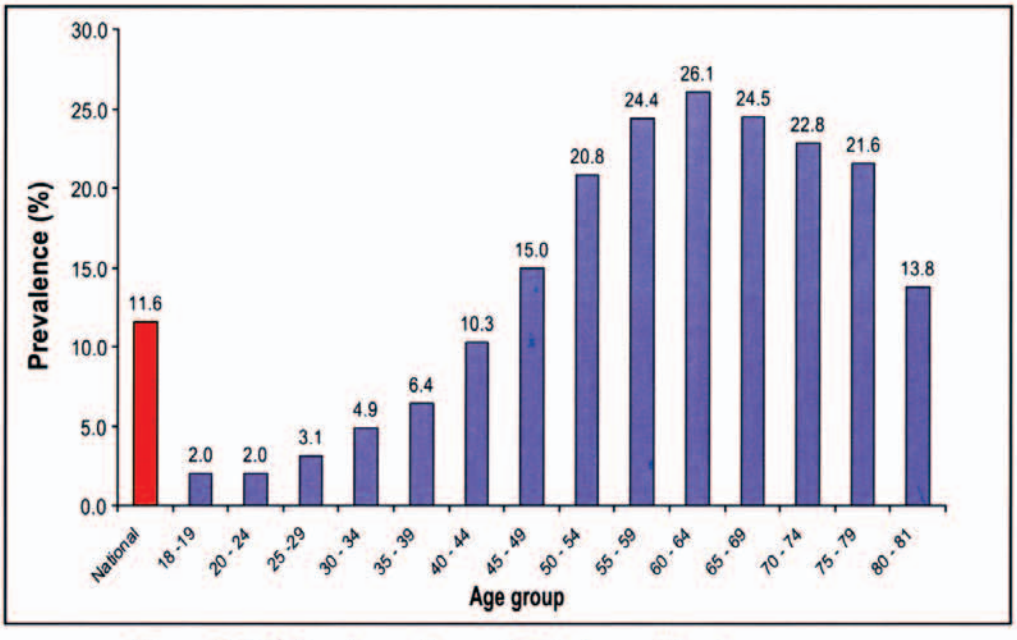


Figure 5.2: National prevalence of diabetes mellitus by age groups

The prevalence was higher in the urban [12.2% (CI: 11.6 - 12.7)] compared to the rural areas [10.6% (CI: 9.9 - 11.1)] (Figure. 5.3)

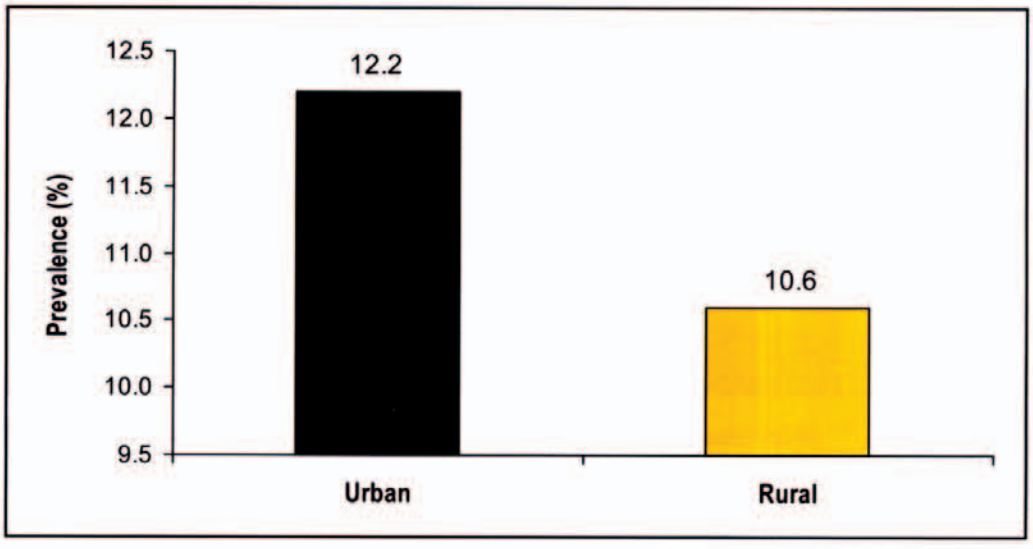


Figure 5.3: National prevalence of diabetes mellitus by residence

The three states with the highest diabetes prevalence were, Negeri Sembilan (15.3%), Malacca (15.2%) and Penang (14.9%). (Fig. 5.4).

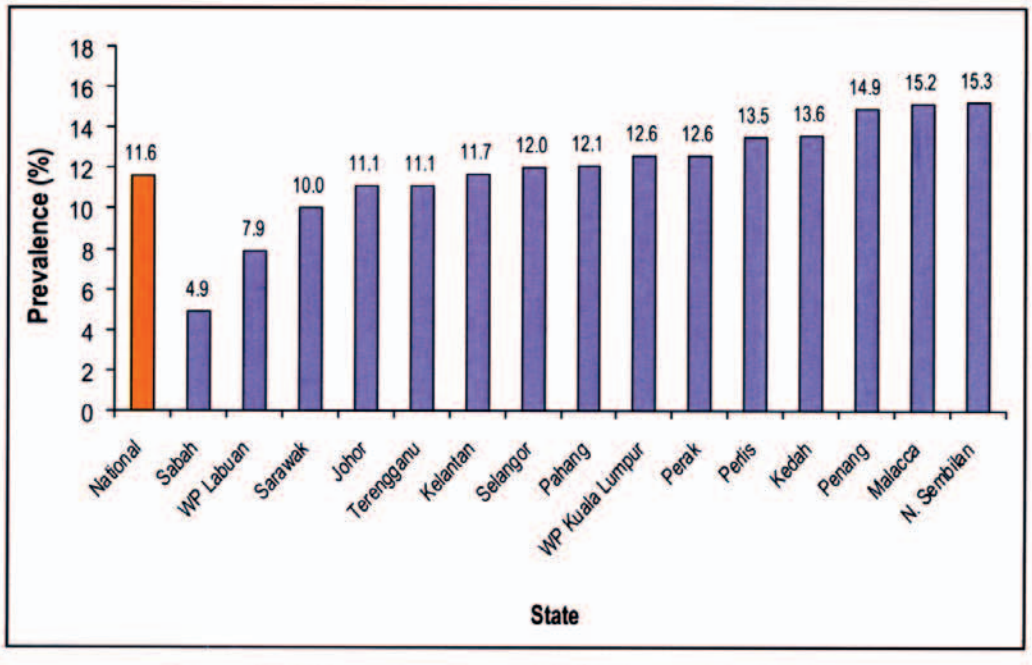


Figure 5.4: National prevalence of diabetes mellitus by states

There was no significant difference in the prevalence of diabetes observed among the males (11.9%) and female (11.3%). (Fig. 5.5). The prevalence of diabetes among the Indians (19.9%) was significantly higher than other races (Fig. 5.6).

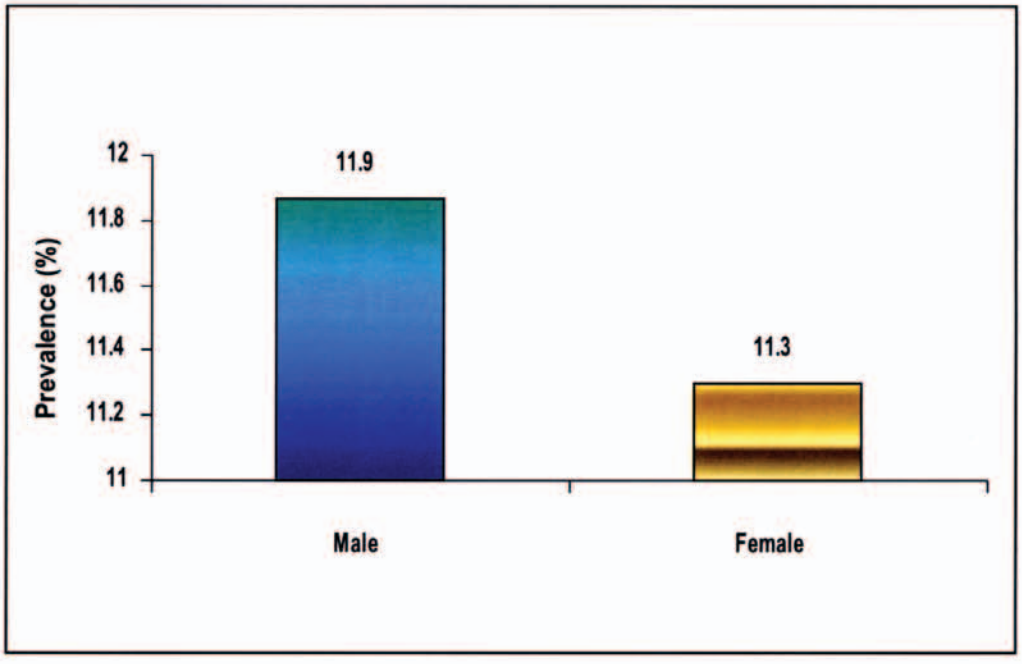


Figure 5.5: National prevalence of diabetes mellitus by sex

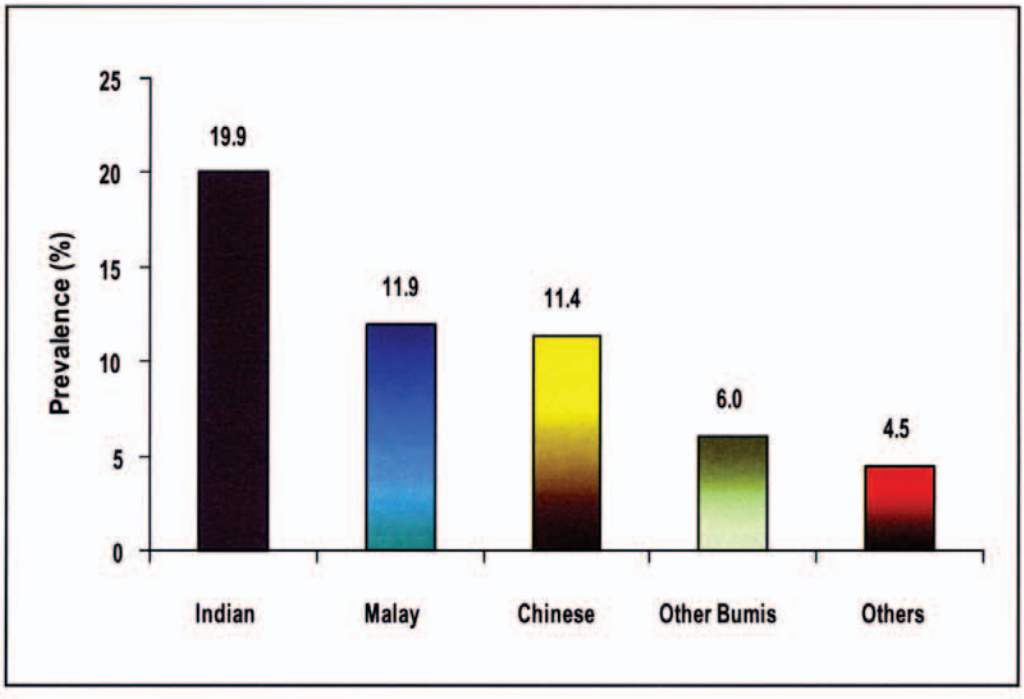


Figure 5.6: National prevalence of diabetes mellitus by race

Among the occupational groups, Senior Officials and Manager group showed highest prevalence at 15.9% (CI: 12.9 - 18.9) (Table 5.2). Housewives, and unemployed also recorded high prevalence at 14.2% and 16.1% respectively.

Table 5.2: National diabetes prevalence by job category in Malaysia

Job Category	Prevalence %	95% CI	
		Lower	Upper
Senior Officials & Managers	15.9	12.9	18.9
Professionals	10.0	8.7	11.3
Technical & Associates	12.1	10.8	13.5
Clerical Workers	8.7	7.4	10.0
Service Workers & Shops	10.7	9.8	11.5
Skilled Agricultural & Fishery	9.7	8.6	10.9
Crafts & Related Trade Workers	6.4	5.2	7.5
Machine Operators & Assemblers	11.7	10.2	13.2
Elementary Occupations	9.0	7.4	10.6
Housewives	14.2	13.3	15.0
Unemployed	16.1	14.8	17.4
Unclassified	6.7	5.4	7.9

5.2 Prevalence of Known Diabetes

5.2.1 General findings

People with known diabetes were those respondents who self-declared that they were medically diagnosed by health personnel and/or taking anti-diabetic agents. The overall prevalence of known diabetes was 7.0% (CI: 6.7 - 7.3). Highest prevalence was observed among the age group 60-64 years old [19.0% (CI: 17.0 - 20.9)] (Fig. 5.7).

The highest prevalence state was Malacca [11.4 % (CI: 8.9 - 13.8)] and the lowest prevalence state was Sabah [2.4% (CI: 1.9 - 2.9)]. (Fig. 5.8).

The prevalence of people with known diabetes was higher in the urban areas [7.4% (CI: 7.0 - 7.8)] (Fig. 5.9). Based on ethnicity, highest prevalence was amongst the Indians [14.7% (CI: 13.3 - 16.0)] (Fig. 5.10). There was no gender difference in prevalence.

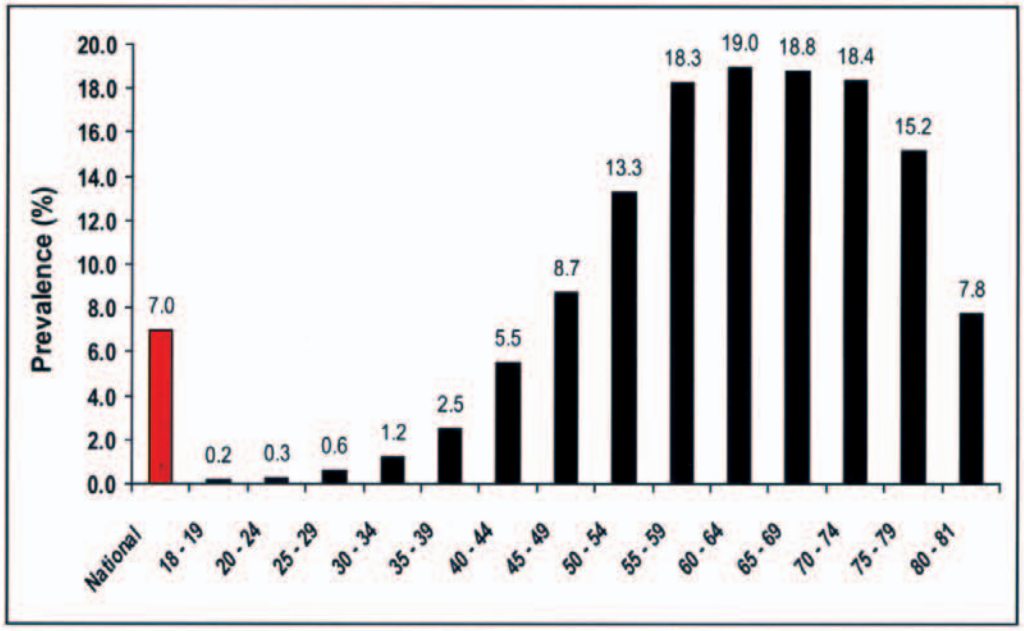


Figure 5.7: Prevalence of known diabetes by age groups

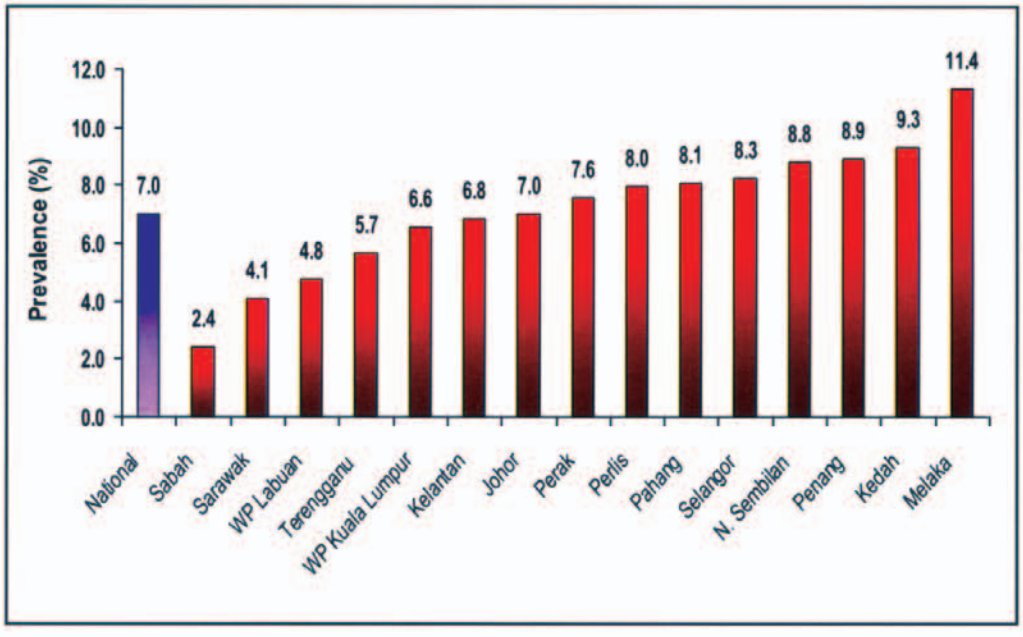


Figure 5.8: Prevalence of people with known diabetes by states

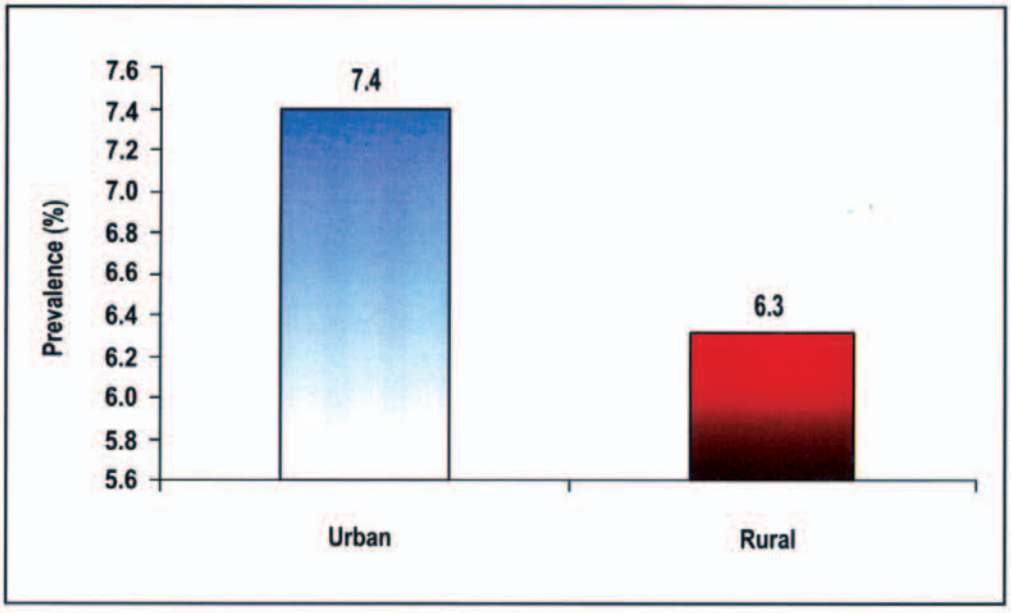


Figure 5.9: Prevalence of known diabetes by residence

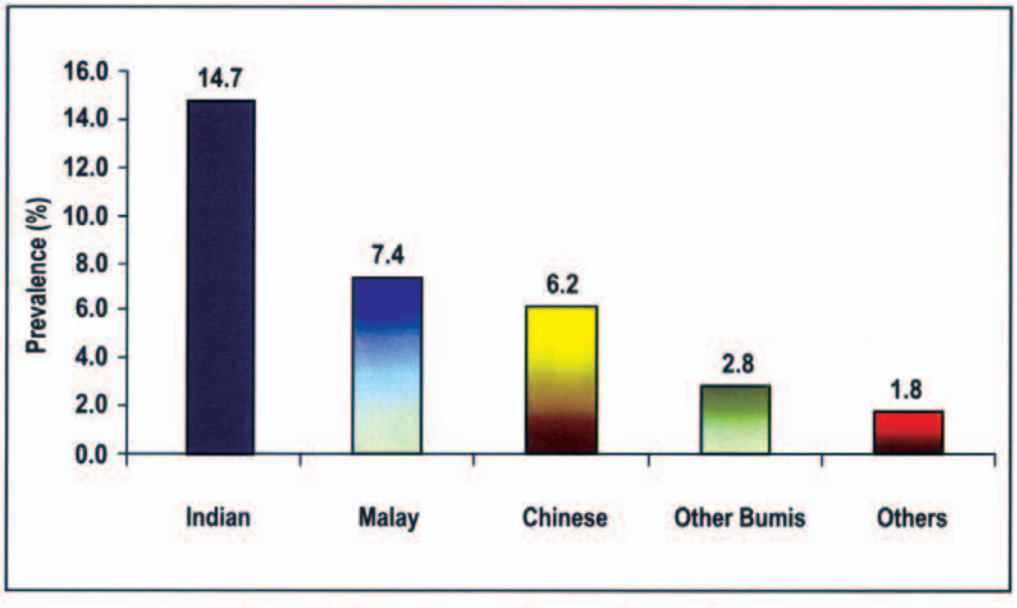


Figure 5.10: Prevalence of known diabetes by race

The prevalence of people with known diabetes was found to be highest among the unemployed [11.7% (CI: 10.5 - 12.8)], housewives [9.4% (CI: 8.7 - 10.0)], technical and associates [7.8% (CI: 6.8 - 8.9)] and senior officials and managers [7.6% (CI: 5.5 - 9.7)] (Table 5.3).

Table 5.3: Status of known diabetes by job category in Malaysia

Job Category	Prevalence %	95% CI	
		Lower	Upper
Senior Officials & Managers	7.6	5.5	9.7
Professionals	4.9	3.9	5.8
Technical & Associates	7.8	6.8	8.9
Clerical Workers	4.7	3.6	5.7
Service Workers & Shops	6.0	5.4	6.7
Skilled Agricultural & Fishery	4.8	4.0	5.7
Crafts & Related Trade Workers	2.7	2.0	3.4
Machine Operators & Assemblers	7.5	6.2	8.7
Elementary Occupations	5.1	3.9	6.3
Housewives	9.4	8.7	10.0
Unemployed	11.7	10.5	12.8
Unclassified	3.6	2.7	4.5

5.3 Prevalence of Newly Diagnosed Diabetes

5.3.1 General findings

People with newly diagnosed diabetes were those who claimed not to have diabetes but when tested, were found to have FBG level of ≥6.1mmol/L. From this survey, a total of 1551 respondents [4.5% (CI: 4.3 - 4.8)] were found to have FBG above or equal to 6.1mmol/L. Similar to that observed for people with known diabetes, the prevalence of people with newly diagnosed diabetes also increased with increasing age and was highest among the 50 to 54 years age group [7.6% (CI: 6.6 - 8.5)] (Fig.5.11).

Among the states, Negeri Sembilan [6.6% (CI: 4.9 - 8.2)] and Kuala Lumpur [6.0% (CI: 5.0 - 7.1)] recorded higher prevalence than other states such as Kelantan [4.9% (CI: 4.0 - 5.9)], Selangor [3.8% (CI: 3.2 - 4.3)] and Sabah [2.5% (CI: 2.0 - 3.0] (Fig.5.12). The prevalence in urban areas [4.7% (CI: 4.4 - 5.0)] was higher than in rural areas [4.2% (CI: 3.8 - 4.5)] which was similar to the people with known diabetes (Fig. 5.13).

Males recorded significantly higher prevalence [5.1% (CI: 4.7 - 5.4)] than females [4.1% (CI: 3.8 - 4.4)] (Fig.5.14). Interestingly, there was a higher prevalence of newly diagnosed diabetes among the Chinese [5.2% (CI: 4.6 - 5.8)] and this is comparable to the Indians [5.3% (CI: 4.4 - 6.2)] (Fig. 5.15).

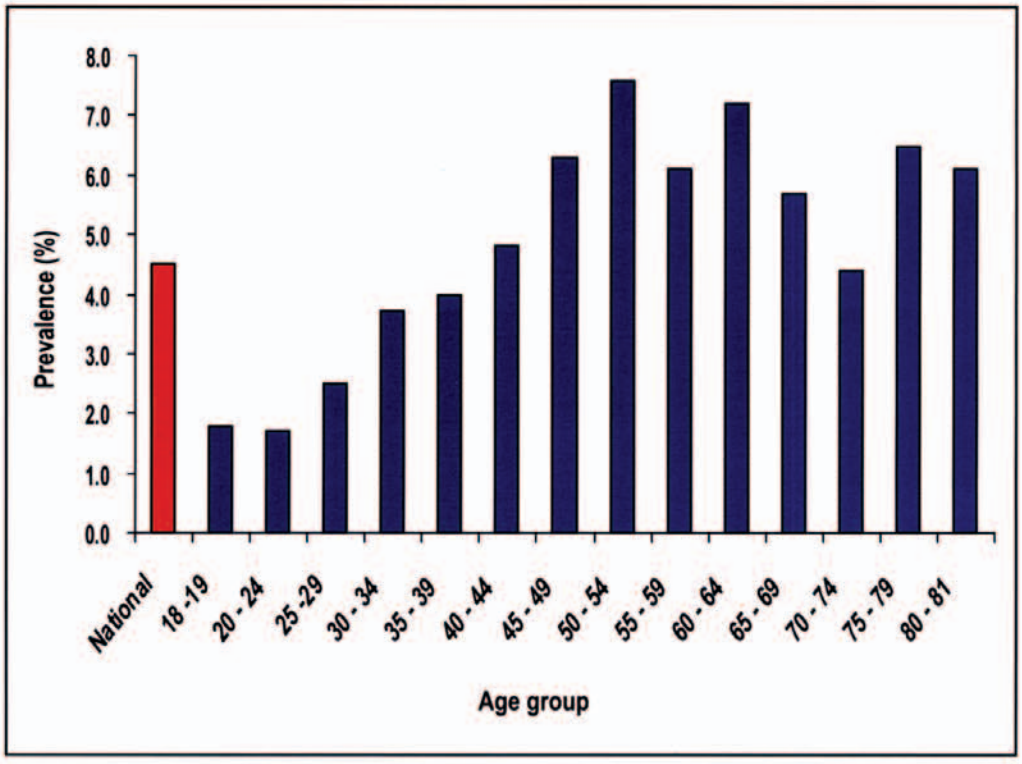


Figure 5.11: Prevalence of newly diagnosed diabetes by age groups

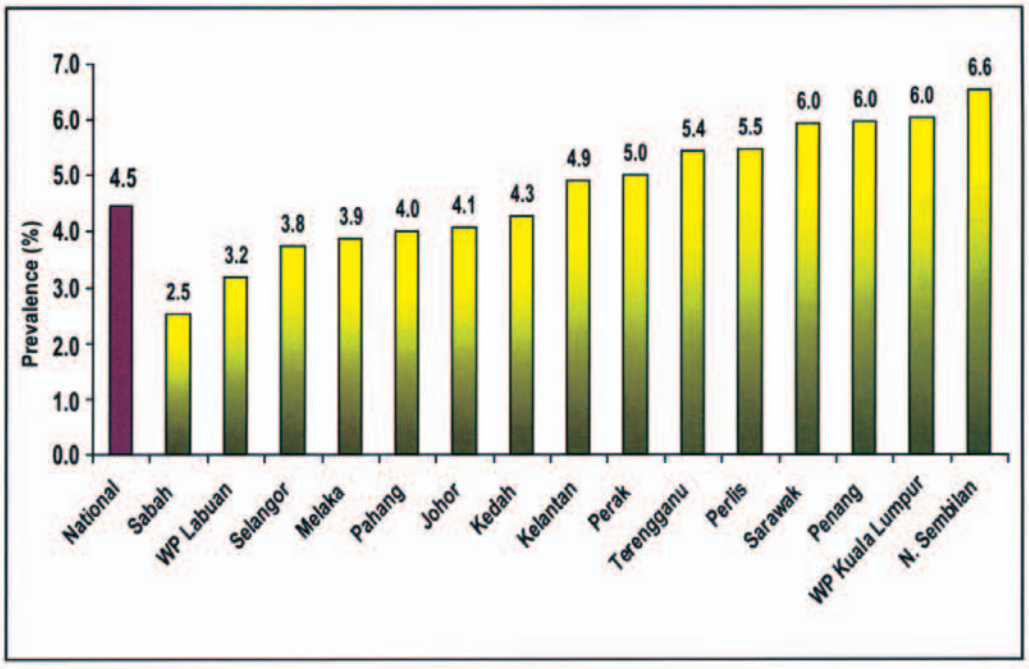


Figure 5.12: Prevalence of newly diagnosed diabetes by states

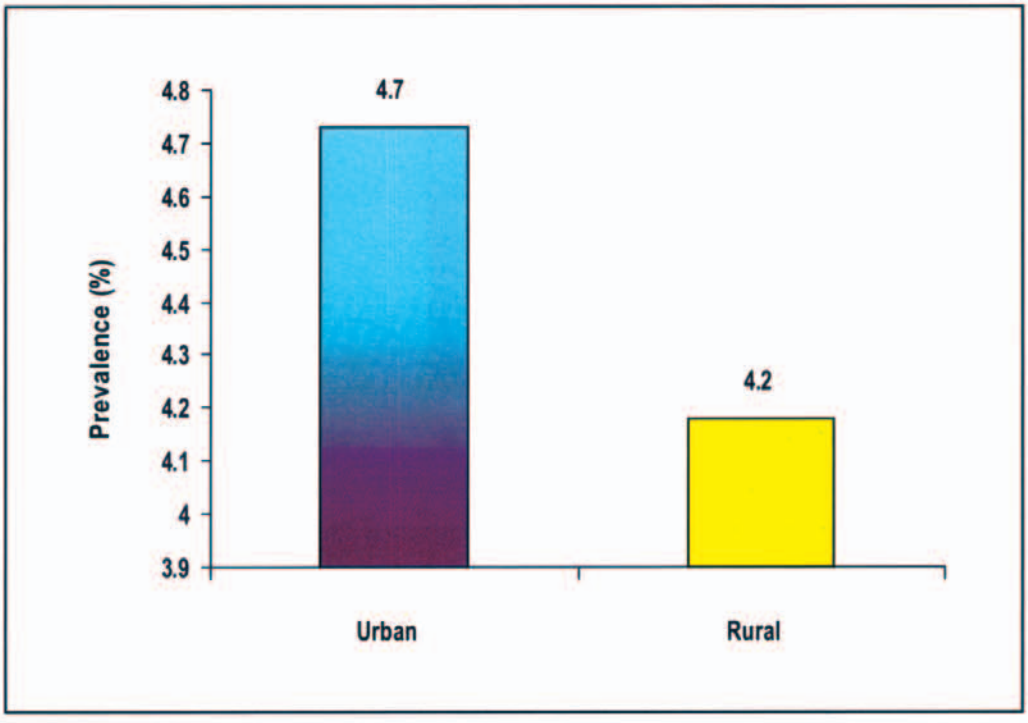


Figure 5.13: Prevalence of newly diagnosed diabetes by residence

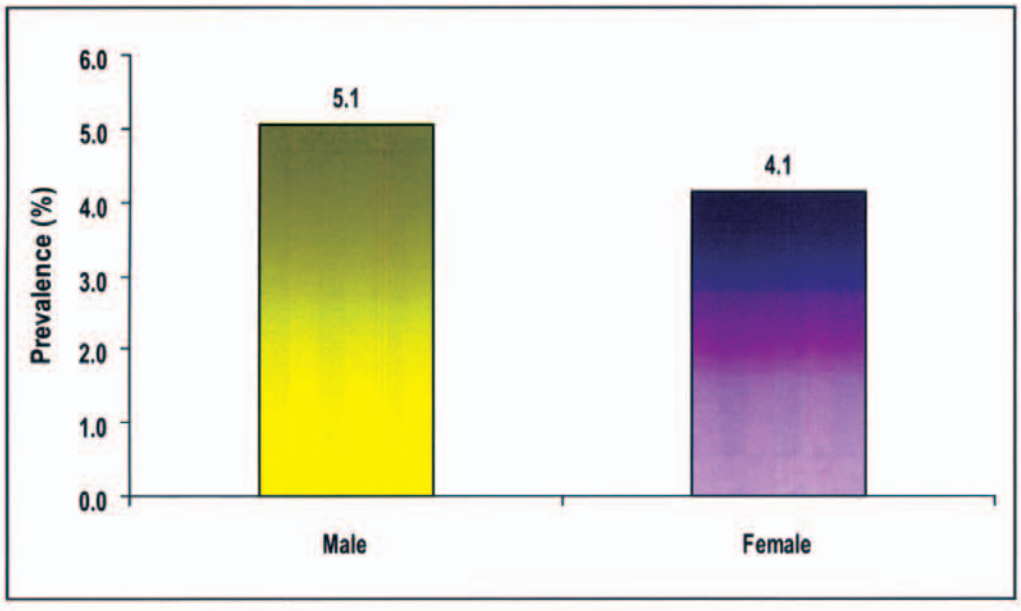


Figure 5.14: Prevalence of newly diagnosed diabetes by gender

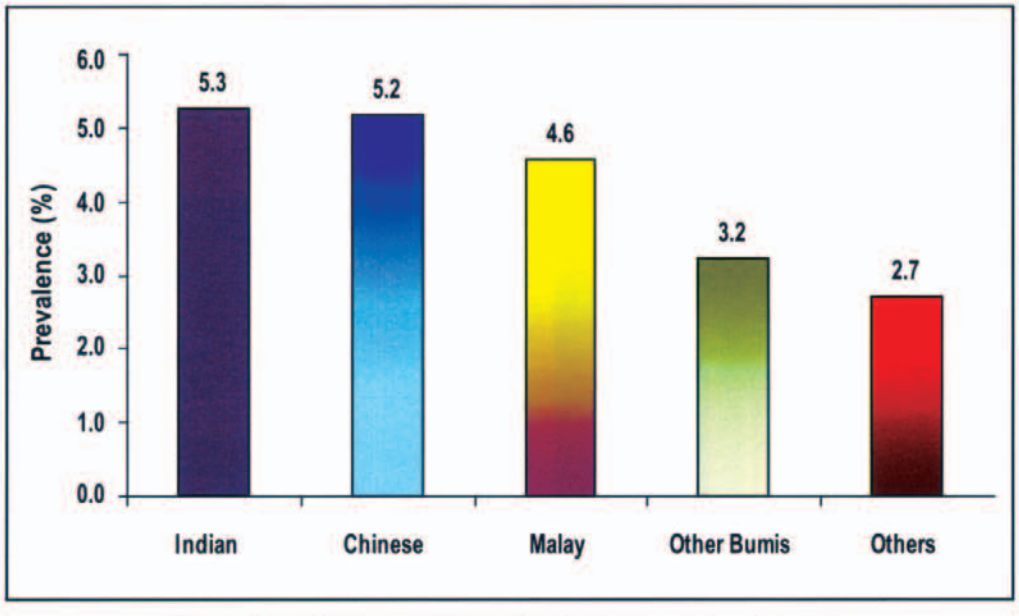


Figure 5.15: Prevalence of newly diagnosed diabetes by race

By job category, senior officials and managers [8.3%, (95% CI: 6.1 - 10.5)], and professionals [5.2%, (95% CI: 4.2 - 6.1)] again ranked highest as people with newly diagnosed diabetes (Table 5.4). In comparison, the prevalence among housewives and the unemployed groups was only 4.8% and 4.4% respectively. This was in contrast to the overall national figures, where these groups had higher prevalence, at 15.9%, 14.2% and 16.1% for the Senior Officials and Managers, the housewives, and the unemployed respectively.

Table 5.4: Status of newly diagnosed diabetes by job category in Malaysia

Job Category	Prevalence %	95% CI	
		Lower	Upper
Senior Officials & Managers	8.3	6.1	10.5
Professionals	5.2	4.2	6.1
Technical & Associates	4.3	3.4	5.1
Clerical Workers	4.0	3.1	4.9
Service Workers & Shops	4.7	4.1	5.2
Skilled Agricultural & Fishery	5.0	4.1	5.8
Crafts & Related Trade Workers	3.7	2.8	4.6
Machine Operators & Assemblers	4.3	3.3	5.2
Elementary Occupations	3.9	2.9	4.9
Housewives	4.8	4.3	5.3
Unemployed	4.4	3.7	5.2
Unclassified	3.1	2.3	3.9

5.4 Prevalence of Impaired Fasting Glucose

5.4.1 General findings

People with IFG were those who claimed not to have diabetes but when tested, had glucose level between 5.6 - 6.1mmol/L. The national prevalence of IFG among Malaysian population was 4.2% (CI: 4.0 - 4.5), with high prevalence in the states of Kuala Lumpur [6.1% (CI: 4.8 - 7.5)], Pulau Pinang [6.1% (CI: 5.0 - 7.1)] and Perak [5.0% (CI: 4.0 - 6.0)] (Fig. 5.16). There was no difference in the prevalence of IFG with age groups.

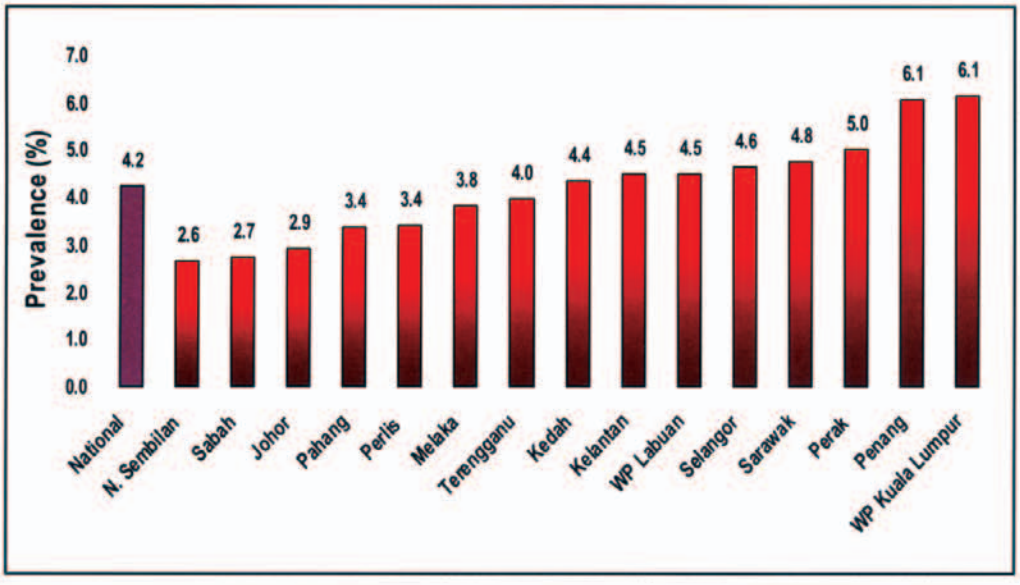


Figure 5.16: Prevalence of impaired fasting glucose (IFG) by states

Prevalence of IFG was significantly higher among the urbanites [4.5% (CI: 4.2 - 4.9)] than rural [3.8% (CI: 3.4 - 4.1)] (Fig. 5.17) and in the males [5.2% (CI: 4.8 - 5.6)] compared to the females [3.5% (CI: 3.2 - 3.8)] (Fig. 5.18).

By ethnicity the Chinese [5.1% (CI: 4.5 - 5.7)] and the Indians [5.2% (CI: 4.3 - 6.1)] showed significantly higher prevalence of IFG than the Malays [4.0% (CI: 3.6 - 4.3)] (Fig. 5.19) and again, highest prevalence was observed among the Senior Officials and Managers [6.1% (CI: 4.2 - 8.0)] and the Professionals [5.3% (CI: 4.3 - 6.2)] (Table 5.5).

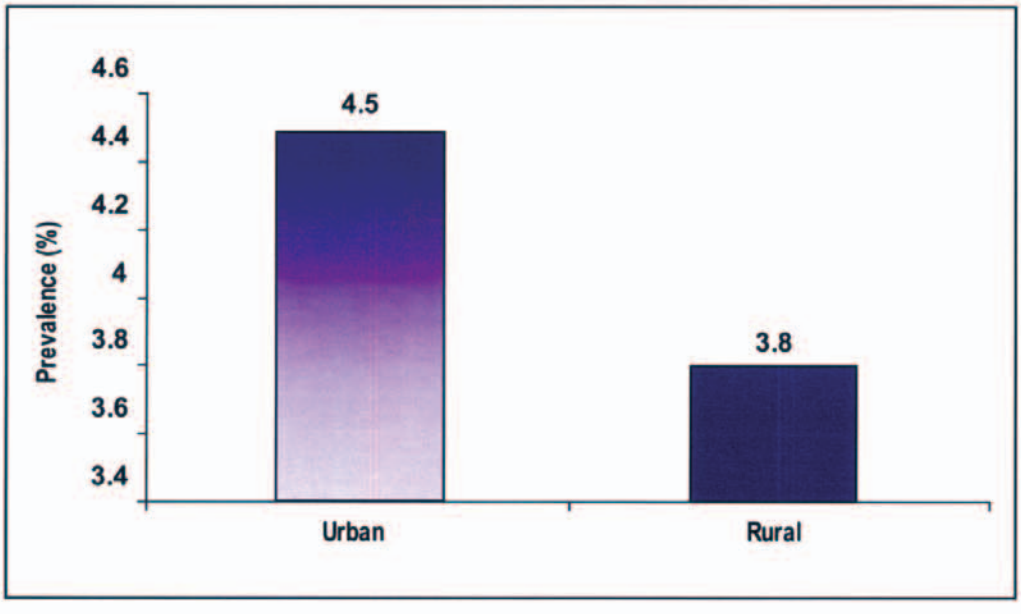


Figure 5.17: Prevalence of impaired fasting glucose by residence

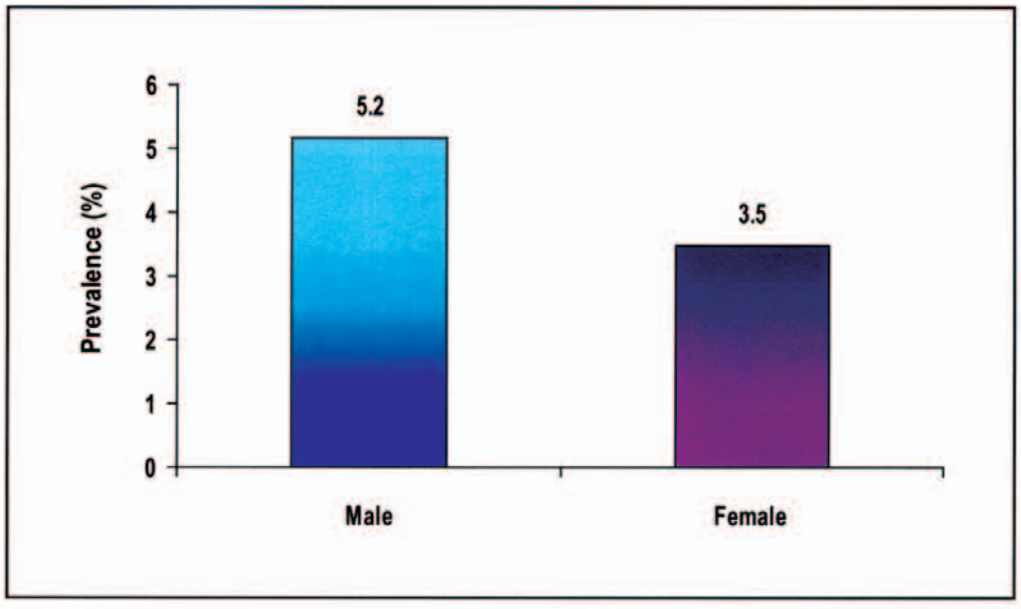


Figure 5.18: Prevalence of impaired fasting glucose by gender

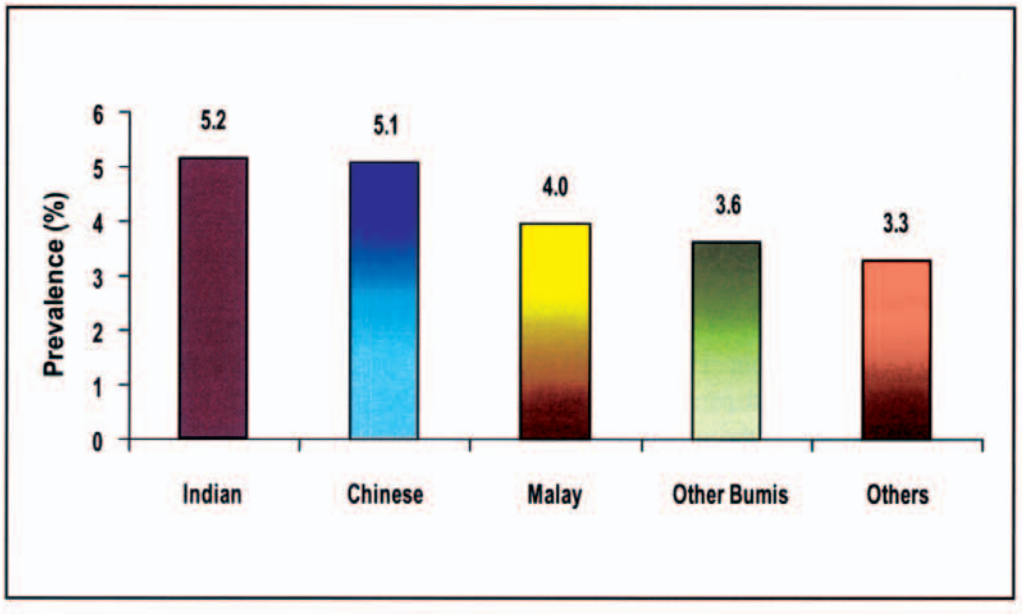


Figure 5.19: Prevalence of impaired fasting glucose by race

Table 5.5: Status of IFG by job category in Malaysia

Job Category	Prevalence %	95% CI	
		Lower	Upper
Senior Officials & Managers	6.1	4.2	8.0
Professionals	5.3	4.3	6.2
Technical & Associates	4.8	4.0	5.7
Clerical Workers	5.3	4.2	6.3
Service Workers & Shops	4.9	4.3	5.6
Skilled Agricultural & Fishery	3.6	2.9	4.4
Crafts & Related Trade Workers	3.5	2.6	4.3
Machine Operators & Assemblers	4.6	3.6	5.6
Elementary Occupations	3.8	2.8	4.8
Housewives	3.8	3.3	4.2
Unemployed	3.6	2.9	4.2
Unclassified	3.2	2.4	4.1

5.5 Treatment Status of Known Diabetes

5.5.1 General findings

This survey revealed that out of the 2180 [91.8% (CI: 90.5 - 92.9)] people with known diabetes who claimed to have taken medications for diabetes, only 2030 [85.8% (CI: 84.2 - 87.2)] were still taking medications at the time of the survey.

5.5.2 Medication

Among people with known diabetes, only 84.2% were found to be on modern medications; 77.1% were on oral, 3.1% on insulin alone and 4.1% were treated with both oral and insulin (Table 5.6). Of the people with known diabetes 76.2% sought treatment from government facilities, 20.7% from private facilities, 2.6% on self-treatment and 0.1% chose not to seek treatment.

Compared to the Chinese and Indians, the Malays (81.9%) and other indigenous groups (82.5%) were found to be the lowest among those who were on modern treatment. There was no gender difference but higher percentage of the urbanites (78.0%) was on modern treatment compared to those living in the rural areas (75.1%).

The percentage of people with known diabetes who chose traditional or alternative methods either alone or along with modern medication for treating their disease was only 0.6%.

Table 5.6: Treatment status of known diabetes

	Modern Treatment (%)				Traditional/ Alternative alone or along with modern treatment (%)
	Oral Medication Only	Insulin Only	Oral and Insulin	Overall	
National	77.1	3.1	4.1	84.3	0.6
Malay	75.1	2.6	4.2	81.9	0.9
Chinese	83.9	1.9	2.8	88.6	0.2
Indians	78.0	5.0	5.8	88.8	(no obs) *
Other indigenous	74.1	6.6	1.8	82.5	(no obs) *
Others	66.2	2.6	(no obs) *	68.8	(no obs) *
Male	76.4	3.4	3.7	83.5	1.1
Female	77.6	2.9	4.4	84.7	0.1
Urban	78.0	3.0	4.3	85.3	0.3
Rural	75.1	3.3	3.6	82.0	1.1

* no observation

5.5.3 Place of treatment

Educational status, occupation and household income had no influence on the percentage of people receiving modern medication. A greater percentage of the lower income groups (below RM2000) sought treatment from government facilities, whilst the higher income chose the private facilities (Fig. 5.20). However, even in these higher income groups, close to 60% still used government facilities.

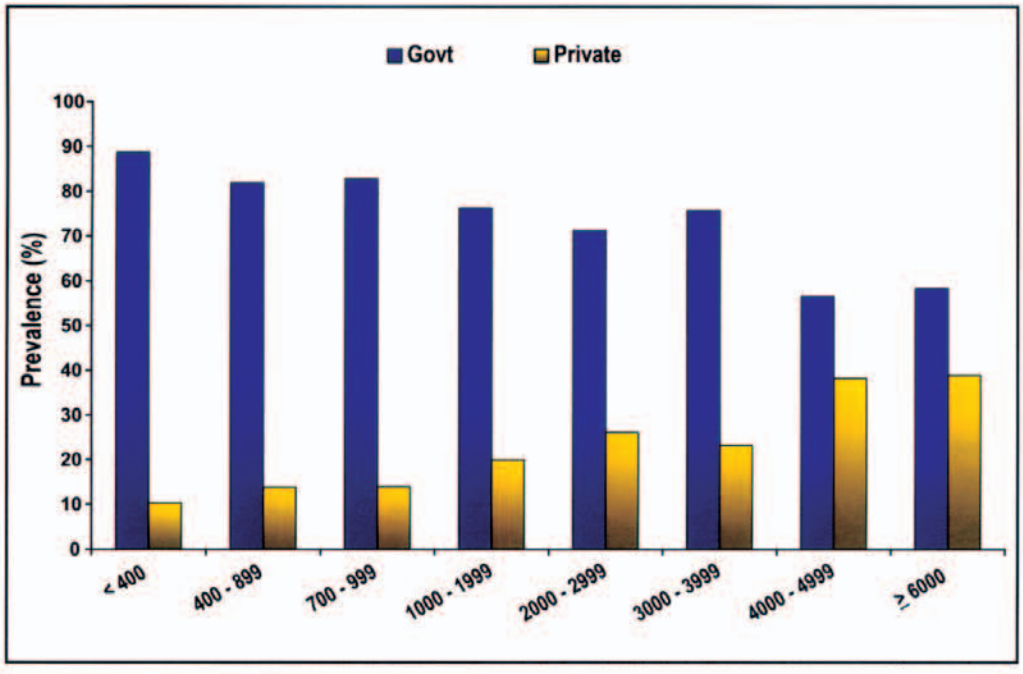


Figure 5.20: Place of treatment by household income (RM)

Comparing the usage of government versus private facilities, the overall utilization of government to private services was 73.5% versus 20.3%. As expected, higher utilization of government facilities was by those living in the rural areas (79.1%) compared to the urbanites (70.8%).

Private facilities were used mostly by the Chinese (32.1%) followed by the Indians (19.9%) and Malays (17.2%).

The percentages of people with known diabetes who sought and obtained their medications from alternative or traditional, medicinal shop and direct selling were 0.6%, 2.0% and 0.3% respectively (Table 5.7). Whilst the percentage of those using alternative or traditional method remained below 1.0%, a percentage of them reported to purchase their medications from medicinal shops; 3.5% among Chinese, 2.0% among Malays and 1.0% among the Indians.

Table 5.7: Place of treatment of known diabetes

	PLACE OF TREATMENT (%)				
	GOVERNMENT	PRIVATE	OTHERS		
			Alternative/ Traditional	Medicinal Shop	Direct selling
National	73.5	20.3	0.6	2.0	0.3
Malay	75.7	17.2	0.9	2.0	(no obs) *
Chinese	62.1	32.1	0.2	3.5	(no obs) *
Indians	76.3	19.9	(no obs) *	1.0	(no obs) *
Other indigenous	88.4	8.7	(no obs) *	(no obs) *	(no obs) *
Others	49.9	34.9	(no obs) *	4.1	0.3
Male	68.5	23.6	1.1	2.3	0.3
Female	77.3	17.8	0.1	1.8	0.1
Urban	70.8	23.6	0.3	1.8	0.2
Rural	79.1	13.5	1.1	2.5	(no obs) *

* - no observation

5.5.4 Complications

Among the 2374 people with known diabetes, 4.3% reported to have lower limb amputations, 3.4% had strokes and 1.6% were on dialysis or had kidney transplants due to diabetes (Table 5.8). The lower limb amputations were 4.1% (180) in the Malays, 4.5% (120) in the Chinese and 4.6 % (49) in the Indians. The percentage of strokes was highest in the Chinese (5.5%), nearly twice of that in the Malays (2.9%). For dialysis or kidney transplants, the Chinese and Indians reported almost double the percentage seen amongst the Malays.

Table 5.8: Occurrence of complication among known diabetes

		COMPLICATIONS (%)		
	n	Lower limb amputations	Strokes	Dialysis / Kidney transplants
National	394	4.3	3.4	1.6
Malay	180	4.1	2.9	1.2
Chinese	120	4.5	5.5	2.3
Indians	49	4.6	3.1	2.4
Other Indigenous	40	7.6	2.6	0.8
Others	5	(no obs) *	(no obs) *	(no obs) *

* no observation

5.5.5 Eye examination

Among the known diabetics surveyed, [45.0% (CI: 43.0 - 47.2)] reported that they had eye examinations. The percentage was lowest among those younger than 30 years at [17.5% (CI: 8.0 - 34.2)]. There was no significant gender and ethnic difference in the percentage of eye examination (Table 5.9).

Of those diabetic patients who had eye examinations, 32.9% reported that their last eye examination was within last one year, 49.7% had it done in the last one to 2 years and 17.4% had it done more than 2 years ago. The pattern of distribution for duration of last eye examination was similar in all age groups, ethnicity and gender. Despite clinical practice guidelines which recommend annual eye examination, only one third of the people with known diabetes were examined as scheduled. Most of the known diabetes have it done within the last 2 years, and 17.4% had it done more than 2 years ago. (Table 5.9).

Table 5.9: Sociodemographic by age group of known diabetes

	N with known diabetes	Eye exam (Prevalence, 95%CI)	Last Eye Exam (years)		
			<1	1-2	>2
All Ages	906,502	45.0 (CI: 43.0 - 47.2)	32.9 (CI: 29.9 - 36.0)	49.7 (CI: 46.5 - 52.9)	17.4 (CI: 15.2 - 19.9)
By age group					
18-29	13,287	17.5 (CI: 8.0 - 34.2)	13.1 (CI: 1.7 - 56.6)	51.4 (CI: 17.2 - 84.3)	35.5 (CI: 8.9 - 75.6)
30-39	49,259	31.1(CI: 23.5 - 39.9)	32.1(CI: 19.3 - 48.3)	58.0 (CI: 41.9 - 72.6)	9.9 (CI: 3.7 - 23.9)
40-49	195,632	40.2 (CI: 36.0 - 44.5)	37.4 (CI: 30.7 - 44.6)	50.6 (CI: 43.5 - 57.7)	12.0 (CI: 8.1 - 17.3)
50-59	327,867	45.7(CI: 42.3 - 49.1)	31.7(CI: 26.9 - 37.0)	50.3 (CI: 44.9 - 55.7)	18.0 (CI: 14.3 - 22.5)
60-69	218,299	50.6 (CI: 46.5 - 54.6)	31.3 (CI: 26.0 - 37.2)	50.6 (CI: 44.6 - 56.6)	18.0 (CI: 13.9 - 23.1)
>=70	102,158	50.7(CI: 44.6 - 56.8)	33.9(CI: 25.8 - 43.1)	41.6 (CI: 33.2 - 50.5)	24.5 (CI: 17.7 - 32.9)
Gender					
Men	393,342	46.9 (CI: 43.8 - 50.0)	32.0 (CI: 27.7 - 36.5)	50.7 (CI: 46.0 - 55.3)	17.4 (CI: 14.2 - 21.2)
Women	513,161	43.6 (CI: 40.9 - 46.4)	33.7 (CI: 29.8 - 37.9)	48.9 (CI: 44.6 - 53.2)	17.4 (CI: 14.5 - 20.8)
Ethnicity					
Malay	516,811	45.0 (CI: 42.3 - 47.8)	32.0 (CI: 28.2 - 36.1)	49.6 (CI: 45.4 - 53.7)	18.4 (CI: 15.4 - 21.9)
Chinese	175,099	42.6 (CI: 38.0 - 47.2)	36.6 (CI: 29.7 - 44.2)	49.2 (CI: 41.7 - 56.7)	14.2 (CI: 9.8 - 19.9)
Indian	166,342	46.3 (CI: 41.3 - 51.4)	30.9 (CI: 24.3 - 38.5)	51.9 (CI: 44.6 - 59.1)	17.1 (CI: 12.2 - 23.5)
Indigenous	37,173	51.2 (CI: 41.3 - 61.0)	38.0 (CI: 25.5 - 52.3)	41.7 (CI: 28.2 - 56.6)	20.3 (CI: 11.6 - 33.3)
Others	11,077	45.0 (CI: 28.3 - 62.9)	30.3 (CI: 11.8 - 58.5)	58.2 (CI: 32.1 - 80.4)	11.5 (CI: 2.8 - 37.0)

Among known diabetes, those treated at government healthcare facilities had significantly higher percentage of eye examinations compared to those treated at private healthcare facilities [40.3% (CI: 37.5% - 45.0%)]. The lowest percentages of eye examination were among those who self medicated or do not seek treatment (74.7% and 79.0% respectively). The difference was significant. (Table 5.10).

Table 5.10: Percentage of known diabetes who had eye examination by place of treatment

Place of treatment	Percentage of known diabetes who had eye examination (95%CI)
Government health care facilities	50.6 (CI: 48.1 - 51.9)
Private health care facilities	40.3 (CI: 35.7 - 45.0)
Self medication	25.3 (CI: 16.0 - 37.7)
Do not seek treatment	21.0 (CI: 12.6 - 32.7)
Others	48.3 (CI: 19.9 - 77.8)

6. DISCUSSION

This study revealed an overall prevalence of diabetes (known and newly diagnosed) among 18 years old and above in 2006 in Malaysia was 11.6%. However, the prevalence of diabetes for over 30 years was 14.6%. The diagnosis of newly diagnosed diabetes in NHMS II was based on 2 hours post glucose while NHMS III was based on fasting glucose. As shown in the NHANES II study (Harris et al. 1987), about 75% of subjects with diagnostic 2h post-glucose (2hPG) levels of ≥11.1mmol/L had fasting glucose values below the level defined as diagnostic by the WHO (7.8mmol/L). Similarly, using ADA criteria, between 32 to 72% of the population who were previously not diagnosed to be diabetic based on fasting plasma glucose of <7.0mmol/L had 2hPG glucose of ≥11.1mmol/L (Barrett-Connor & Ferrara 1998; Shaw et al. 1999; The DECODE Study Group 1999). Hence the prevalence of newly diagnosed diabetes would be higher if 2 hours post prandial levels were used.

The definition of diabetes by WHO was changed in 1999 i.e. the threshold for fasting plasma glucose was reduced from 7.8mmol/L to 7.0mmol/L, This would have contributed to the higher rate of known diabetes reported in this present study. Similar increase in rates was shown by Unwin et al. (1998) who reported the effect of changing from a definition of diabetes based on previous WHO criteria to the new ADA criteria was an increase in the prevalence of diabetes from 4.8% to 7.1% in Caucasians, from 4.7% to 6.2% in people of Chinese origin and from 20.1% to 21.4% in people of South Asian origin.

In addition, the age group studied in NHMS II was 30 years and above while in NHMS III, it was 18 years and above. This would have a lowering effect of the total prevalence rate.

Nevertheless the rise in prevalence was alarming in spite of taking into account the above mentioned differences in methodology and definitions. Prevalence of known and newly diagnosed diabetes among adults above 30 years old had risen from 8.3% in NHMS II to 14.9% in NHMS III. This represented an 80.0% rise in prevalence or 8% per year. This rate of increase is much higher than that reported recently by Centers for Disease Control and Prevention (CDC, USA) which showed that the prevalence of diabetes rose 5% annually since 1990. The CDC report linked the

increase to the rise of obesity in the U.S. population which began to go up at a more rapid rate in 1986, four years prior to the time when diabetes began to increase significantly (Amos et al. 1997). As a nation, our prevalence rate in 2006 is already similar to the estimate for 2025 by IDF. Malaysia's prevalence is above average when compared to the estimate for all regions in the world by IDF (IDF 2003).

For the same age group, the prevalence of known diabetes was 5.7% and 9.5% in NHMS II and NHMS III respectively; a rise of 66% over 10 years i.e. 6.6% per year. Among newly diagnosed diabetes, the prevalence had increased from 2.5% in NHMS II to 5.5% in NHMS III, a rise of 12% per year. The Ministry of Health had consistently organised annual healthy life style campaigns with emphasis on screening. Hence it would have been expected for the undiagnosed diabetes rate to be lower but the reverse occurred. Accessibility to screening maybe an issue as our primary health centres are already crowded daily. Another possible factor is gain in knowledge but not resulting in behaviour change. People may know and understand the importance of screening and there are many clinics; both public and private where it can be done but not actually taking the effort. This group of undiagnosed diabetes may present later with complications thereby increasing premature morbidity and mortality. There is a worldwide emphasis on early screening especially in those with increased waist circumference and other features of metabolic syndrome. How this will influence our percentage of undiagnosed diabetes will only be known in the future.

Impaired fasting glucose (IFG) was defined as whole blood capillary glucose level between 5.6 and less than 6.1mmol/L. In this survey, the national prevalence of IFG amongst Malaysians of $\geq$18 years old was found to be 4.2%. Both IFG and IGT are known to predict subsequent diabetes. In a recent prospective study of the 5-year cumulative incidence of diabetes in the Pima Indians, it was shown that IFG had a similar positive predictive value as IGT for predicting subsequent diabetes but this may not be true for all populations. People with IGT have been shown to have a risk of developing diabetes of 4.3% per year among ethnic Chinese in Singapore (Wong et al. 2003), 8.8% per year in Taiwan (Chou et al. 1998) and 11.2% per year in China (Pan et al. 1997). However there is significant ethnic difference in the prevalence of IGT and IFG. IGT was reported to be more common than IFG in Mauritius (36% vs. 19%) (Shaw et al. 1999), in the USA (39% vs. 25%) (Harris et al. 1998), and in Canarian population (17.1% vs. 8.8%) (de Pablos-Velasco et al. 2001). Whether there is such a difference in Malaysian population needs further study.

This was the first time NHMS was conducted in the age group of above 18 years and less than 30 years old. Alarmingly, the prevalence was 2.4%, out of which people with newly diagnosed diabetes was 2.0%. Impaired fasting glucose was also high at 3.1%. People in this age would consider themselves to be free of disease. They would not normally undergo screening for chronic diseases and that would explain the relatively high percentage of newly diagnosed diabetes. This high prevalence of diabetes and IFG does not augur well for the future health status of our nation.

Indians continued to lead with a prevalence rate of 19.9% which was almost double that of other major races. Other studies have also shown this inherent risk in Indians. (Ramachandran et al. 2001; Amos et al. 1997). Interestingly, among the newly diagnosed diabetes and IFG, the difference in the prevalence rates among the races was relatively small. The likely explanation for this is the postulation that there is a difference in the relative proportion of IGT to IFG in separate ethnic groups. Indians formed the biggest category to use insulin. Those needing insulin would have had

a longer duration of diabetes and also relatively less insulin reserve. IGT and IFG may represent distinct phenotypic pathways (insulin deficiency versus insulin resistence) to the development of type 2 diabetes. (Meigs et al. 2003) Hence Indians may have a different phenotypic pathway compared to the other races. Thus the reason for the IFG and newly diagnosed diabetes rates to be relatively smaller in comparison to the overall prevalence of diabetes among Indians maybe due to the fact that in this study the fasting values were used instead of post prandial.

The urban-rural prevalence ratio was 12.1:10.6. This was to be expected as the lifestyle of urban folks tend to be minimal expenditure of energy and rich in total calorie value of their diet. In terms of occupation; Senior Officials & Managers had a much higher prevalence than those in the Crafts & Related Trade. The reasons for this difference are probably similar to the reasons for the above urban-rural difference. In the sub group analysis among patients with known diabetes the biggest category was 'Unemployed'. This raises a concern whether the disease and its complications make a person unproductive.

There was a striking difference in the prevalence rate between the states with the lowest (Sabah, 2.4%) and highest (Melaka, 11.4%) prevalence. This finding needs to be investigated further taking into account the prevalence of obesity, age structure of population, urban-rural ratio and ethnic composition of these states.

Males (11.9%) had a slightly higher prevalence than females (11.3%). This is in keeping with the general trend globally (Wild 2004).

With regards to treatment, majority (73.5%) of patients went to government healthcare facilities. As expected the higher income group in general and the Chinese as a race formed the biggest subpopulation that obtained treatment form the private sector. However it needs to be highlighted that even among them the majority still depended on public facilities. Chronic diseases incur large expenses over the long run. Hence it would be logical to seek help in the Government facilities.

Majority of the patients were on oral medication (77%) and only a small percentage on insulin alone or in combination (7.2%). It is a fact that most patients would eventually need insulin to reach the glycaemic target. In comparison, in the STENO 2 trial among Type 2 patients of mean age 55.1 years, where the target HbA1c was below 6.5%, 48.3% of the patients were on insulin towards the end of the study. (Goede et al. 2003) The relatively low insulin in use reflects the continued unhealthy collusion between patients and their doctors to prolong a failing treatment regimen.

Surprisingly, only 0.6% of the population reported that they took traditional medicine for diabetes. We suspect that there must have been gross underreporting. It was not surprising to note that Chinese formed the largest group to use medicinal shops even though the overall use was low (2.0%).

Amputees formed 4.3% of the patients with known diabetes. Lower limb amputations confer much morbidity and mortality. We believe amputation rate among patients with diabetes is a good reflection of the overall state of health care services.

Less than half of known diabetic patients (45.0%) ever had any eye examination in this survey. It is also disturbing to note that only one third of known diabetic's had last eye examination within one year. This is clearly unsatisfactory as CPG on management of diabetic retinopathy recommends eye examination at diagnosis and then yearly for Type 2 Diabetes. The non compliance was equally present in the rural as well as in urban health centers. The percentage of eye examination is significantly lower for those treated at private healthcare facilities as compared to those treated at government healthcare facilities. The low proportion among known diabetics who ever had eye examination could be due to lack of patients' awareness or lack of eye screening services which may be due to inadequate skills, insufficient time for fundus examination or lack of instrumentation.

Chinese had the highest stroke prevalence rate at 5.5%. This is similar to other studies that showed relatively higher prevalence of cerebrovascular complications among the Chinese compared to the westerners (Kay et al. 1992).

Malays reported lower dialysis and kidney transplant rates. Accessibility to dialysis centers may be an issue here as Malays have a higher rural population.

7. CONCLUSION

Diabetes Mellitus prevalence rate in Malaysia has risen much faster than expected. Food rich in carbohydrates and fat is a characteristic feature of the Malaysian diet. Coupled with modernization where less expenditure of energy is needed, the rise in prevalence is not unexpected. In the overall management of chronic diseases, it is most effective to put limited resources in primary prevention interventions. Mere public forums and television advertisements of healthy lifestyle would not stem the tide as shown in the last ten years. Having knowledge does not always translate to behavior change. All stake holders have a responsibility to overcome this problem. Though there are drugs available now to prevent or rather delay the onset of diabetes, it has been consistently been shown that lifestyle measures are the most effective intervention.

This study did highlight the high percentage of undiagnosed diabetes in particular among the younger age group. It further pin points there maybe a problem in just using the fasting glucose for screening as shown by the low pick up rate among the Indians.

There is a huge difference in the prevalence of diabetes between the states with the highest (Negeri Sembilan 15.9%) and lowest prevalence rate (Sabah 4.9%).

The provision of care was below expectations in terms of low insulin use, low fundus examination and high amputation rates. Any significant intervention to correct this needs to be in the public sector. This is because the major responsibility in provision of care for diabetes lies with the public sector even though the majority of the registered doctors are in the private sector. The National Health Insurance, if implemented, may correct this imbalance to some degree.

8. RECOMMENDATIONS

A National Programme on 'Staying Healthy Together' with involvement of multiple stakeholders (multiple ministries, local councils and NGOs') with the purpose of enhancing or inducing change of public behaviour. Innovative solutions like widespread covered walk ways, bicycle lanes, better public transport (Healthy City Concept), in-house provision of sporting activities, legislated small food portions, audit on cooking methods of food preparers, easy availability of cool drinking water, proactive action in school canteens etc are some ways that can induce behavior change. No chronic disease management can succeed without community participation i.e. with groups like school PTA/PIBG, teachers, teacher training colleges and Rukun Tetangga committees.

For purposes of screening, both fasting and post prandial glucose levels should be used.

a) Provision of care: by KKM

The public health centers can still do much more to delay the dreaded complications of diabetes in their patients. Dedicated clinics with specially trained nurses and doctors would make a difference. Periodic audit on outcomes of every clinic with reward and punitive measures may initiate the much needed push to reach targets. Identification of areas with poor outcome and correcting deficiency objectively-whether it is lack of expertise or lack of manpower is important. There is a strong need for a publicity blitz on the need for insulin therapy.

b) Diabetic eye screening

To create awareness among patients and health care providers on the needs of regular eye examination among diabetics. This is best performed at the primary healthcare level with the use of a fundus camera.

c) Clinical practice guidelines

All health care providers should be compliance to CPG recommendation on management of diabetes and its complications

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