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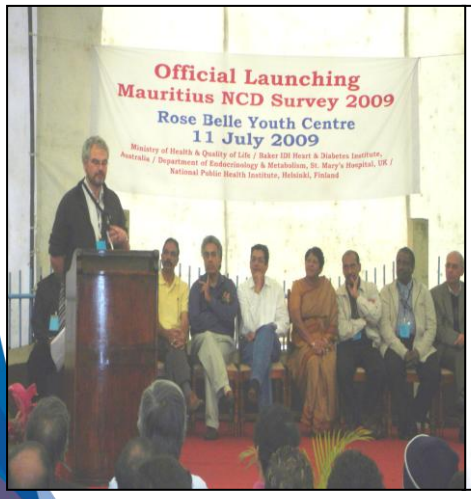
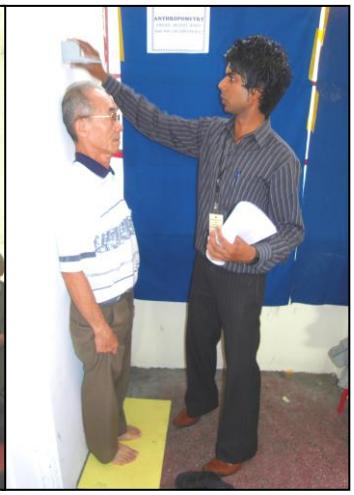
Ministry of Health &
Quality of Life

The Trends in Diabetes and Cardiovascular Disease Risk in Mauritius

The Mauritius Non Communicable Diseases Survey 2009





The Mauritius Non Communicable Diseases Survey 2009

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Executive summary

A non-communicable disease (NCD) survey employing similar methodologies and criteria to surveys undertaken in Mauritius in previous years, was carried out in 2009. This report provides a summary of the burden of the key NCDs and their risk factors.

Diabetes mellitus

- The prevalence of type 2 diabetes in the Mauritian population aged 20-74 years was 21.3%: 21.9% in men and 20.6% in women.
- The prevalence of type 2 diabetes in the Mauritian population aged 25-74 years was 23.6%: 24.5% in men and 22.8% in women.
- The prevalence of type 2 diabetes in the Mauritian population aged 30-74 years was 26.9%: 28.0% in men and 25.8% in women.
- For every known case of diabetes, there was one newly diagnosed case.
- There are an estimated 172,400 people between the ages of 25 and 74 years with diabetes in Mauritius.
- The prevalence of diabetes has increased by over 60% since 1987 in adult Mauritian Population aged 25-74 years.
- The prevalence of impaired glucose metabolism (being either impaired glucose tolerance or impaired fasting glycaemia – otherwise known as pre-diabetes) in the population was 24.2%: 25.6% for women and 24.3% for men in adult Mauritian Population aged 25-74 years.
- Among those people known to have diabetes, control of their diabetes as judged by blood glucose levels was poor (47% had HbA1c ≥9.0%), indicating very high risk of developing diabetic complications.

Almost 1 in 2 Mauritians 25-74 years has either diabetes or impaired glucose metabolism (pre-diabetes). Impaired glucose metabolism is associated with substantially increased risk of developing heart disease (2 to 3-fold) as well as risk of developing diabetes.

Overweight and obesity

- Using the European BMI cutpoints, the prevalence of obesity was 16.0%: 11.3% for men and 20.5% for women and the prevalence of overweight was 34.9%: 34.7% in men and 35.1% in women.
- Thus, 50.9% of the participants were overweight or obese. The rate for men was 46.0%, and for women, 55.6%.
- Using the ethnic specific BMI cutpoints, the prevalence of obesity was 43.3%: 47.9% for women and 38.4% for men and the prevalence of overweight was 22.3%: 20.3% in women and 24.4% in men. For BMI, the Asian-specific cutpoints were applied to the Hindu, Muslim and Chinese populations while the European cutpoints were applied to the Creole and *other* (Franco-Mauritian) population.
- Thus, 65.6% of the participants were overweight or obese. The rate for men was 62.8%, and for women, 68.2%.
- There are an estimated 477,000 people between 25 and 74 years of age who are obese in Mauritius.

Hypertension

- The prevalence of hypertension was 37.9%: 35.4% for women and 40.5% for men
- Anti-hypertensive medication was being taken by 15.5% of the population: 17.0% of women, and 13.9% of men.
- Of those with hypertension, only 41.4% of individuals were currently on medication for hypertension. Thus, for every treated case of hypertension, there was at least one untreated case.
- Among those with treated hypertension, at least 70% continued to have elevated blood pressure.

Lipids (abnormal cholesterol and other blood fats)

- The prevalence of elevated total cholesterol (≥ 5.2 mmol/l) was 34.7%.
- The prevalence of elevated total cholesterol (≥ 5.5 mmol/l) was 30.3%: 29.0% for women and 33.5% for men.
- The prevalence of elevated triglycerides (≥ 2.0 mmol/l) was 16.9%: 8.9% for women and 25.1% for men.
- Lipid-lowering agents were being taken by only 10.2% of the population.

- One in two Mauritians had at least one abnormality in one of the four lipids, putting them at increased risk of cardiovascular disease.

  - *(In adult Mauritian Population aged 25-74 years)*.

Metabolic syndrome

- The prevalence of the metabolic syndrome (MetS) was 36.3%: 35.1% of women and 37.5% of men. This is a high risk condition for heart disease, stroke and diabetes.

Smoking

- The prevalence of current smoking was 21.7%: 3.7% in women and 40.3% in men**.**

Physical Activity

- Only 16.5% of Mauritian adults aged 25-74 years were undertaking sufficient physical activity to meet the national guidelines of 30 minutes of leisure time activity (moderate to vigorous) per day to maintain good health.

- Approximately 1 in 2 people (56.2%) reported no participation in moderate or vigorous leisure time physical activity at all.

Kidney Disease

- Albuminuria was detected in 12.4% of the survey population.
- Over half of Mauritian adults have one of hypertension, albuminuria or diabetes and thus are at increased risk of kidney disease.

Conclusions

The prevalence of type 2 diabetes in Mauritius is extremely high. Indeed, the prevalence of diabetes presented in this report would give Mauritius the second highest figure of any country in the world, according to the International Diabetes Federation's recently-published *Diabetes Atlas.* [1]

Apart from the escalating rate of diabetes, there is a high prevalence of pre-diabetes, a condition associated with increased risk of heart disease and subsequent diabetes. The high rates of diabetes and pre-diabetes, coupled with those of obesity, dyslipidaemia and hypertension, constitute a significant threat in terms of the future social and economic burden of cardiovascular disease and diabetes complications for Mauritius, both in relation on direct medical costs but also national productivity due to the impact of these diseases on the workforce as discussed below.

Diabetes and its complications are associated with very high social and economic costs for both the person with diabetes, and governments. The high rates of diabetes and cardiovascular disease risk factors represent a very large public health burden that requires urgent measures both for prevention and treatment of diabetes and its associated complications.

Recommendations

The magnitude of the diabetes epidemic in Mauritius, coupled with the significant premature ill health and death due to the enormous burden associated with diabetic complications, including heart and kidney disease, heralds the need for increased attention and resources. The fact that potent environmental and behavioural risk factors for type 2 diabetes such as obesity and exercise are modifiable, points to the case for lifestyle intervention. This involves the incorporation of a healthy diet with an increase in physical activity and less sedentary activity, as a means of curbing the impact of this epidemic.

Recent years have seen a great increase in our knowledge of the lifestyle and pharmacological strategies required at both an individual and community level to reduce the risk of developing diabetes. The finding of a continuing rise in the prevalence of diabetes in Mauritius mandates that current diabetes prevention activities in Mauritius are reviewed against the world's best practices as

established both in developed and developing countries. Although the prevalence of diabetes is also rising in virtually every other country in the world, the extremely hi gh prevalence in Mauritius means that the need to act is urgent.

It will be essential to consider interventions that have not yet been tested in clinical trials. These should include transport, education, food supply and labelling, and town-planning interventions. These interventions are probably at least as important as interventions directed at individuals.

Furthermore, there is also increasing evidence that the effect of the maternal environment of the foetus *in utero* may have a long term effect in increasing risk of heart disease and diabetes when the child reaches adult life. In this respect, the importance of optimal maternal and child health must not be underestimated. Maternal health during pregnancy cannot be ignored in diabetes prevention activities. It is clear that reinforcement of existing programmes is essential but there is also a need to evaluate new strategies such as those relating to early life development. Only then will the relentless increase in NCD prevalence be halted.

Treatment of those with established diabetes and hypertension also needs consideration. A focus on improving the glycaemic control of the diabetes in those with the worst current levels of control (haemoglobin A1C (HbA1c) ≥9.0%) would have the greatest benefit in terms of reducing the risks of complications such as blindness and kidney failure. Adequate control of both lipids (cholesterol) and hypertension will reduce the risk of cardiovascular, kidney and eye disease.

It is a known fact that genetic factor is also associated with the development of diabetes. In order to investigate further into this issue, there is a need to conduct a Family Diabetes Study.

In view of the huge investments (financial, human and technical) on diabetes and its complications it is essential for a study on the Economic Impact of Diabetes to be undertaken as a priority.

A high level Multisectorial Health Promotion Committee has to be set up, if possible under the chairmanship of Hon Minister of Health & Quality of Life. The committee would comprise representatives of the following Ministries and other institutions:
Ministry of Finance and Economic Empowerment
Ministry of Youth and Sports
Ministry of Women's Rights, Child Development and Family Welfare

Ministry of Social Security, National Solidarity and Senior Citizens Welfare & Reform Institution
Ministry of Education, Culture and Human Resource
Ministry of Environment and National Development Unit
Ministry of Public Infrastructure
Ministry of Local Government, Rodrigues and Outer Islands
Ministry of Agro Industry, Food Production and Security
Ministry of Consumer Protection and Citizen Charter
Ministry of Civil Service Affairs and Administrative Reforms
Attorney General's Office
National Transport Authority
Central Electricity Board
Mauritius College of the Air
Mauritius Institute of Education
University of Mauritius
Police Department
Road Development Authority
Mauritius Institute of Health
Joint Economic Council
Mauritius Export Processing Zone Authority
Mauritius Employers Federation

Health Impact studies have also to be carried out for all programmes geared towards health intervention and health promotion activities.

Maternal health

Although this study was not designed to examine the prevalence of gestational diabetes, nor did it examine factors around maternal health, a child's risk of developing later obesity, diabetes and heart disease is in part determined by the mother's nutrition during pregnancy. We recommend that research is initiated to study the prevalence of gestational diabetes and risk of adverse outcomes in the offspring and mothers. Further, a study assessing the diet and percent body fat of mothers and their *infants* to examine if helping obese mothers to change to their diet and physical activity during pregnancy can improve the lifelong health of their children may also be informative.

Increasing uptake of breastfeeding could form an important part of population strategies to prevent obesity. Interventions during the pre-conception stage could include helping mothers to attain and maintain a healthy weight during pregnancy. Other than encouraging and supporting breastfeeding, post-conception strategies for childhood obesity prevention remain a challenge. A proposed strategy is to target household behaviours and routines that can lead to healthy weight for children which also promote those other developmental outcomes that appear to be more meaningful to parents. These household routines include having regular family meals, establishing sleep routines, and increasing unstructured outdoor play.

1.0 Introduction

The multi-racial population of Mauritius (Asian Indian Hindus, Asian Indian Muslims, Chinese and Creoles) has undergone rapid industrialisation and economic growth over the past several decades, and this has brought in its wake a shift in the disease pattern.

Mauritius has experienced rapid industrialisation and general improvements in living standards over the past five decades. However, through previous surveys in 1987, 1992, 1998 and 2004 conducted by the Ministry of Health and Quality of Life (MoH&QL), in collaboration with the World Health Organization and partners, it has been shown that the prevalence rates for diabetes mellitus are very high.

While total mortality is falling, death from diseases of the circulatory system has risen significantly (viz. from 114 to 297 per thousand between 1942 and 1986 i.e. to around 45% of total deaths).

Numerous studies of diabetes and other NCDs in Mauritius have been carried out under the leadership of Professor Zimmet (Baker IDI Heart and Diabetes Institute - previously the International Diabetes Institute), in collaboration with the MoH&QL since 1987, and have shown the emergence of NCDs in parallel with lifestyle change. Their contribution to the scientific understanding of the aetiology of NCDs is invaluable and has generated many health promoting initiatives such as the establishment of a NCD and Health Promotion Unit. However, the undiminished rise in NCDs is a cause of great concern to the whole community.

The first study on the prevalence of NCDs carried out in 1987 showed an overall crude prevalence of 14.3% for type 2 diabetes mellitus and 19.3% for impaired glucose tolerance (IGT) (which is a risk marker for both type 2 diabetes and cardiovascular disease such as ischaemic heart disease (IHD)). About 60% of those found to have type 2 diabetes were previously undiagnosed, indicating a large pool of unknown morbidity in the community. IHD was also common in the age group 35–74 years, as probable or possible ischaemia was found in 19% of men and 31% of women with normal glucose tolerance.[2]

A follow-up survey carried in 1992 showed that the prevalence of type 2 diabetes and IGT had increased moderately, but that there was an increased awareness of NCDs in the community resulting in a fall in the proportion of undetected cases.

The detection of new diabetes cases in the five years was high and the proportion of poorly controlled diabetic patients reached 42%.[3]

There was a local NCD survey conducted in 2004 and although it may not be directly comparable methodologically with the ones performed with the overseas collaborators, we have included it for completeness.

Mauritius has major problems with NCDs (viz. type 2 diabetes mellitus, hypertension and cardiovascular disease and their risk factors). These NCDs have assumed epidemic proportions. The findings of the NCD surveys between 1987 and 1998 show a high prevalence of type 2 diabetes and its associated risk factors, and among those with diabetes, poor levels of glucose control and high levels of complications[3]. Metabolic syndrome, a clustering of risk factors for cardiovascular disease including central or abdominal (visceral and retroperitoneal) obesity, abnormal glucose tolerance (diabetes, impaired fasting glucose (IFG) or impaired glucose tolerance (IGT)), raised triglycerides, decreased high-density lipoprotein cholesterol (HDL-C), elevated blood pressure, and hyperinsulinaemia with underlying insulin resistance, is also common. Much needs to be done for their prevention and control. New strategies need to be developed to reduce NCDs and their risk factors, and better control of all individuals with established diseases.

In 2009, a new survey was conducted in collaboration with the Baker IDI Heart and Diabetes Institute, the Cardiology Department, Umea University Hospital, Sweden, National Public Health Institute, Helsinki, Finland and the Department of Endocrinology and Metabolism, St Marys Hospital, United Kingdom. Within the context of the epidemiological transition, and constraints on resources, the purpose of the collaborative effort is to help strengthen national strategies for the prevention and control of NCDs.

Study Objectives

The 2009 NCD Survey in Mauritius had the following objectives:

- To measure the prevalence of non-communicable diseases (i.e. type 2 diabetes, hypertension, stroke, coronary heart disease and cancer);

- To examine complications for diabetes including retinopathy, nephropathy, and peripheral neuropathy;
- To examine risk factors associated with chronic disease (diabetes and cardiovascular disease) such as obesity, microalbuminuria, physical inactivity, sedentary behaviour, diet, cigarette smoking and serum lipids, insulin and haemoglobin A1C (HbA1c);
- To measure the prevalence of sleep problems (apnoea) in Mauritians.

This report summarises some of the key findings of the study. At the time this report was prepared, data on electrocardiograms, grading of retinal photographs and cleaning and analysis of other key data were not completed.

2.0 The population sample

2.1 Sample frame

Mauritius was divided into nine districts to ensure geographical representation. The sample drawn from each district was proportional to the population size of the district. Within each district, an *index* primary sampling unit (PSU) (an area representing approximately 300 households) was chosen randomly proportional to size of the PSU and then combined with two nearby PSU to form a *main* cluster. A total of 20 *main* clusters were selected for the whole island. Two additional PSUs, each with approximately 200 households, were selected in the district of Port Louis to ensure that all ethnic groups were adequately represented.

In each of the 20 *main* clusters, a selection of 1 in 3 households were to be made to have on average 320 households per main cluster and to have around 200 households for the two additional abovementioned clusters. In each household selected, only one person was to be randomly chosen to give an approximate survey sample size of 6600 subjects for the whole island.

The total number of participants recruited was 6371. Table 2.1 describes key demographic variables of the study sample.

Table 2.1 Demographic characteristics of the participants: the Mauritius NCD survey 2009

	Men	Women
N	2904	3467
Age (years, SD)	45.7 (13.3)	45.8 (13.9)
Age range (years)	19 – 78	19 – 75
Education (%)		
Less than 4 years	6.0	14.4
4-6 years	33.3	39.4
7-9 years	11.7	9.7
10-12 years	37.8	30.3
Tertiary level	11.3	6.2
Ethnicity (%)		
Hindu	54.5	55.1
Muslim	19.2	18.7
Creole	23.0	23.2
Asian	3.2	2.7
Other	0.2	0.4
District (%)		
Port Louis	14.7	13.4
Pamplemousses	9.8	10.3
Riviere du Rempart	10.6	9.7
Flacq	14.8	15.7
Grand Port	8.6	9.1
Savanne	4.9	5.0
Plaine Wilhelms	27.3	27.8
Moka	4.8	4.5
Black River	4.4	4.6

2.2 Response rate

A major aim of the survey team leaders was to promote a high participation rate. In line with this strategy, a strong motivation campaign was sustained throughout the field survey.

Among those invited to participate to the survey, the overall response rate was 85%. The response rate was 79% for men and 90% for women.

This survey was carried out during normal working hours, starting early in the morning up to around midday. As a result, it was particularly challenging to recruit employed participants, with many participants requiring release from work from their respective employers. Participation in this study required patience as the time to be spent having measurements, medical examinations, tests and interviews was significant.

3.0 Diabetes and pre-diabetes

Background

The term diabetes mellitus describes a metabolic disorder with multiple causes characterised by chronically elevated blood glucose (hyperglycaemia) levels, with disturbances of carbohydrate, fat and protein metabolism. The effects of diabetes include long-term damage, dysfunction and failure of various organs and tissues. It predisposes those suffering from it to many severe conditions, including cardiovascular disease, as well as visual loss, amputations and renal failure.

Diabetes is a disease with mixed aetiology. There are many risk factors for the development of the disease including obesity, hypertension, sedentary lifestyle, dyslipidaemia and the metabolic syndrome, many of which are also risk factors for cardiovascular disease.

Type 2 diabetes constitutes about 90% of all diabetes in developed countries. It is now a common and serious global health problem, which, for most countries, has evolved in association with rapid cultural and social changes, ageing populations, increasing urbanization, dietary changes leading to obesity, reduced physical activity and other unhealthy lifestyle and behavioural patterns.

On December 21st 2006, the United Nations General Assembly unanimously passed Resolution 61/225 declaring diabetes an international public health issue and declaring World Diabetes Day as a United Nations Day, only the second disease after HIV/AIDS to attain that status. For the first time, governments have acknowledged that a non-infectious disease poses as serious a threat to world health as infectious diseases like HIV/AIDS, tuberculosis and malaria. This United Nations resolution recognises that tackling diabetes is likely to be one of the most important challenges for the global public health community in the 21st century.

Definitions

Diabetes and pre-diabetes

The diagnostic criteria for diabetes, IGT and IFG were based on the values for venous plasma glucose concentration (fasting and two-hour measurements) outlined in the World Health Organization report on the Diagnosis and Classification of Diabetes[4] (Table 3.1). People who reported taking oral hypoglycaemic medication and/or insulin were classified as having diabetes regardless of their plasma glucose levels. The term 'pre-diabetes' is used to include all those with either IGT or IFG. In this report, results for type 1 and type 2 diabetes have not been reported separately, as the vast majority of cases were classified as type 2.

Known diabetes

Participants were classified as having known diabetes if they satisfied at least one of the following criteria:

1. receiving current treatment in the form of tablets or insulin (or both) at the time of the study, or;

2. having ever been told by a doctor or nurse that they had diabetes, and had a fasting blood glucose or 2-hr post load glucose levels over the cut-offs for diabetes mellitus (Table 3.1).

Newly Diagnosed Diabetes

Newly diagnosed cases of diabetes consisted of those:

- not previously diagnosed with diabetes, and who had fasting or 2-hour plasma glucose measurements over the diabetes cut-off range (Table 3.1).

Table 3.1 Classification values for the oral glucose tolerance test

	Plasma glucose (mmol/l)		
Glucose tolerance	**Fasting glucose**		**2-hour glucose**
Diabetes	≥7.0	or	≥11.1
Impaired glucose tolerance (IGT)	<7.0	and	7.8–11.0
Impaired fasting glucose (IFG)	6.1–6.9	and	<7.8
Normal glucose tolerance (NGT)	<6.1	and	<7.8

Notes: All participants on oral hypoglycaemic medication or insulin were classified as having diabetes.

Results

3.1 Glucose tolerance status

The prevalence of diabetes (age and gender standardised to the national population of Mauritius) in adults aged 20-74 years was 21.3%: 21.9% in men and 20.6% in women.

The prevalence of diabetes (age- and gender-standardised to the national population of Mauritius) in adults aged 25-74 years was 23.6%: 22.8% for women and 24.5% for men. Figure 3.1 shows the age-specific prevalence of diabetes for each gender. Applying the age-specific prevalence of diabetes for each gender to the total population of Mauritius in 2008 produces an estimate of 172,400 people aged between 25 and 74 years with diabetes.

The prevalence of diabetes in adults aged 30-74 years was 26.9%: 28.0% in men and 25.8% in women.

The survey found that only about one half of the persons found to have diabetes had been previously diagnosed. Table 3.2 shows the prevalence of known and newly diagnosed diabetes according to age. Table 3.3 shows the prevalence of diabetes according to ethnic group. Due to the small numbers of Chinese and those belonging to the 'other' group, these ethnic groups were combined. The prevalence of diabetes in rural and urban areas was 26.0% and 26.3%, respectively.

Table 3.2 Age-specific prevalence (%) of known and newly diagnosed diabetes: the Mauritius NCD survey 2009.

	Age groups (years)						
	19-24	**25-34**	**35-44**	**45-54**	**55-64**	**65+**	**Total***
Men							
Newly diagnosed	1.2	4.9	11.8	16.7	17.8	19.0	12.3
Known	0.0	0.9	6.8	18.4	27.6	28.9	12.3
Women							
Newly diagnosed	1.5	4.4	11.7	14.4	14.2	15.9	11.8
Known	1.0	2.2	5.4	13.1	29.0	29.0	11.0
All persons							
Newly diagnosed	1.3	4.6	11.7	15.5	15.9	17.1	11.6
Known	0.5	1.6	6.0	15.7	28.3	28.9	12.0

Notes: *Standardised to the 2008 population of Mauritius aged 25-74 years.

Table 3.3 Age and gender standardised prevalence of diabetes according and ethnic group: Mauritius NCD survey 2009.

	Hindu	**Muslim**	**Creole**	**Chinese +other***
All persons				
DM	25.1	22.4	22.6	14.4

Notes: *The *other* population includes those who are 'Franco-Mauritian'. Prevalences were standardised to the 2008 population of Mauritius aged 25-74 years.

The age- and gender-standardised prevalence of IGT was 15.6%: 19.0% in women and 13.4% in men. The prevalence of IGT increased with age for both genders. The prevalence of IGT was higher in women than men. The age- and gender-standardised prevalence of IFG was 8.6%: 6.6% in women and 10.9% in men. The prevalence of IFG was higher in men than women. The age-specific prevalences of IFG and IGT are shown in Table 3.4. The prevalence of impaired glucose metabolism (being either IGT or IFG) in the population was 24.2%: 25.6% for women and 24.3% for men.

Table 3.4. Age-specific prevalence (%) IGT and IFG according to gender: the Mauritius NCD survey 2009.

	Age groups (years)						
	19-24	25-34	35-44	45-54	55-64	65+	Total*
Men							
IGT	5.4	12.1	14.3	13.1	13.0	17.8	13.4
IFG	6.0	7.5	13.2	12.3	11.5	10.3	10.9
Women							
IGT	7.3	15.2	20.9	21.3	17.0	23.5	19.0
IFG	1.5	5.1	6.0	8.0	8.1	5.5	6.5
All persons							
IGT	6.4	13.9	17.9	17.3	15.2	21.2	15.6
IFG	3.5	6.1	9.3	10.1	9.6	7.4	8.6

Notes: *Prevalences were standardised to the 2008 population of Mauritius aged 25-74 years.

Figure 3.1: Age-specific prevalence of diabetes according gender: the NCD survey Mauritius 2009.

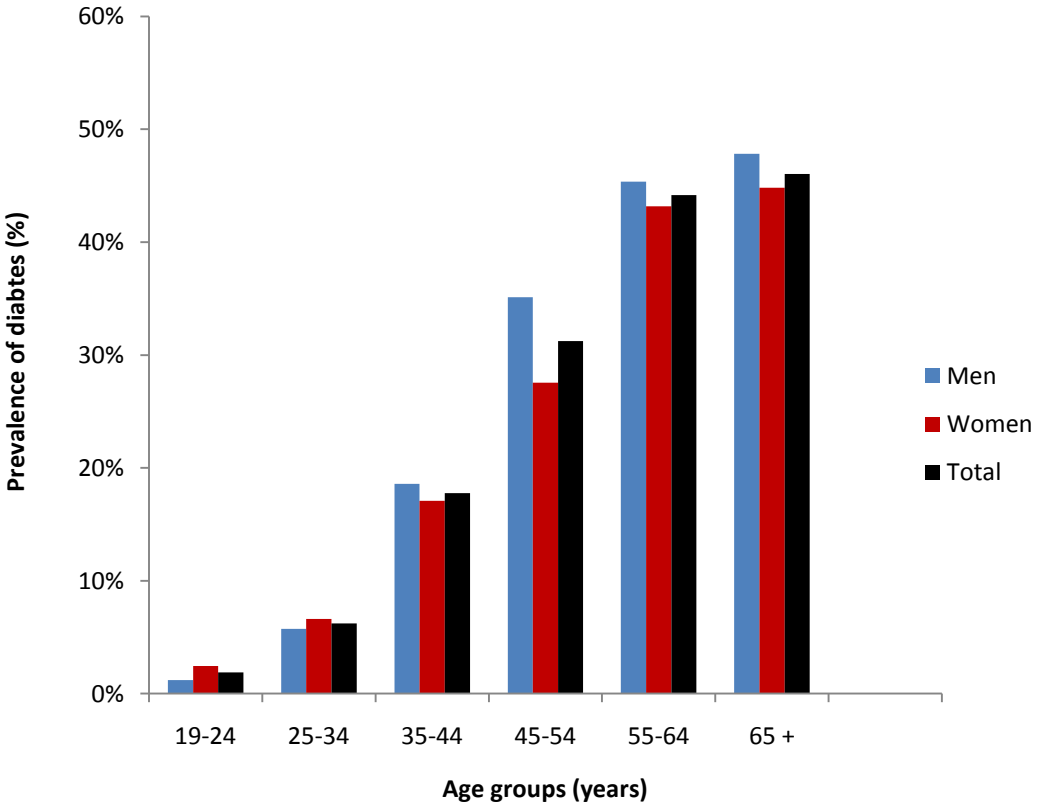

Figure 3.2 shows the prevalence of diabetes in 2009 compared to the 1987, 1992, 1998 and 2004 surveys. All estimates were standardised to the 2008 estimated population of Mauritius. The first three of these surveys were conducted by the

Baker IDI with funding from National Institute of Health in conjunction with other collaborators. The 2004 was conducted by the Ministry of Health and Quality of life, while the 2009 was conducted by the Ministry of Health and Quality of Life with *in kind* support by Baker IDI. The methodologies of the surveys and age distributions of the samples were similar. It is important to note that the 1992, 1998 and 2004 surveys were predominantly follow-ups of the 1987 survey, while the 2009 survey was an entirely independent sample. The prevalence of diabetes has increased steadily over the last 20 years. Since 1987, there has been a 61.5% increase in the prevalence of diabetes.

Figure 3.2: Age-standardised prevalence of diabetes across the five surveys according to gender.

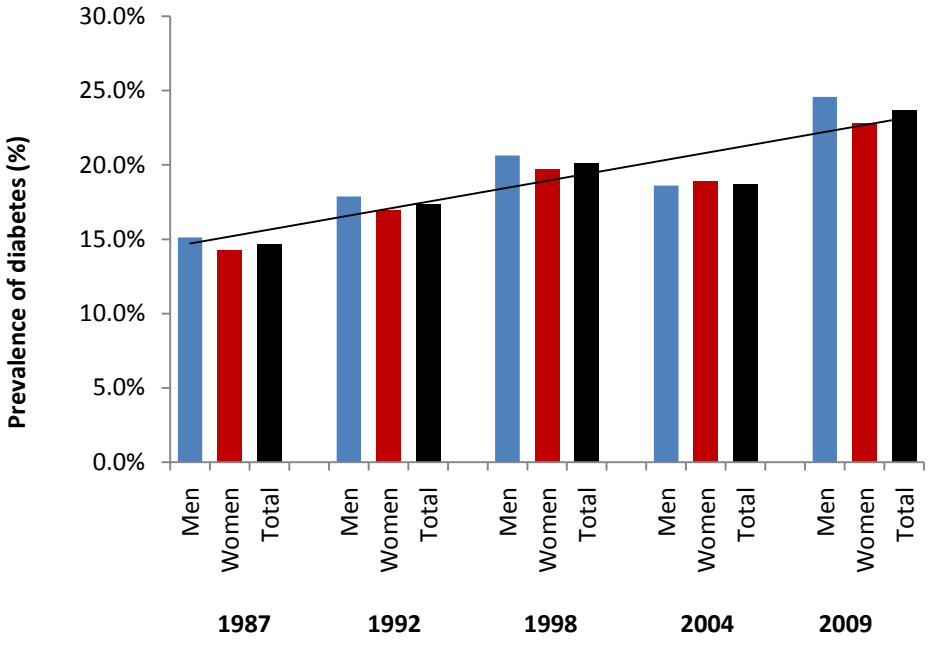

Figure notes: All prevalences were standardised to the 2008 population of Mauritius aged 25-74 years.

Table 3.5 shows the achieved level of glycaemic control (as measured by HbA1c) among people with previously diagnosed diabetes, according to their treatment category. Among those treated with oral hyperglycaemic drugs or insulin treatment, 47.3% had an HbA1c level greater than or equal to 9%.

Table 3.5 Glycaemic control in all participants reporting a diagnosis of diabetes: the Mauritius NCD survey 2009.

		Haemoglobin A1c groups					
Self reported treatment for diabetes	N	0-5.9%	6-6.9%	7-7.9%	8-8.9%	9-9.9%	≥10%
None	17	0.0	0.0	23.5	23.5	0.0	52.9
Diet only	37	2.7	18.9	32.4	8.1	5.4	32.4
Herbal	3	0.0	0.0	0.0	0.0	0.0	100.0
Oral medication	620	6.0	16.0	18.7	18.1	13.4	27.9
Insulin	61	3.3	6.6	0.0	18.0	16.4	55.7
Oral & Insulin	95	3.2	3.2	9.5	13.7	10.5	60.0
Total	833	5.2	13.6	16.9	17.2	12.6	34.6

4.0 Obesity

Background

Obesity is strongly linked to type 2 diabetes, and is a major risk factor not only for type 2 diabetes, but other chronic conditions such as hypertension, cardiovascular disease, dyslipidaemia, some cancers and arthritis. The most serious form of obesity is the central (abdominal) rather than peripheral form, as it is associated with substantially higher risks for diabetes and cardiovascular disease.

Definition

Overweight and obesity were defined using the World Health Organization classification[3] based on BMI (weight/height^2), and waist circumference. The WHO recommend different cut points depending on ethnicity (see below). While the BMI is used as a measure of overall adiposity (Table 4.1) the waist circumference is a more accurate measure of central adiposity (Table 4.2).

Table 4.1. Body mass index classification of obesity.

	Body mass index (kg/m^2)	
	Europids (including Creoles)	**Asians**
Normal	<25.0	<23.0
Overweight	25.0–29.9	23.0–24.9
Obese	≥30.0	≥25.0

Table 4.2 Classification of abdominal obesity by waist circumference.

	Waist circumference (cm)	
	Males	**Females**
Large waist	≥90.0	≥80.0

Results

4.1 Obesity

Table 4.3 shows the prevalence of normal weight, overweight and obesity. Using the European BMI cutpoints, the age and gender standardised prevalence of obesity was 16.0%: 11.3% in men and 20.5% in women (Mauritian adult population aged 25 -74 years).

Table 4.3.

	Men	Women	Total
BMI (cutpoints for European)			
Normal weight	54.0	44.4	49.1
Overweight	34.7	35.1	34.9
Obese	11.3	20.5	16.0

Table 4.4 shows the prevalence of normal weight, overweight and obesity using BMI cutpoints for ethnic specific BMI cutpoints.[5,6] For BMI, the Asian-specific cutpoints were applied to the Hindu, Muslim and Chinese populations while the European cutpoints were applied to the Creole and *other* (Franco-Mauritian) population. Using ethnic-specific BMI cutpoints, the age and gender standardised prevalence of obesity was 43.3% with more women being obese than men. Using ethnic-specific waist circumference cutpoints, the prevalence of obesity was 38.2%.

Applying age-specific prevalence of obesity for each gender to the total population of Mauritius in 2008 produces an estimate of 477,000 Mauritius aged between 25 and 74 who are obese using ethnic-specific BMI groups.

Table 4.4 Age- and gender-standardised prevalence of normal weight, overweight and obese by BMI and large waist circumference according to gender.

	Men	Women	Total
BMI (cutpoints for Asians and Europids)			
Normal weight	37.2	31.8	34.5
Overweight	24.4	20.3	22.3
Obese	38.4	47.9	43.3
Waist Circumference			
Large obese	30.7	45.5	38.2

Notes: Standardised to the 2008 population of Mauritius aged 25-74 years.

5.0 Hypertension and Lipoproteins

Definitions

Hypertension

Participants who reported having hypertension and taking drug treatment or reported hypertension and had a blood pressure of greater or equal to 140/90 mmHg were classified as hypertensive. Participants who had systolic blood pressure or diastolic blood pressure greater or equal to 140/90 mmHg and not on anti-hypertensive medication were defined as *untreated hypertension.*

Lipoproteins

The following thresholds were using to classify participants according to lipid levels.

Table 5.1. Classification of lipid values.

Classification	Blood lipid concentration (mmol/l)			
	Cholesterol	HDL-cholesterol	LDL-cholesterol	Triglycerides
Normal	< 5.5	> 1.0	< 3.5	< 2.0
Abnormal	≥ 5.5	≤ 1.0	≥ 3.5	≥ 2.0

Results

5.1 Hypertension

Table 5.2 show the prevalence of hypertension according to age-group. The age and gender-standardised prevalence of hypertension was 37.9%: 35.4% in women and 40.5% in men. The prevalence of hypertension rose steadily with age in both men and women. The age-standardised prevalence of hypertension was higher in men than women.

The diagnostic criteria for hypertension recommended by the WHO include both untreated persons with hypertension and those who have been diagnosed and are on treatment. At all ages, untreated hypertension was more common among men than women. Overall, for every participant being treated for hypertension there was at least another untreated person except for the older age groups. Medication to control hypertension was being taken by 15.5% of the population: 13.9% of men and 17.0% of women. In both genders the usage of such medication increased with age, from levels of 2% or less for the youngest groups, to nearly 51% for the oldest female group. Of those participants with hypertension, 35% of males and over 48% of females were taking medication for hypertension, with the remaining 65% of men and 52% of women being untreated cases of hypertension. For those on treatment, 70.4% continued to have elevated blood pressure levels.

Table 5.2. Age-specific classification by treatment status of hypertensive participants according to gender: the Mauritius NCD survey 2009.

Hypertension Category	Age (years)					
	19-24	25 – 34	35 – 44	45 – 54	55 – 64	65 +
Males						
Untreated[a]	7.5	14.0	26.4	30.2	35.3	42.3
Treated[b]	1.2	1.0	6.9	20.0	31.3	37.9
Total hypertensive	8.7	15.0	33.1	50.2	36.6	80.2
Females						
Untreated [a]	1.7	6.8	15.6	23.3	26.2	35.2
Treated[b]	1.3	1.8	7.5	21.0	37.1	50.7
Total hypertensive	3.0	8.6	23.1	44.3	63.3	85.9
All Persons						
Untreated[a]	4.2	9.9	20.5	26.7	30.3	38.1
Treated[b]	1.2	1.4	7.2	20.5	34.5	45.5
Total hypertensive	5.2	10.3	27.7	47.2	34.8	83.6

Notes: [a]Systolic pressure ≥ 140 mmHg, or diastolic pressure ≥ 90 mmHg, and not on anti-hypertensive medication. [b]On hypertensive medication. Totals may not equal sum of the two because of rounding and missing data in the treatment variable. Prevalences are standardised against the 2008 Mauritian population.

5.2 Lipids

The age and gender-standardised prevalences of various lipid abnormalities are shown in table 5.3. Men had a higher prevalence of elevated low density lipoprotein cholesterol (LDL-C), total cholesterol, elevated triglycerides and low high density lipoprotein cholesterol (HDL-C) than women. Almost 51% of Mauritians had at least one abnormality in one of the four lipids.

Table 5.3. Age- gender standardised prevalence of elevated LDL-C, total cholesterol, low HDL-C and triglycerides according to: the Mauritius NCD survey 2009.

	Elevated LDL-C	Elevated Total Cholesterol	Low HDL-Cholesterol	Elevated Triglycerides
Men	27.1	33.5	22.1	25.1
Women	22.5	27.2	13.1	8.9
All Persons	24.7	30.3	17.5	16.9

Notes: LDL cholesterol ≥ 3.5 mmol/; Total cholesterol ≥ 5.5 mmol/l; HDL cholesterol ≤ 1.0 mmol/l; Triglycerides ≥ 2.0 mmol/l. Prevalences are standardised against the 2008 Mauritian population

The age-sex standardised prevalence of elevated total Cholesterol (≥ 5.2 mmol/l) was 34.7%.

Lipid-lowering agents were being taken by 8.7% of the population, comprising 9.0% of men and 11.1% of women, respectively. Table 5.5 indicates the prevalence of any lipid abnormality with and without therapy, and usage rates of lipid lowering therapy by age and gender. For both genders, the use of lipid therapy increased markedly with age, from nearly no use for the youngest participants to 25% for those aged 65 or older. Fifty-eight percent of men and 43% of men and women had abnormal lipid profiles which were not treated.

Table 5.5. Age and gender-specific prevalence (%) of lipid lowering drug treated versus non treated, according to abnormal lipid levels and gender: the Mauritius NCD survey 2009.

	Age (years)						
	19-24	**25 – 34**	**35 – 44**	**45 – 54**	**55 – 64**	**65 +**	**Total ***
Males							
Treated	0.6	0.8	4.4	9.8	17.3	22.2	7.7
Untreated No abnormality	68.6	43.9	37.3	30.9	36.1	32.3	37.2
Abnormality	30.9	54.3	57.5	59.1	46.2	45.1	54.5
Females							
Treated	0.0	0.8	4.5	10.5	23.9	26.7	9.6
Untreated No abnormality	72.7	69.7	59.3	49.4	28.5	29.9	52.9
Abnormality	26.5	29.5	35.8	40.0	47.4	43.1	37.4
All persons							
Treated	0.2	0.8	4.5	10.2	20.9	24.8	8.7
Untreated No abnormality	70.9	58.3	49.2	40.4	32.0	30.9	45.2
Abnormality	28.4	40.5	45.8	49.3	46.8	44.0	45.8

Notes: [a]Abnormality: calculated as % of population, who had any, of: total cholesterol ≥ 5.5 mmol/l, LDL cholesterol ≥ 3.5 mmol/l, HDL cholesterol ≤ 1.0 mmol/l, triglycerides ≥ 2.0 mmol/l. Totals may not add to 100 due to missing data.

6.0 Metabolic syndrome

Background

The metabolic syndrome (MetS) is characterised by central or abdominal (visceral and retroperitoneal) obesity and a clustering of other cardiovascular risk factors including abnormal glucose tolerance (diabetes, IFG or IGT), central obesity, raised triglycerides, decreased HDL-C, elevated blood pressure, and hyperinsulinaemia with underlying insulin resistance. The clustering of these risk factors confers a higher risk of diabetes and cardiovascular disease. This chapter presents the prevalence of the MetS.

Definition

Metabolic syndrome

The metabolic syndrome (MetS) was defined according to the modified definition by International Diabetes Federation definition.[7, 8] Classification of the MetS is outlined in Table 6.1. Individuals who possess any 3 of the 5 characteristics listed in Table 6.1 are defined as having the MetS.

Table 6.1. Classification of the metabolic syndrome.

Component	Threshold
Metabolic syndrome is defined in anyone with 3 of 5 of the characteristics below	
Waist circumference	Europids: ≥ 94 cm in men, ≥ 80 cm in women South and Southeast Asians: ≥ 90 cm men, ≥ 80 cm women
Raised triglycerides	≥ 1.7 mmol/l or specific treatment of this lipid abnormality
Reduced HDL-C	<1.03 mmol/l in males; <1.29 mmol/l in females or specific treatment for this lipid abnormality
Raised blood pressure	Systolic ≥ 130 mmHg or diastolic ≥ 85 mmHg or treatment of previously diagnosed hypertension
Raised plasma glucose	Fasting plasma glucose ≥ 5.6 mmol/l or previously diagnosed type 2 diabetes

Results

6.1 Metabolic syndrome

The age- and gender-standardised prevalence of the MetS using the modified International Diabetes Federation definition[8] was 36.3%: 35.1% in women and 37.5% in men.

The prevalence of the MetS is increased with age for both genders (Figure 6.1).

Figure 6.1: Age and gender specific prevalence of MetS according to age: the Mauritius NCD survey 2009.

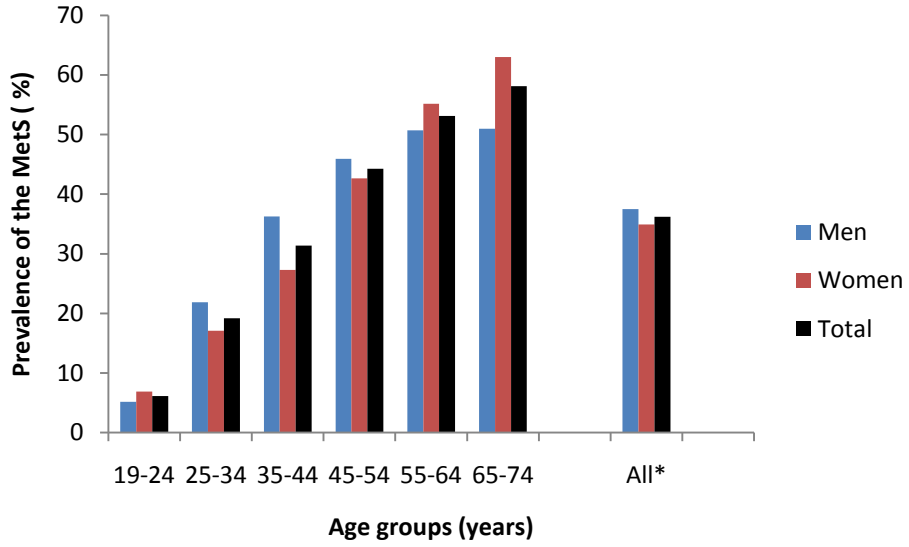

Figure notes: *Age and gender-standardised to the Mauritius population of 2008 aged 25-74.

7.0 Lifestyle behaviours

7.1 Smoking

The age- and gender-standardised prevalence of smoking was 21.7%: 3.7% in women and 40.3% in men. The prevalence of smoking was highest in the younger age-groups with over 50% of men aged 19-24 years of age reporting smoking. Smoking decreased with age in both men and women.

Table 7.1. Age-specific prevalence (%) of smoking status categories according to gender: the Mauritius NCD survey 2009.

Smoking status	Age (years)					
	19-24	25 – 34	35 – 44	45 – 54	55 – 64	65 +
Men						
Ex-smoker	4.6	6.7	11.3	13.4	17.7	26.9
Current smoker	55.8	47.1	41.4	39.5	33.1	25.7
Women						
Ex-smoker	3.0	3.2	2.9	3.3	2.2	3.5
Current smoker	8.2	4.8	4.6	3.1	2.0	2.2
All persons						
Ex-smoker	3.7	4.8	6.8	8.2	9.2	13.1
Current smoker	28.5	23.5	21.5	20.9	16.2	11.8

7.2 Physical activity

Self–reported data on physical activity was collected using the Global Physical Activity Questionnaire (GPAQ). This questionnaire asks about moderate and vigorous physical activity during leisure time and walking. The Ministry of Health and Quality of Life recommend that Mauritians should undertake 30 minutes of exercise each day comprising of brisk walking, jogging, swimming, cycling or dancing (aerobic). Table 7.2 shows the crude prevalence of Mauritians who meet these guidelines. These data have been analysed by combining self-reported moderate and vigorous leisure physical activity and excludes information collected in the questionnaire about walking or cycling to get to and from places. These data show that only 16.5% of Mauritians (10.9% of women and 23.2% of men) undertook sufficient vigorous or moderate physical activity to meet the national guidelines. Fifty six percent of Mauritians (65.8% of women and 45.7% of men) reported doing no moderate or vigorous leisure time physical activity at all.

Table 7.2 Crude prevalence of Mauritians who meet National guidelines of 30 mins of moderate or vigorous leisure physical activity each day: the Mauritius NCD survey 2009.

	Age (years)						
	19-24	**25 – 34**	**35 – 44**	**45 – 54**	**55 – 64**	**65 +**	**Total***
Men	46.5	26.2	21.4	20.5	21.3	18.1	23.2
Women	12.1	10.8	11.2	10.6	11.7	9.3	10.9
All persons	26.7	17.6	15.9	15.4	16.0	12.9	16.5

Notes: *These estimates are crude.

7.3 Alcohol consumption

A total of 48.5% individuals (33.8% of women and 65.9% of men) reported consuming alcohol at least once a week (Table 7.1). Among those who reported consuming any alcohol, more than 50% of the men and almost 90% of the women were light drinkers consuming fewer than two drinks per day (Table 7.2).

Table 7.1. Age-specific prevalence (%) of alcohol consumption according to gender: the Mauritius NCD survey 2009.

	19-24	25-34	35-44	45-54	55-64	65+	Total*
Men							
Never	27.6	29.0	23.2	28.3	32.2	31.4	28.2
Ex drinker	2.3	3.7	3.7	7.3	6.5	12.6	5.9
Once per week or less	64.9	52.7	53.9	42.4	38.5	36.1	46.8
2-3 days per week	5.2	11.8	12.6	14.0	12.7	10.2	12.2
≥4 days per week	0.0	2.9	6.6	8.0	10.1	9.8	6.9
Women							
Never	63.8	57.5	60.4	66.8	70.3	66.8	64.2
Ex drinker	2.2	2.0	2.1	1.8	1.7	3.3	2.1
Once per week or less	32.3	38.9	35.8	29.2	27.3	27.5	32.1
2-3 days per week	1.7	1.5	1.6	1.9	0.5	0.8	1.4
≥4 days per week	0.0	0.2	0.1	0.3	0.2	1.7	0.3
All persons							
Never	48.3	44.8	43.2	48.0	52.9	52.2	47.7
Ex drinker	2.2	2.7	2.8	4.5	3.9	7.1	3.8
Once per week or less	46.3	45.0	44.2	35.7	32.4	31.0	38.9
2-3 days per week	3.2	6.1	6.7	7.8	6.1	4.7	6.3
≥4 days per week	0.0	1.4	3.1	4.1	4.7	5.0	3.3

Notes: *These estimates are not standardised.

Table 7.2. Frequency of alcohol consumption according to gender: the Mauritius NCD survey 2009.

	Men	Women	All persons*
Fewer than 2 drinks per day	53.4	89.9	67.2
3-4 drinks per day	32.1	8.9	23.4
≥5 per day	14.5	1.1	9.5
Total	100	100	100

Notes: *These estimates are not standardised.

7.4 Sleep apnoea

Sleep apnoea is a sleep disorder characterised by pauses in breathing during sleep. It is associated with an increased risk of cardiovascular disease, stroke, high blood pressure, arrhythmias, diabetes, and accidents. A modified version of Berlin sleep questionnaire[9] was used to measure the prevalence of those at *high risk* of sleep apnoea. This questionnaire has been validated for use in an Indian population[9]. It must be noted that this is not a diagnostic test for sleep apnoea but highlights those at *high risk* for sleep apnoea. The crude prevalence of those at high risk for sleep apnoea was 21.4%: 24.1% in women and 18.7% in men. Among those with diabetes, the prevalence was higher at 32.5%: in 36.8% women and 27.8% in men.

8.0 Chronic kidney disease

Background

Chronic kidney disease is common in the general community and causes significant disability. Individuals with chronic kidney disease are at risk of experiencing end-stage kidney failure requiring dialysis or transplantation and are also predisposed to develop premature cardiovascular disease with an increased risk of death due to heart attack or stroke.

Definitions

Impaired glomerular filtration rate

Chronic kidney disease is defined as present when there is impaired kidney function. The standard measure of kidney function is the glomerular filtration rate (GFR). GFR can be estimated from the results of a blood test (so called 'estimated' GFR or eGFR) and an impaired eGFR is defined as an eGFR of <60 ml/min/1.73m^2 [7] The eGFR has been calculated using the abbreviated Modification of Diet in Renal Disease (MDRD) formula.[8]

Albuminuria

Early kidney disease can manifest as the leakage of protein into the urine. The earliest manifestation of an excessive leakage of protein into the urine can be detected by measuring the urinary albumin levels and is called albuminuria. We considered albuminuria to be present if the spot urine albumin:creatinine ratio was ≥2.5 mg/mmol for men and ≥3.5 mg/mmol for women. Albuminuria is a recognised early risk factor for the development of chronic kidney disease and additionally, is an important risk factor for cardiovascular disease and mortality.

Results

8.1 Albuminuria and impaired glomerular filtration rate

The age- and gender-standardised prevalence of albuminuria in the Mauritius population was 12.4%: 11.2% in women and 13.6% in men. The age-specific prevalence of albuminuria is shown in Figure 8.1. The prevalence of albumuria was higher in women than men under the age of 35, and higher in men over the age of 45. The age- and gender-standardised prevalence of those with impaired glomerular filtration rate (<60 ml/min/1.73m^2) was 7.6%: 8.0 % in women and 7.1% in men (Figure 8.2).

The proportion of Mauritians who have either hypertension, diabetes or albuminuria was 53%.

Figure 8.1. Age-specific prevalence of albuminuria according to gender: the Mauritius NCD survey 2009.

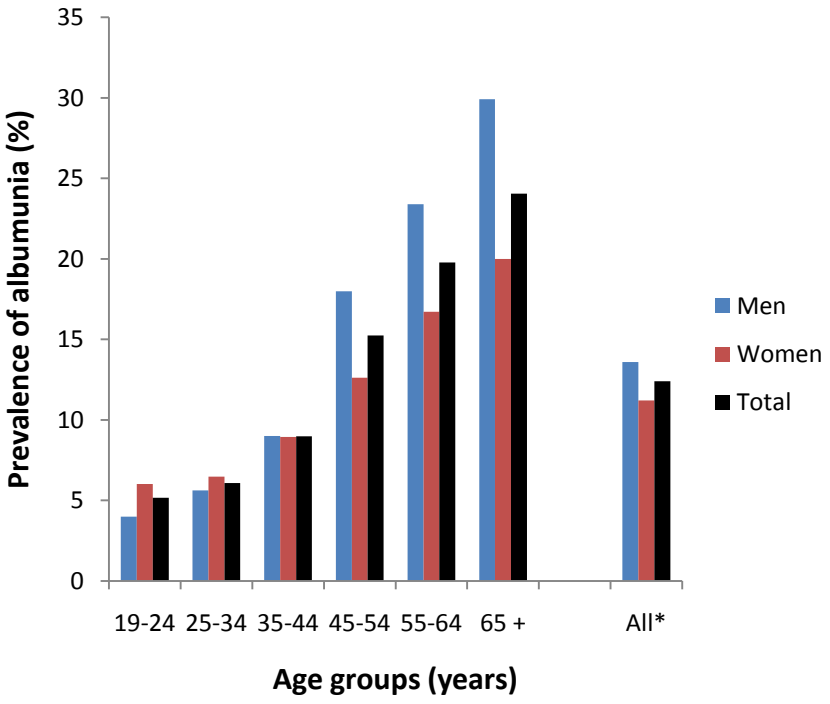

Figure notes: *Age and gender standardised to the Mauritius population of 2008 aged 25-74

Figure 8.2: Gender specific prevalence of impaired glomerular filtration rate (<60 mins/ml/1.73 m^2): the Mauritius NCD survey 2009.

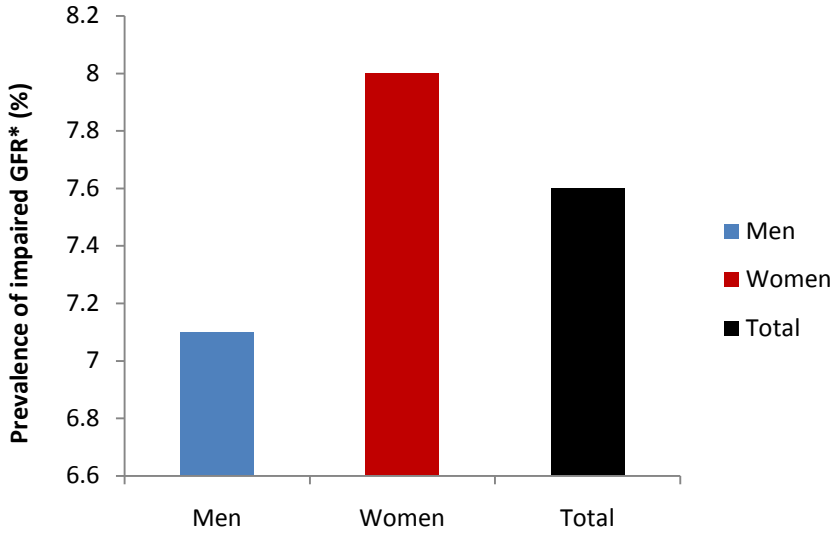

Figure notes: Standardised to the 2008 Mauritian population.

9.0 Discussion

There were several findings of major importance:

Diabetes and pre-diabetes:

- The high prevalence of diabetes - approximately 172,400 Mauritians adults have diabetes
- The high prevalence of IGT and IFG
- The prevalence of diabetes has increased 62% since 1987
- For every known case of diabetes, there is one undiagnosed case
- The glycaemic control of people with diagnosed diabetes is poor, with 47.3% having an HbA1c ≥9.0%

Although the ratio of newly diagnosed diabetes to known diabetes has improved from 1987, when there were three new cases to two known diabetes cases, these results still suggest that there is more work which needs to be done.

All of these factors have major implications for public health and the national health burden and failure to adequately treat is associated with an increased rapidity of progression to the many complications of diabetes.

Obesity:

- The high prevalence of obesity and overweight which implies that approximately 477,000 Mauritians are obese or overweight

There is a high likelihood that these levels of obesity have been a significant contributing factor in the escalating prevalence of diabetes. The epidemic of obesity must be curtailed in order to reduce the burden of diabetes, as well as other obesity-related conditions.

Metabolic syndrome:

- The high prevalence of metabolic syndrome seen in this study is consistent with the high prevalence of obesity and diabetes and highlights a group of individuals at risk of both diabetes and cardiovascular disease, for which prevention would be beneficial

Hypertension:

As a major risk factor for both cardiovascular and kidney disease, it is critically important that hypertension should be prevented, recognised and controlled. The high prevalence of hypertension in Mauritius of around 38.0% is of concern. For those on treatment, approximately 70.4% continued to have elevated blood pressure levels. This highlights a group of individuals for which control has not been optimised.

Kidney disease:

- Albuminuria prevalence in Mauritians is high, both in women and men and this indicates a population clearly at risk for whom intervention should be complemented

- The use of impaired glomerular filtration rate as indicator of renal disease has not been fully validated in all ethnic groups and thus the figures relating to this should be interpreted with caution

- The proportion of Mauritians with either diabetes, hypertension, or albuminuria (i.e. at risk of developing kidney disease) is 53.2%.

Other conditions leading to kidney disease such as diabetes and hypertension were present in a large proportion of the study population. Given the plethora of literature demonstrating the adverse relationship between diabetes and hypertension, and subsequent long term poor renal outcomes, the impact of such high rates on future prevalence of kidney disease in Mauritius, although not known, is expected to be significant.

Serum Lipids:

- Despite the availability of lipid-lowering drugs, about a third of Mauritians had elevated total cholesterol levels and almost 51% of the study population had an abnormality in one of four lipid levels.
- Fifty-eight percent of men and 43% of men and women had abnormal lipid profiles which were not treated. In younger people, awareness of lipid levels should be promoted so as to encourage healthy dietary practices (low saturated fat intake to reduce LDL-C levels and lifestyle measures) to raise HDL-C and lower triglycerides. In the middle ages and the elderly where vascular disease exists, statin therapy has an important role.
- The importance of nutrition in the control and prevention of high cholesterol cannot be underestimated as a first line therapy for the prevention of cardiovascular disease.

Smoking:

- Smoking rates in Mauritian men are still very high
- Smoking prevalence is highest in young people, particularly young men and deceases with age in both genders. Anti-smoking campaigns should be targeted at young men.

10.0 Survey methods

Survey protocol and procedures

10.1 Sample size

The target population for the survey was adults aged 20 – 74 years. Considering information from past surveys on the prevalence of diabetes, the degree of precision desired around the new prevalence estimate, and the cluster effect, a minimum sample size of 5400 was required for the study. Taking into account non-response, a sample size of 6000 - 7000 subjects was considered adequate for the field survey.

10.2 Sample design

Mauritius was divided into nine districts to ensure geographical representation. The total sample size to be drawn from each district was proportional to the population size of the district. Within each district, an 'index' primary sampling unit (PSU) was randomly chosen proportional to the population size of the PSU. Each PSU comprises approximately 300 households. Two neighbouring PSU were annexed to the *index* cluster to make a *main* cluster. Thus a *main* cluster comprised 3 PSU. A total of 20 *main* clusters were then selected for the whole island with each *main* cluster consisting of 900 – 1100 households. Two additional smaller clusters, each with approximately 200 households, were selected in the district of Port Louis to ensure particular ethnic groups adequate representation.

In each of the 20 *main* clusters, a selection of 1 in 3 households was to be made to have on average 320 households per cluster and to have around 200 households for the two additional abovementioned clusters. In each household selected, only one person was randomly chosen to give an approximate survey sample size of 6371 subjects for the whole island.

10.3 Enumeration

The enumeration exercise consisted of a household census in each main cluster, with around 900 – 1100 households to be enumerated per cluster. A total enumeration of around 20,000 households was made.

10.4 Invitation and recruitment

In each household selected, the randomly chosen person was invited to attend the survey at a given date in writing. They were asked to arrive at 7 am and were asked to fast for at least 12 hours and bring along any medications.

Participants were tested at each of the 22 sites. On-site testing commenced on 11 July 2009 and finished on 17 August 2009. The list of sites is shown in Table 10.1.

10.5 Training

Two teams of survey staff were recruited to administer the survey. All staff attended a three-day training workshop, which was conducted by the project manager, staff from the Ministry of Health and Quality of Life and Dr Magliano and Professor Soderberg. Staff were briefed on the survey's background, objectives and methodology to ensure accurate and consistent data collection.

10.6 Physical examination

The physical examination procedures closely follow the study protocol as recommended by the World Health Organization for the study of diabetes and other non-communicable diseases. The physical examination was conducted on both weekdays and weekends over a 6-week period in each of the sampled areas. Local survey sites included community halls, scout halls, sporting halls, church halls and schools. Survey activities at the testing site commenced at 7am and typically finished at 1pm. On average, approximately 90 participants attended daily.

All participants gave written informed consent to participate in the survey upon arrival at the testing site. Participants were moved through the physical examination procedures in a circuit-like manner that took approximately 2–2.5 hours to complete. Participants were asked to remain on site until all tests were performed. Central to the physical examination was the standard two-hour oral glucose tolerance test (OGTT), during which time all other procedures were performed.

10.7 Blood sampling, oral glucose tolerance test and laboratory procedures

Blood was collected by venepuncture after an overnight fast (nine hours or more). Specimens were collected into separate tubes in the following order: a plain tube for measurement of total cholesterol, high-density lipoprotein cholesterol, triglycerides, creatinine and urea, a fluoride/oxalate tube for plasma glucose and an EDTA tube for HbA1c. Blood specimens collected in the fluoride/oxalate tubes and the plain tubes were centrifuged on-site to separate out the plasma and serum. Glucose was assayed on site using a YSI 2300 STAT PLUS instrument. All other analyses were conducted at Victoria Hospital. Serum triglycerides, total cholesterol and HDL-C were measured by enzymatic methods adapted on the automated systems of Targa and Cobas Mira plus. HbA1c was analysed using the HPLC method on the Tosoh G7 automated system. Low-density lipoprotein cholesterol was derived by calculation using the Friedewald formula. A 75 g OGTT was performed on all participants, except those on insulin or oral hypoglycaemic drugs, those who were pregnant or those who failed to fast.

10.8 Urine collection and laboratory procedures

A morning spot urine sample was taken. Each sample was screened for presence of protein using the Medi-test protein 2 strips (Macherey-Nagel, Germany). Urine creatinine was measured by the modified kinetic Jaffe reaction on the Roche Cobas Integra 400 (Roche Diagnostics) chemistry-analyser. Urine albumin was measured by a method based on radioactive label from Immunotech (Beckman Coulter-France).

10.9 Anthropometry

Height was measured to the nearest 0.5 cm without shoes using a stadiometer. Weight was measured without shoes and excess clothing to the nearest 0.1 kg using a mechanical beam balance and weighing scales. Body mass index (BMI: kg/m2) was calculated. Waist circumference and hip circumference were measured using a dress-maker's measuring tape applied horizontally. Waist girth was measured at the mid-point between the iliac crest and the lower margin of the ribs. Hip girth was recorded as the maximum circumference around the buttocks. Waist and hip circumference were measured to the nearest 0.5 cm.

10.10 Blood pressure

Blood pressure measurements were performed in a seated position after resting for five minutes or more using an automated blood pressure monitor that was regularly calibrated (Omron Blood pressure machine SEM-1). A cuff of suitable size was applied on the participant's exposed upper arm (the arm not used for blood collection), which was supported on a table at heart level. An 'obese' cuff was available. Two measurements were taken, with a 1 minute interval between them, and the mean of the two measurements was calculated. If the difference between the first and second measurement was greater than 10 mmHg, for either systolic or diastolic blood pressure, a third measurement was taken, and the mean was calculated from the two closest readings.

10.11 Questionnaires

A series of interviewer-administered questionnaires was used to ascertain a range of health and social information including, previous diagnosis of diabetes and cardiovascular disease, exercise, and smoking.

Table 10.1. List of clusters used in the survey

SN	District Name	Clusters
1.	Port Louis	Tranquebar
		Cité Vallijee
		China Town
		Plaine Verte
2.	Pamplemousses	Terre Rouge
		Pamplemousses
3.	Riviere Du Rempart	Plaines des Roches
		Roche Noires
4.	Flacq	Bel Air
		Lallmatie
		Quatre Soeurs
5.	Grand Port	Rose Belle/ Madame Lolo
		La Sourdine
6.	Savanne	Chemin Grenier / Camp Charlot
7.	Plaine Wilhems	La Caverne
		Quatre Bornes/ La Source
		Coromandel
		Mare Gravier, Beau Bassin
		Engrais Martial, Curepipe
		Floreal
8.	Moka	Petit Verger, St Pierre
9.	Black River	Bambous

Table 10.2. A list of staff who worked on the study.

Chief Investigator	Mrs Jotee Ramdewor	Retinal Photography Officers	Mrs Ramjaun Razia Bibi
Dr N. Gopee	Mr Bangalee Vidianath	Mrs Ramhit Oomawtee	Mr Jangi Ravindra Kumar
Principal Investigators	Mrs Purgass Vishwani	Mr Ponen Poospanaden	Mrs Sahabooleea Nashrine
Dr N. Jaypaul	Mr Seethiah Vikash	Mr Dooboree Vinay	Mr Hossain Saib Mehboob
Dr A. Deelchand	Mrs Bhagoo Dhanwantee	Mr Mohabeer Vishal	Mrs Bauhroo Bharati
General Administrator/ Investigator	Mrs Bhivah Babeeta	Interview Supervisor	Mrs Mohit Lata
Mr D. Gaoneadry	Mrs Coopen Venmani	Mrs Joganah Shashee Devi	Mrs Sobrun Savita
Survey Project Manager / Investigator	Mrs Priyamvada Sowaruth	Survey Procurement Officer	Mr Moongah Shashi
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