Republic of Mauritius

Ministry of Health and Wellness

Mauritius Non Communicable Diseases Survey 2021

The Trends in Diabetes and Cardiovascular Disease Risk in Mauritius

The Mauritius Non Communicable Diseases Survey 2021

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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 (1987, 1992, 1999, 2004, 2009 and 2015), was carried out in 2021. This report provides a summary of the burden of the key NCDs and their risk factors. The data presented here are standardized for age and sex.

Diabetes Mellitus

- The standardized prevalence of Type 2 Diabetes in the Mauritian population aged 25-74 years was 19.9%: 21.6% in men and 18.5% in women.

- The prevalence of pre-diabetes, being either impaired glucose tolerance or impaired fasting glycaemia, in the population was 15.9%: 17.1% for women and 14.4% for men in Mauritian adults aged 25-74 years.

- Among those people known to have diabetes, metabolic control of their diabetes as judged by blood glucose levels was moderately poor (31.7% had HbA1c ≥9.0%); this is indicative of a very high risk of developing diabetic complications, although this proportion has fallen since the last survey in 2015 (35.6%).

Hypertension

- The standardized prevalence of hypertension was 27.2%: 26.9% in men and 27.5% in women.

- Of those with hypertension, only 60.5% of individuals were currently on medication for hypertension: 53.7% in men and 62.9% in women.

- Among those treated for hypertension, 49.9% continued to have an elevated blood pressure (i.e. above 140/90 mmHg): 47.8% in men and 51.3% in women.

Overweight and Obesity

- Using the Body Mass Index (BMI) with ethnic specific cut-off points,

- the standardized prevalence of obesity was 36.2%: 29.9% in men and 41.6% in women and
- the standardized prevalence of overweight was 36.0%: 38.7% in men and 33.8% in women.

- Thus, 72.2% of the participants were classified as overweight or obese. The rate of men was 68.6% and for women, 75.4%.

Lipids

- The age and sex adjusted prevalence of high cholesterol (≥ 5.2 mmol/L) was 34.8%: 39.6% in men and 30.8% in women.
- 14.6% of those with previously diagnosed diabetes achieved lipid control with a Low-Density Lipoprotein (LDL) equal or lower than 1.7 mmol/L.
- 18.4% of those with self-reported cardiovascular disease had lipid control with LDL equal or below 1.7 mmol/L.
- Lipid-lowering agents were being taken by 18.6% of the study population.

Smoking

- The standardized prevalence of current smoking was 18.1%: 35.3% in men and 3.7% in women.
- The prevalence of smoking was highest in the younger age groups with 48% of men aged 25–34 years reporting smoking.

Physical Activity

- 67% reported Physical Activity (PA) corresponding to 600 MET (Metabolic Equivalents) or more: 73.6% in men and 61.4% in women.

  MET is defined as the energy cost of sitting quietly and is equivalent to a caloric consumption of 1 kcal/kg/hour.

- 40.2% reported PA during leisure time or during transport equal or more than 30 minutes per day: 46.9% in men and 34.6% in women.

- 14.0% and 38.8% of the study population respectively, reported any vigorous and moderate intensive physical activity at work.

Alcohol Consumption

The standardized prevalence of harmful consumption of alcohol was 15.4% in 2021: 26.3% in men and 4.5% in women.

Chronic Kidney Disease

- The standardized prevalence of reduced kidney function (<60 ml/min) was 3.9% in 2021: 3.7% in men and 4.1% in women.

- Albuminuria (ACR ≥3 mg/mmol), an index of kidney disease, was detected in 6.3% of the survey population in 2021: 6.4% of men and 6.2% of women had micro-albuminuria.

Asthma

- The age and gender standardized prevalence of asthma in adults was 7.5%: 6.8% in men and 8.0% in women.

Retinopathy

- Among participants eligible for retinal screening (participants with diabetes or newly diagnosed with diabetes), 10.8% had evidence of any grade of retinopathy in one or both eyes.

Conclusions

The Mauritius NCD Survey 2021 showed a decrease in the prevalence of diabetes as well as pre-diabetes since last measured, some six years back. The prevalence of hypertension appears stable. There has been an increase in the percentage of persons undertaking physical activity.

Improvement in terms of public awareness of Non-Communicable Diseases is observed as shown by a decrease in the proportion of both newly diagnosed diabetes and poorly controlled diabetes. A decrease in the prevalence of high cholesterol has also been noted.

Overall, improvements in the status of NCDs and their risk factors have been observed. However, NCDs remain a major public health problem in Mauritius. Pre-diabetes and obesity are major precursors of diabetes and cardiovascular disease. Consequently, their high prevalence coupled with that of hypertension may contribute to a significant threat in terms of the future social and economic burden of heart disease and diabetes complications in Mauritius.

CVD risk factors tend to occur simultaneously due to the combined effect of genetic susceptibility and lifestyle factors. This highlights that future interventions must address several key risk factors together.

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, strategies which also target obesity, as a means of curbing the impact of this epidemic. Since this survey shows evidence that there is a decrease in the prevalence of diabetes, the measures taken in recent years to prevent diabetes should be reinforced and expanded.

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. This knowledge should drive intervention strategies. However, it is also essential to consider interventions that have not yet been tested in clinical trials. These should include transport, education, workplace, food supply and labelling, and town-planning interventions. These interventions, which target the whole population are considered to be as important as those directed at individuals.

In regard to the prevalence of NCDs and their risks factors in the Mauritian population it has been recommended to renew the **National Service Framework for Non Communicable Diseases** and the **Integrated National Action Plan for Non Communicable Diseases.**

The framework will include technical protocols, service standards and will align them with the individual NCD Action Plans. It will be a policy set by the national health authorities to define standards of care for non-communicable diseases enshrined in a service protocol by setting appropriate quality standards. The purpose of the document will be to support people with prevention and management of NCDs, maintaining independence and achieving the best possible quality of life through an integrated process of education, information sharing, assessment, care planning and service delivery.

This Integrated National Action Plan for the prevention and management of NCDs in Mauritius, along with the National Service Framework for Non Communicable Diseases, will be a key policy and action tool for delivering a real change in the way health and social care bodies and their local partners will work with people with long-term conditions to plan and deliver the services which they need to make their lives better.

It is recommended to **reduce salt intake** in the mean population as salt reduction helps to decrease blood pressure and the incidence of hypertension and it is also associated with a reduction in morbidity and mortality from cardiovascular diseases.

The **Salt Intake Survey needs to be done again** as the last one was done in 2012 and it has become outdated. This survey will enable the establishment of the current baseline average consumption of salt (sodium), potassium and iodine through 24-hr urinary excretion testing and to assess the knowledge, attitudes, practices and behavior around dietary salt in order to device a more effective salt reduction strategy in Mauritius.

Physical Activity Prescription should be adopted in hospitals, Mediclinics, AHCs and CHCs by trained physicians where patients will obtain a physical activity referral as per their medical condition and capacity. In the right dose, physical activity can help to prevent, treat, and manage a range of chronic health conditions that increasingly impact the quality of life and physical function on a global scale.

The **Project of Family Doctor** has a high potential in providing holistic care to diabetic patient within the family and community setting since diabetes is hereditary. **Local Health Committees** should be used to raise awareness and commission tailored lifestyle interventions to people who are at high risk.

Interpretative nutrition labelling like traffic lights should be supported to decrease sugar sweetened beverages/food and unhealthy snacks. The nutrition labelling (listing nutritional information on menus and menu boards) should be extended to grocery stores and restaurants where it will act as a health education tool, to help consumers achieve healthier diets and better overall health. Offer (tax) subsidies to companies who actively support their employees' health and support companies to develop and implement measures of operational health management. Advertisement of unhealthy food choices across the media spectrum should be restricted.

The NCD, Health Promotion and Research Unit has played a crucial role in the prevention and control of NCDs in Mauritius. Thus, the NCD screening and health promotion programme should be sustained as well as supported by financial and human resources in the fight against NCD and their risk factors.

It is recommended to restyle the post of Specialised Diabetes Nurse to NCD Nurse who will form part of the multidisciplinary team and will become multitask nurses empowered to provide professional and personalized care regarding NCDs / comorbidities and their related complications, rather than sticking to diabetes care only.

Reactivation of the Multi-Sectoral Approach in combatting NCDs, given the magnitude of the burden, can prevent and manage non-communicable diseases effectively. The Multi-disciplinary, coordinated approach across health, finance, education, sports, agriculture and the food industry sectors can contribute towards reversing the underlying causes of diabetes. The setting up of a high level Multi-sectoral NCD Prevention Committee under the chairmanship of the Hon Minister of Health and Wellness is recommended. The committee would include representatives of the following Ministries and other Agencies:

- Ministry of Finance and Economic Planning and Development
- Ministry of Youth Empowerment, Sports and Recreation
- Ministry of Gender Equality and Family Welfare
- Ministry of Social Integration, Social Security and National Solidarity
- Ministry of Education, Tertiary Education, Science and Technology
- Ministry of Environment, Solid Waste Management and Climate Change
- Ministry of National Infrastructure and Community Development
- Ministry of Local Government and Disaster Risk Management
- Ministry of Agro Industry and Food Security
- Ministry of Commerce and Consumer Protection
- Ministry of Public Service, Administrative and Institutional Reforms
- Ministry of Information Technology, Communication and Innovation
- Attorney General's Office
- National Transport Authority
- Central Electricity Board
- Open University of Mauritius
- Mauritius Institute of Education
- University of Mauritius (UOM)
- University of Technology Mauritius (UTM)
- Mauritius Police Force
- Road Development Authority
- Mauritius Institute of Health
- Joint Economic Council
- Economic Development Board
- Mauritius Employers Federation
- Mauritius Telecom
- World Health Organization
- Non-Governmental Organisations
- Private Health Institutions / Doctors' Association
- Mauritius Enterprise

1.0 Introduction

Mauritius, which comprises a multi-ethnic population (Asian Indian Hindus, Asian Indian Muslims, Chinese and Creoles) has undergone rapid industrialisation, economic growth and general improvements in living standards over the past several decades, and this has brought in its wake a shift in the disease pattern in the country.

In Mauritius, diabetes mellitus and heart diseases were the first two principal underlying causes of mortality in 2020, with 2,269 (21.1%) and 2,056 (19.1%) deaths respectively; Cancer and other neoplasm of all sites taken together was in the third position with 1,378 (12.8%) deaths. Deaths due to cerebrovascular diseases which amounted to 924 (8.6%) was in the fourth position, followed by hypertensive diseases with 497 deaths (4.6%). Mortality due to "Diabetes Mellitus" followed a decreasing trend from 26.5% in 2012 to 21.1% in 2020.

Numerous population surveys of diabetes and other Non-Communicable Diseases (NCDs) have been carried out in Mauritius since 1987, and the 2021 survey was the seventh study. The first three surveys were conducted by the International Diabetes Institute (Australia) with funding from the National Institute of Health (US) in conjunction with other collaborators. Since 2004, the surveys were conducted by the Ministry of Health (Mauritius) in close collaboration with Baker Heart and Diabetes Institute (Australia), University of Helsinki (Finland), University of Umea (Sweden), and Imperial College (UK).

These studies have shown the emergence of NCDs concurrently with lifestyle changes. Their contribution to the scientific understanding of the causes of NCDs in Mauritius 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 in 1987 showed an overall crude prevalence of 14.6% for diabetes mellitus and 16.8% for impaired glucose tolerance (IGT) (which is a risk marker for both type 2 diabetes and cardiovascular disease, such as, ischaemic heart disease (IHD)). In 1987, about 60% of those found to have type 2 diabetes were previously undiagnosed, indicating a large pool of unknown morbidity in the community.

In the subsequent surveys carried out approximately every five years, the prevalence of diabetes showed an increasing trend in 1992, 1998, 2004 and 2009. The prevalence of diabetes in the middle-aged population increased to 22.9% in 2015. Subsequently, there was an increased awareness of NCDs in the community resulting in a fall in the proportion of undiagnosed cases of diabetes, and in 2015, this proportion was 38%. Notably, the prevalence of Impaired Glucose Tolerance (IGT) had decreased to 14% in 2015.

The previous survey reports revealed that the burden of risk factors for NCDs was high. Mauritius has thus major problems with NCDs (diabetes mellitus, hypertension and cardiovascular disease and their risk factors). A lot of work was needed for their prevention and control measures were developed and several new strategies were implemented to reduce NCDs and their risk factors, and to better manage individuals with established diseases.

In 2021, a new NCD survey was conducted in collaboration with the Monash University, Australia; University of Helsinki, Finland; Umea University Hospital, Sweden; Baker Heart and Diabetes Institute, Australia; and Imperial College, UK with the aim to strengthen national strategies for the prevention and control of NCDs.

2.0 Study Objectives

2.1 Overall

To determine the prevalence and study the trends in diabetes, pre-diabetes, hypertension, cardiovascular diseases, obesity and their associated risk factors in the Mauritian population.

2.2 Specific

- To measure the prevalence of diabetes mellitus and pre-diabetes (IGT and IFG).
- To examine complications of diabetes including retinopathy and nephropathy.
- To measure the prevalence of cardiovascular risk factors including general and abdominal obesity, hypertension, blood cholesterol levels, cigarette smoking, alcohol consumption and physical inactivity.
- Assess the public awareness of diabetes mellitus, and the importance of its metabolic control (levels of haemoglobin A1C).
- To measure the public awareness of hypertension, and its control.
- To measure the prevalence of asthma-like symptoms.
- To measure the prevalence of ischemic heart disease according to resting electrocardiogram (ECG).
- To measure vascular health by pulse wave velocity.
- To validate the physical activity questionnaire (Accelerometer).

3.0 Study Design and Methodology

3.1 Study design

The Mauritius NCD Survey 2021 is a cross-sectional study based on a representative sample of the Mauritian adult population.

Since 1987, the methodologies of the surveys and age distributions of the samples were generally similar. It is important to note that the 1992 and 1998 surveys were predominantly follow-ups of the 1987 survey, while the 1987, 2009, 2015 and 2021 survey samples were entirely independent samples. The 2004 survey consisted of both follow-up and independent samples. In addition, in 2015 a follow-up was done of the 1998 sample.

3.2 Sampling frame

Considering information from past surveys on the prevalence of diabetes, the degree of precision desired around the new prevalence estimates, and the cluster effect, a minimum sample size of 4000 participants was required for the study.

Mauritius is divided into nine districts and the number of participants drawn from each district was approximately proportional to the population size of each district. Ensuring that all the 9 districts of Mauritius were included in the sample while considering the ratio of urban/rural regions, 14 localities (excluding China Town/Ward IV) were randomly selected to be covered by the study, as follows:

SN	DISTRICT	SN	LOCALITY	IN THE REGION OF
1	Port-Louis	1	Plaine Verte	Dr I. Goomany Street
		2	Sainte Croix	Père Laval
		3	China Town / Ward IV	China Town / Ward IV
2	Plaines Wilhems	4	Curepipe	Forest Side
		5	Quatre-Bornes	Belle Rose
		6	Vacoas/Phoenix	Reunion, Vacoas
		7	Beau-Bassin/Rose-Hill	Mont Roches
3	Pamplemousses	8	Pointe aux Piments	Near Government school
4	Rivière du Rempart	9	Plaine des Papayes	Central
5	Flacq	10	Camp de Masque Pavé	Central
		11	Laventure	Central
6	Grand-Port	12	New Grove	Central
7	Savanne	13	Camp Diable	Around Riche Bois Road
8	Moka	14	Petit Verger, St Pierre	Petit Verger
9	Black-River	15	Bambous	NHDC

The target population for the survey was Mauritian adults aged 20 to 74 years. Because of the heterogeneity of the Mauritian population and in order to obtain reliable estimates of the prevalence of the diseases being studied and their risk factors, it was necessary that participants be drawn from all over the nation to represent all socio-economic groups. Therefore, a two-stage cluster sampling was used in the 2021 NCD survey.

After the selection of the 15 localities, a listing exercise was carried out within each region. The participants were then randomly selected from the sampling frame obtained through the listing exercise. The 15 localities included 2 clusters, namely Plaine Verte and China Town/Ward IV, which were listed to ensure that all ethnic groups were adequately represented in the sample. The details collected of each person within each of the enumerated households during the listing exercise included names, contact details, address, date of birth, gender and ethnic group. A total of 6,500 households was finally enumerated.

After the exercise of data capture, the listed individuals from the 15 clusters were pooled together to obtain a master file. To ensure that the sample was representative of the Mauritian population, all the listed adults were grouped by ethnic group and sex and then sorted by age.

A systemic sampling was carried out within each group. A total of 4,305 participants were invited to participate in the survey.

To obtain reliable comparable estimates of the parameters under study across the various NCD surveys that have been carried out, the main findings of the 2021 survey have been standardized using the 2008 population of Mauritius distributed by age-group and sex.

4.0 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. Site-names, number of selected participants and attendance rates are given in Table 1.

Table 1. Response rate 2021 by survey site

SITE	PARTICIPANTS SELECTED	PARTICIPANTS ATTENDED	% ATTENDANCE
Bambous	301	256	85.0
Belle Rose	230	193	83.9
Camp de Masque Pavé	460	411	89.3
Camp Diable	267	209	78.3
China Town/Ward IV	228	188	82.5
Forest Side	245	203	82.9
Laventure	393	312	79.4
Mont Roches	236	215	91.1
New Grove	301	265	88.0
Petit Verger	310	267	86.1
Plaine des Papayes	235	181	77.0
Plaine Verte (BAT)	315	266	84.4
Pointe aux Piments	211	172	81.5
Sainte Croix	273	226	82.8
Vacoas	300	258	86.0
Total	**4305**	**3622**	**84.1**

Among those invited to participate in the survey (n=4305), 3622 responded, making the overall response 84.1%.

Altogether 37% of all participants were chosen from an urban setting. The characteristics of the survey population are described in Table 2.

Table 2. Demographic characteristics of the participants of NCD Survey 2021

	SURVEY 2021
No	**3622**
Sex (%)	
Female	54
Male	46
Age (mean)	49.8
Age group (%):	
<25	4.9
25-34	13.0
35-44	19.3
45-54	21.9
55-64	25.2
65-74	14.7
75+	0.9
Ethnicity (%):	
Indian Asian	79.5
Creole	14.8
Chinese	5.6
Educational level (%):	
None or I-IV	32.9
Secondary	53.1
Tertiary	12.6

All prevalence given in this report is based on participants aged between 25 to 74 years. This age interval has also been used in previous reports from Mauritius enabling comparison backwards.

Before discussing different diseases and cardiovascular risk factors, it is important to highlight that 75.5% of the participants described their health as good to excellent: 79.4% in men and 72.1% in women. The difference between men and women is statistically significant and deserves further studies.

5.0 Diabetes and Pre-diabetes

5.1 Background

The term diabetes mellitus describes a metabolic disorder with multiple causes and is characterised by chronically elevated blood glucose levels (hyperglycaemia), 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 the person to many severe health conditions, including cardiovascular disease, as well as visual loss, amputations, and renal failure.

Type 2 diabetes constitutes at least 90% of all diabetes. It is now a common and serious global health problem, which, for most countries, has evolved in association with rapid cultural and social changes. These include ageing populations, increasing urbanization, dietary changes, reduced physical activity, sleep disorders leading to obesity and other unhealthy lifestyle and behavioural patterns. Many of these risk factors for type 2 diabetes are also risk factors for cardiovascular disease and other chronic diseases.

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. This is the second only disease, after HIV/AIDS, to attain that status. For the first time, governments 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 recognised that diabetes would likely be one of the most important health challenges for the global public health community in the 21st century.

5.2 Definitions

5.2.1 Diabetes and pre-diabetes

The diagnostic criteria for diabetes and pre-diabetes [Impaired Glucose Tolerance (IGT) and Impaired Fasting Glucose (IFG)] were based on the values for venous plasma glucose concentration (fasting and two-hour measurements) outlined in the 1999 WHO report on the Diagnosis and Classification of Diabetes (Table 3). People who reported taking oral glucose-lowering drugs 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 IGT and/or IFG. In this report, results for type 1 and type 2 diabetes have not been reported separately, as the majority of cases were classified as type 2.

5.2.2 Known diabetes

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

1. Receiving glucose-lowering drug 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 at the current survey examination had a fasting plasma glucose or 2-hr post-load glucose over the cut-off levels for diabetes mellitus (Table 3).

Newly diagnosed (NDM) cases of diabetes were those who at the current survey examination had a fasting or 2-hour plasma glucose measurement over the diabetes cut-off range, but were not aware of the diagnosis and did not receive any glucose lowering drugs.

Table 3. Classification values for the oral glucose tolerance test.

	FASTING GLUCOSE		2-HOUR POST GLUCOSE LOAD
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: Plasma glucose (mmol/L) values are shown. All participants on oral hypoglycaemic medication or insulin were classified as having diabetes. Those who fulfil the criteria for both IFG and IGT are labelled as IGT in this report.

5.3 Results

The prevalence of diabetes (age and sex standardised to the national population of Mauritius in 2008) in adults aged 25-74 years was 19.9%: 21.6% for men and 18.5% for women. The age specific prevalence of total diabetes (DM), known diabetes (KDM), and newly diagnosed diabetes (NDM) stratified for sex and ethnicity are shown in Table 4 and in Table 5. Furthermore, the tables show that most participants with diabetes had a known diagnosis (KDM) already at the time of the survey, and the proportion of NDM was 26.2% for all: 27.5% for men and 24.9% for women.

The age and sex adjusted prevalence of diabetes in Asian Hindu Indians and Asian Muslim Indians was 21.6% and 18.9%, respectively, and the prevalence of KDM and NDM in Asian Hindu Indians were 15.5% and 16.6%, respectively, and the prevalence of KDM and NDM in Asian Muslim Asians was 13.3% and 5.6%, respectively. The prevalence for all categories (DM, KDM and NDM) was thus numerically lower in Asian Muslim Indians, and the difference in prevalence of NDM was statistically significant.

Table 4. Age specific prevalence of diabetes in 2021 for all participants, and after stratification for age and sex.

	ALL			**MEN**			**WOMEN**		
Age	DM	KDM	NDM	DM	KDM	NDM	DM	KDM	NDM
25-34	4.4	2.2	2.2	4.9	2.9	1.9	4.1	1.6	2.5
35-44	12.4	7.7	4.7	15.4	9.3	6.2	9.6	6.3	3.3
45-54	27.2	18.1	9.1	29.2	20.6	8.4	25.6	15.9	9.7
55-64	40.0	30.6	9.3	43.1	32.0	11.1	37.3	29.5	7.8
65-74	42.3	35.0	7.3	44.9	35.2	9.7	40.2	34.8	5.4
All*	19.9	14.0	5.9	21.6	15.1	6.4	18.5	13.1	5.4

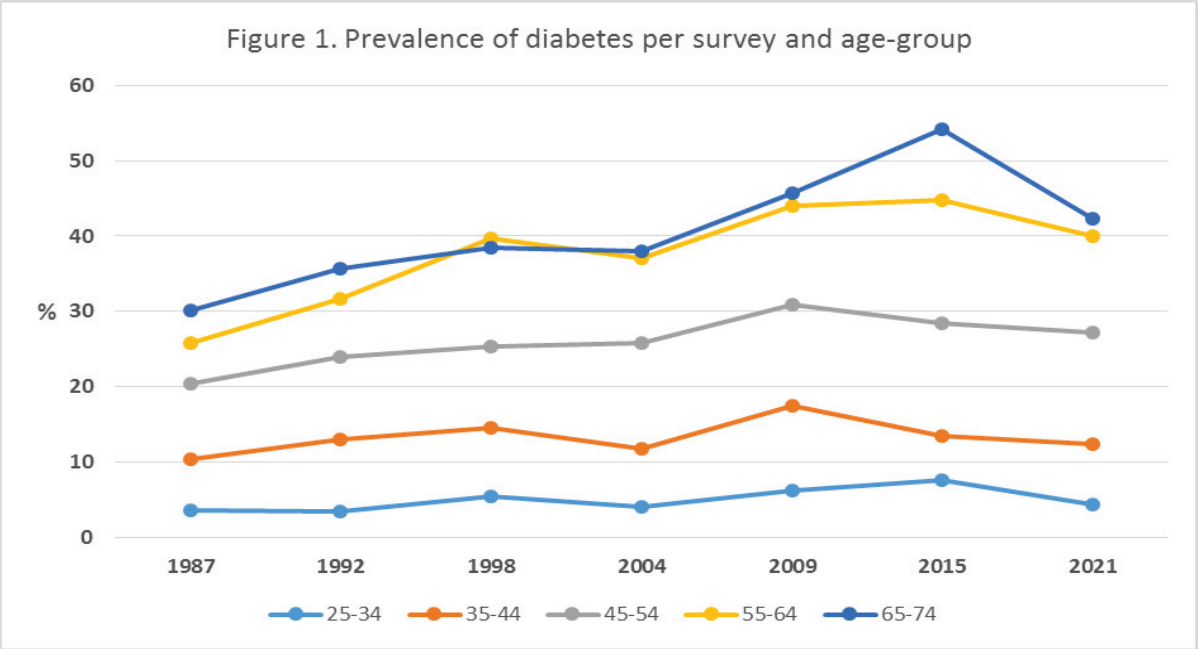
*The prevalence for all is age and sex adjusted to the national population of Mauritius in 2008. DM denoted total diabetes, KDM previously known diabetes, and NDM newly diagnosed diabetes.

Table 5. Age specific prevalence of diabetes in 2021 after stratification for ethnicity.

	ASIAN INDIANS			CREOLES			CHINESE		
Age	DM	KDM	NDM	DM	KDM	NDM	DM	KDM	NDM
25-34	4.2	2.2	2.0	6.3	2.5	3.8	0.0	0.0	0.0
35-44	13.7	8.4	5.3	7.2	5.4	1.8	0.0	0.0	0.0
45-54	27.6	18.3	9.2	28.2	18.8	9.4	10.0	5.0	5.0
55-64	41.8	33.1	8.8	39.8	26.8	13.0	18.0	9.8	8.2
65-74	46.8	39.9	6.9	47.1	40.0	7.1	14.7	5.3	9.3
All*	20.9	14.9	5.9	19.7	13.4	6.2	6.1	3.0	3.1

*The prevalence for all is age and sex adjusted to the national population of Mauritius in 2008. DM denoted total diabetes, KDM previously known diabetes, and NDM newly diagnosed diabetes.

In 2015, the prevalence of diabetes was 22.9%: 21.8% for men and 23.9% for women. The proportion of NDM at the 2015 survey was 37.7% for all. The trends in prevalence of diabetes stratified for survey and age-group is shown in Figure 1.



The prevalence of diabetes has thus gone down numerically since 2015 in both men and women and in all age-groups and in all ethnicities. The difference was statistically significant for women, Indian Asians and Chinese.

The age and sex standardised prevalence of pre-diabetes (IFG and IGT combined) was 15.9%: 14.4% for men and 17.1% for women. The prevalence of IFG was 5.8%: 6.1% for men and 5.6% for women, and the prevalence of IGT was 10.0%: 8.2% for men and 11.5% for women. The age specific prevalence of all IFG and IGT stratified for sex and ethnicity are shown in Table 6 and in Table 7. IGT was generally more common than IFG in all age-groups and IGT was more common in women than in men. In contrast to previous studies, the prevalence of IFG was similar in both men and women. Notably, IFG was more common than IGT in Chinese participants, but due to the small number of the Chinese participants, this finding should be considered with caution.

Table 6. Age specific prevalence of IFG and IGT in 2021 for all and stratified for sex.

	ALL		**MEN**		**WOMEN**	
Age	IFG	IGT	IFG	IGT	IFG	IGT
25-34	2.4	7.1	2.9	6.8	2.0	7.4
35-44	5.7	11.4	6.8	9.0	4.7	13.5
45-54	7.7	11.8	7.2	8.6	8.1	14.5
55-64	8.2	10.5	8.7	9.0	7.8	11.9
65-74	9.0	9.9	7.9	8.8	9.8	10.8
All*	5.8	10.0	6.1	8.2	5.6	11.5

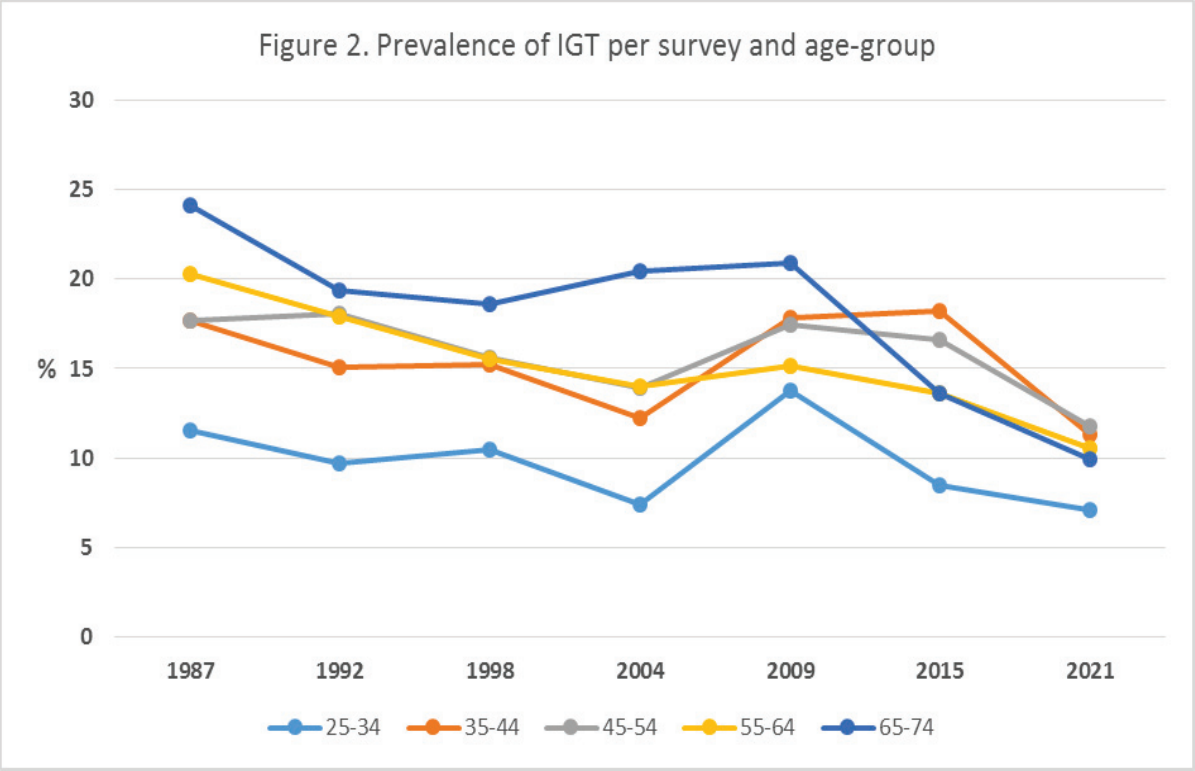
*The prevalence for all is age and sex adjusted to the national population of Mauritius in 2008. IFG denotes impaired fasting glucose, and IGT impaired glucose tolerance.

Table 7. Age specific prevalence of IFG and IGT in 2021 stratified for ethnicity.

	ASIAN INDIANS		**CREOLES**		**CHINESE**	
Age	IFG	IGT	IFG	IGT	IFG	IGT
25-34	1.4	7.0	3.8	8.9	21.4	0.0
35-44	5.3	12.1	5.4	8.1	20.0	6.7
45-54	6.7	12.4	7.7	9.4	40.0	5.0
55-64	6.8	10.9	6.5	9.8	27.9	8.2
65-74	6.3	10.3	5.7	8.6	25.3	9.3
All*	4.8	10.4	5.7	8.9	26.7	4.8

*The prevalence for all is age and sex adjusted to the national population of Mauritius in 2008. IFG denotes impaired fasting glucose, and IGT impaired glucose tolerance.

In 2015, the prevalence of pre-diabetes (IFG and IGT combined) was 19.6%: 18.8% for men and 20.4% for women, and the prevalence of IGT was 14.0%: 12.3% for men and 15.5% for women. The trends in prevalence of IGT stratified for survey and age-group is shown in Figure 2.



The prevalence of pre-diabetes and IGT has gone down numerically in both men and women, and in all age-groups. The difference was significant for both men and women.

Adequate level of glycaemic control in people with KDM was defined as having an HbA1c level below 9%. The proportion of those treated with oral glucose-lowering drugs or insulin with an HbA1c level greater than or equal to 9% was 31.7% in 2021: 35.4% in men and 28.5% in women. The corresponding numbers in Indian Asian and in Creole participants were 31.0% and 38.4%, respectively. There were too few Chinese participants in these categories for any meaningful estimation.

Notably, 9% is today seen as too high level, and 8% is a more appropriate level indicating glycaemic control. Using 8% as a cut off, 50.8% of those with KDM had an HbA1c level greater than or equal to 8% in 2021: 53.3% in men and 48.4% in women, 50.7% in Indian Asians and 51.6% in Creoles.

Compared with 2015, the public awareness of diabetes has increased as measured by a decreasing proportion of NDM, 26.2% in 2021 vs. 37.7% in 2015, with no major differences between men and women or between ethnicities. Furthermore, the proportion with poorly controlled diabetes (HbA1c $\geq$ 9%) has decreased, from 35.6% in 2015 to 31.7% in 2021. Notably, a slightly less favourable development was seen in men and in Creole participants.

6.0 Hypertension

6.1 Background

Participants who reported having hypertension and taking drug treatment for high blood pressure or those who reported hypertension and had a blood pressure of greater or equal to 140/90 mmHg at the survey examination were classified as hypertensive. Participants who had systolic blood pressure greater or equal to 140 mmHg or diastolic blood pressure greater or equal to 90 mmHg and not on blood pressure-lowering drug treatment were defined as having untreated hypertension.

6.2 Results

Table 8 shows the prevalence of hypertension according to age-groups stratified for sex and ethnicity. The prevalence of hypertension rose steadily with age in both men and women. The age and sex adjusted prevalence of hypertension was 27.2%: 26.9% in men and 27.5% in women. The prevalence was higher in women than men especially in the age group 65-74 years. The age and sex adjusted prevalence of untreated hypertension was 19.6%: 20.5% in men and 19.5% in women. In 2015, the prevalence was 27.3%: 28.6% in men and 26.2% in women.

Table 8. Prevalence of hypertension stratified for sex and ethnicity in 2021.

AGE	ALL	MEN	WOMEN	INDIAN ASIAN	CREOLE	CHINESE
25-34	6.4	5.2	7.4	6.5	6.0	5.9
35-44	18.2	21.3	15.4	17.6	21.6	13.3
45-54	35.9	36.3	35.4	34.0	49.2	18.2
55-64	52.1	51.8	52.4	51.7	55.6	50.0
65-74	61.7	56.7	65.6	64.3	67.6	42.3
All*	27.2	26.9	27.5	26.8	32.0	20.0

*The prevalence for all is age and sex adjusted to the national population of Mauritius in 2008.

Overall, 61.7% of those with hypertension had been told by a doctor that their pressure was elevated. Only 60.5% of people with hypertension were treated with blood pressure-lowering drugs: 53.7% in men and 62.9% in women. Of those treated with blood pressure lowering drugs, 49.9% had still elevated systolic and/or diastolic blood pressure: 47.8% in men and 51.3% in women. In 2015, 50.0% of those having treatment had elevated blood pressure levels.

Altogether 61.0% of those with diabetes had hypertension: 59.6% in men and 62.3% in women. The corresponding numbers for IGT were 39.7%: 40.5% in men and 39.2% in women, and for IFG 42.0%: 38.0% in men and 45.5% in women.

Compared with the results from the 2015 survey, blood pressure levels, treatment status and efficacy of blood pressure-lowering drug treatment had not changed by 2021.

Approximately one third of the adult Mauritian population have hypertension and a large proportion of them are not aware that they have the disease. Hypertension affects all age groups, and the prevalence increases steadily in both men and women irrespective of ethnicity, and, above 55 years of age, more than every second person is affected by high blood pressure. Unfortunately, half of people on blood pressure-lowering drug treatment still have elevated blood pressure. Hypertension is common in subjects with glucose intolerance.

7.0 Overweight and Obesity

7.1 Background

Obesity is strongly linked to type 2 diabetes and is a major risk factor not only for type 2 diabetes but also for other chronic conditions such as hypertension, cardiovascular disease, dyslipidaemia, some cancers, sleep disturbances 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.

7.2 Definition

Overweight and obesity were defined using criteria based on BMI (weight/height^2), and waist circumference. The WHO recommends different cut points depending on ethnicity (see below), with lower cut-offs for Asians vs. Creoles. The European cut-offs are used for Creoles. While BMI is used as a measure of overall adiposity (Table 9), the waist circumference is a more accurate measure of central adiposity (Table 10).

Table 9. Body mass index (BMI) classification of obesity.

	CREOLES	INDIAN ASIANS /CHINESE
Underweight	<18.5	<18.5
Normal	18.5–24.9	18.5–22.9
Overweight	25–29.9	23–27.4
Obese	30+	27.5+

Table 10. Classification of abdominal obesity by waist circumference

	MALES	FEMALES
Large waist *	90	80
Large waist#	94	80

Notes: * Indian Asian/Chinese cut-off points; # European and African (Creole) cut-off points.

7.3 Results

Table 11 shows the prevalence of normal weight, overweight and obesity according to BMI using ethnicity specific cut points (see Table 9). The age and sex standardised prevalence of obesity was 36.2%: 29.9% in men and 41.6% in women, and the prevalence of overweight was 36.0%: 38.7% in men and 33.8% in women. Table 12 shows the prevalence of normal weight, overweight and obesity according to BMI using ethnicity specific cut-off points and stratified for ethnicity.

Table 11. Normal weight, overweight and obesity in all and stratified for sex in 2021.

	ALL			MEN			WOMEN		
Age	NW	OW	Obesity	NW	OW	Obesity	NW	OW	Obesity
25-34	27.9	33.0	32.6	28.0	36.0	29.4	27.8	30.6	35.3
35-44	20.3	33.5	43.0	22.3	34.1	39.6	18.5	33.0	46.0
45-54	20.7	38.3	37.9	26.0	43.3	27.7	16.1	34.0	46.8
55-64	22.5	40.6	32.8	28.3	43.8	22.0	17.6	38.0	41.8
65-74	26.7	40.0	27.3	30.9	41.6	18.5	23.4	38.8	34.1
All*	23.3	36.0	36.2	26.3	38.7	29.9	20.8	33.8	41.6

*The prevalence for all is age and sex adjusted to the national population of Mauritius in 2008.
NW=normal weight, OW=overweight

Table 12. Normal weight, overweight and obesity stratified for sex and ethnicity in 2021.

	INDIAN ASIAN MEN			INDIAN ASIAN WOMEN		
Age	NW	OW	Obesity	NW	OW	Obesity
25-34	29.3	35.9	27.5	23.4	30.5	38.1
35-44	18.9	35.5	41.1	16.6	34.6	46.2
45-54	22.7	45.0	29.1	14.7	36.0	45.7
55-64	25.2	45.7	23.7	15.8	36.9	44.7
65-74	29.2	41.7	20.2	18.6	42.3	36.3
All*	24.4	39.8	30.5	18.1	34.7	42.8

	CREOLE MEN			CREOLE WOMEN		
Age	NW	OW	Obesity	NW	OW	Obesity
25-34	25.7	31.4	40.0	38.3	34.0	27.7
35-44	40.4	27.7	29.8	24.2	27.4	46.8
45-54	46.9	32.7	18.4	17.4	26.1	56.5
55-64	47.1	25.0	17.6	17.9	44.6	35.7
65-74	45.7	37.1	5.7	22.2	30.6	44.4
All*	39.0	30.1	26.7	25.4	31.9	41.8

	CHINESE MEN			CHINESE WOMEN		
Age	NW	OW	Obesity	NW	OW	Obesity
25-34	11.1	55.6	22.2	75.0	12.5	12.5
35-44	27.3	27.3	45.5	75.0	0.0	25.0
45-54	28.6	42.9	28.6	40.0	26.7	26.7
55-64	17.9	67.9	14.3	36.1	38.9	19.4
65-74	23.3	46.7	23.3	45.8	29.2	16.7
All*	21.3	46.4	28.7	58.6	18.0	20.4

*The prevalence for all is age and sex adjusted to the national population of Mauritius in 2008.
NW=normal weight, OW=overweight

Women were more often obese than men in all age groups. Obesity was more common than overweight in women whereas overweight was more common than obesity in men. Chinese women were less obese than Indian Asian and Creole women.

In 2015, using ethnicity specific cut-off points, the age and sex standardised prevalence of obesity, as per NCD Survey 2015, was 45.5%: 39.4% in men and 50.6% in women. The prevalence of overweight was 39.4%: 44.7% in men and 35.0% in women. Compared with 2015, the prevalence of obesity and overweight has decreased in both men and in women.

In 2021, 62.8% had a large waist circumference (see Table 9) according to ethnicity specific cut points: 54.7% in men and 69.9% in women. In 2015, the prevalence was 60.5%: 45.4% in men and 73.2% in women. The prevalence has thus increased significantly in men, and this was seen in both Indian Asian and Creole men.

8.0 Lipids

8.1 Background

Today, it is well established that blood lipids are a major cause for the development of atherosclerotic vessel disease, i.e. acute coronary syndromes and angina pectoris if located in the coronary vessels; ischemic and haemorrhagic strokes and transient ischemic attacks if located in the cerebral and carotid arteries; and aortic aneurysms and lower leg ischemia if located in the abdominal aorta and its more distal branches. The decreasing incidence of acute coronary heart disease in many Western European countries have been attributed to decreasing levels of cholesterol in the population due to life-style changes and usage of effective cholesterol lowering therapies. Highly effective statins in combination with ezetimibe can reduce cholesterol levels to target levels in most cases.

Total serum cholesterol (TC) is an umbrella for different lipoprotein fractions like High-Density Lipoprotein (HDL) and Low-Density Lipoprotein (LDL). For initiation of treatment and for the assessment of treatment efficacy, non-HDL cholesterol (TC-HDL) or LDL is used. HDL is not used on its own for risk estimation and pharmacological trials trying to improve the CVD risk by increasing HDL levels have failed.

Serum triglycerides (TG) is another lipid, reflecting more the metabolic condition and varies highly depending on food intake. In contrast, TC can be used even in a non-fasting state.

LDL can be determined directly but is more commonly calculated from TC, HDL and TG using Friedwald's formula. In this report, calculated LDL values are reported, and a goal for achieved lipid control was set to 1.7 mmol/L. However, it should be emphasised that according to the latest European guidelines, the goal is 1.4 mmol/L in high-risk populations such as individuals with diabetes and/or previous CVD. In previous reports, a cut-off of ≥ 5.2 mmol/L was used to indicate high cholesterol levels. Results are also given in this report for comparison, although the important public health message is LDL (or Non-HDL levels) in high-risk populations.

8.2 Results

Mean levels of TC, HDL, LDL and TG are given in Table 13. The levels from 2015 are included for comparison. Lipid levels in 2021 stratified for ethnicity are given in Table 14.

In 2021, 14.6% of people with KDM had an LDL level equal or below 1.7 mmol/L compared to 12.2% in 2015. Similarly, 18.4% of those with self-reported CVD had an LDL level equal or below 1.7 mmol/L in 2021 compared to 16.3% in 2015.

In 2021, 18.6% of the study population reported lipid lowering medication (64% reported correct drugs), and 52.6% of those with KDM reported lipid lowering medication and 78.0% of those with self-reported CVD.

In 2021, the age and sex adjusted prevalence of high cholesterol (≥ 5.2 mmol/L) was 34.8%: 39.6% in men and 30.8% in women. It has decreased compared to the NCD Survey 2015 (44.1%).

Table 13. Mean levels (with 95% confidence intervals) of serum lipids

	2021		2015	
	Men	Women	Men	Women
TC	4.9 (4.9–5)	4.9 (4.8–4.9)	5.2 (5.1–5.2)	5.2 (5.1–5.2)
HDL	1.2 (1.2–1.23)	1.4 (1.38–1.41)	1.2 (1.28–1.3)	1.4 (1.44–1.47)
LDL	3.0 (2.9–3)	2.9 (2.9–2.9)	3.1 (3–3.1)	3.1 (3.1–3.1)
TG	1.8 (1.7–1.8)	1.2 (1.2–1.3)	1.9 (1.8–1.9)	1.3 (1.3–1.4)
Non-HDL	3.7 (3.7–3.8)	3.5 (3.4–3.5)	3.9 (3.8–3.9)	3.7 (3.7–3.8)

Table 14. Serum lipid levels in 2021 stratified for ethnicity.

	INDIAN ASIAN	CREOLE	CHINESE
TC	4.9 (4.9–5.0)	4.9 (4.8–5.0)	4.9 (4.8–5.1)
HDL	1.3 (1.29–1.31)	1.3 (1.31–1.37)	1.4 (1.41–1.53)
LDL	3.0 (2.9–3.0)	2.9 (2.8–3.0)	2.9 (2.7–3.0)
TG	1.5 (1.4–1.5)	1.5 (1.4–1.5)	1.4 (1.2–1.5)
Non-HDL	3.6 (3.6–3.6)	3.5 (3.4–3.6)	3.5 (3.3–3.6)

TC=Total Cholesterol, HDL=HDL cholesterol (measured), LDL=LDL cholesterol (calculated), TG=Triglycerides. The unit is mmol/L.

Total cholesterol and LDL- cholesterol levels have decreased in Mauritius since 2015. Lipid levels were similar in all ethnic groups. A larger proportion of people with increased risk for

CVD has achieved a better control of their LDL-levels. The usage of lipid lowering therapy was higher in these groups than in the general population.

9.0 Smoking

9.1 Background

Previous surveys have shown a very high prevalence of active smoking in men whereas the prevalence in women has been low. Smoking was more common in younger age groups. Smokers in this report were those reporting active and ongoing smoking at the time of the survey. Ex-smokers were not reported. Type of smoking (e.g cigarettes and water-pipe, etc.) were not reported.

9.2 Results

The age and sex adjusted prevalence of smoking was 18.1%: 35.3% in men and 3.7% in women. Table 15 shows the prevalence by age groups stratified for sex.

Table 15. Prevalence of smoking stratified for age and sex in 2021.

AGE	MEN	WOMEN
25-34	47.9	6.7
35-44	36.5	4.9
45-54	30.3	1.4
55-64	26.2	1.2
65-74	13.0	0.7
All*	35.3	3.7

*The prevalence for all is age and sex adjusted to the national population of Mauritius in 2008. M=men, W=women.

The prevalence of smoking was highest in the younger age groups with 48% of men aged 25–34 years of age reporting smoking. Smoking decreased with age in both men and women.

The prevalence of smoking stratified for survey and age-group is shown in Figure 4 (men) and in Figure 5 (women). The prevalence in men has decreased from the very high levels in 1987 but has plateaued since 2009, although total values hide the fact that smoking has decreased in older age groups whilst levels remain high in younger males. In women, the prevalence has also decreased since 1987 although from very low levels and the findings should be interpreted cautiously due to small numbers. Notably, the prevalence has not decreased in women in the younger age-groups since 2004.

Figure 4. Smoking in men

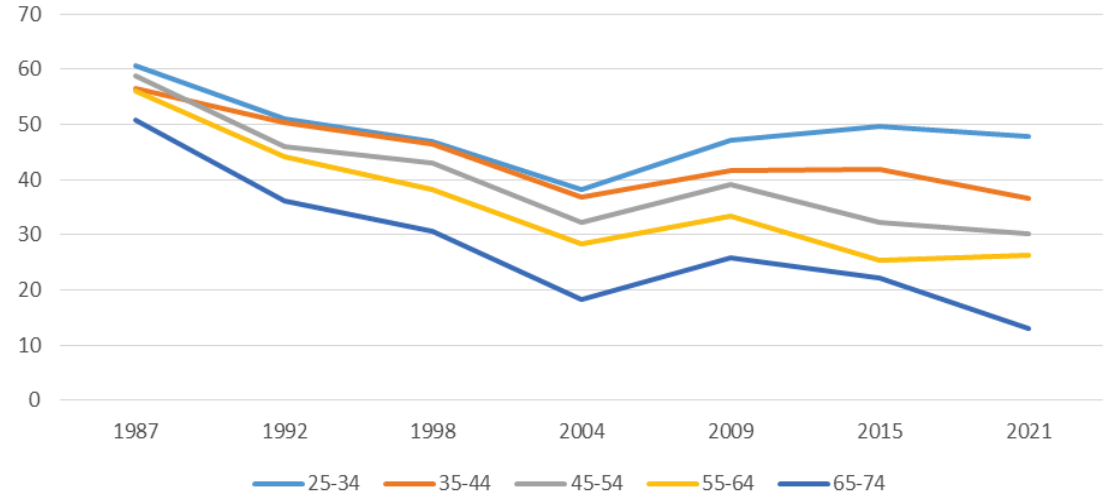
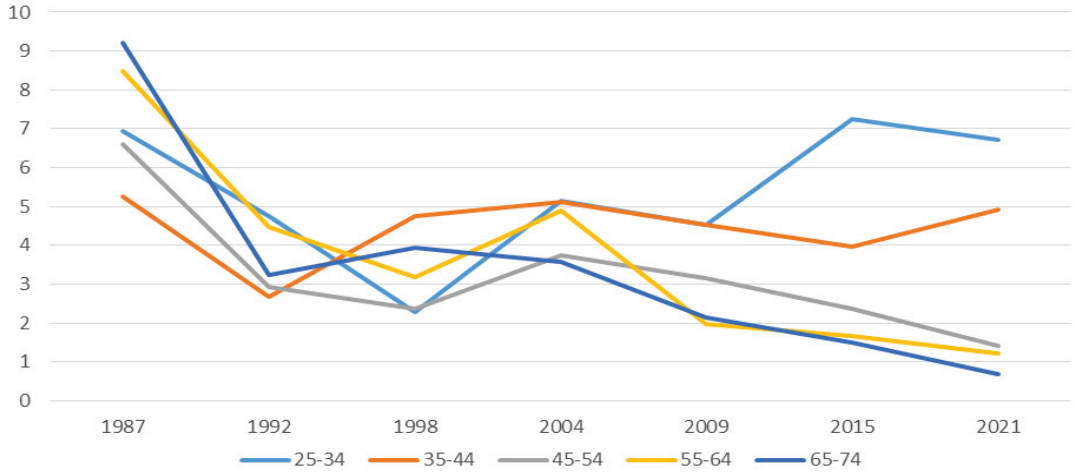


Figure 5. Smoking women



10.0 Alcohol Consumption

10.1 Background

Excessive alcohol consumption is a major public health issue but is notoriously difficult to evaluate as questionnaire data are very often unreliable due to various biases, not least in women. Furthermore, "zero-consumption" is often used as the "healthy" reference but not consuming alcohol can truly represent a lifelong teetotaller, or be due to various health problems. Until recently, alcohol research used only questionnaire data for estimation of individual consumption. Today, a biomarker for alcohol intake has been discovered (PETh) reflecting intake over a couple of weeks. This biomarker should ideally be used in future studies. In this study, a harmful consumption was defined as three drinks per day and/or drinking more than 2–3 days per week. In addition, if the participant reported any disease and/or hospital admission due to alcohol, the consumption was labelled as harmful.

10.2 Results

The age and sex adjusted prevalence of harmful alcohol consumption was 15.4% in 2021: 26.3% in men and 4.5% in women. If disease and/or hospital admissions due to alcohol were included, the prevalence was 16.9%, 30.4% in men and 5.4% in women. The prevalence of ex-drinkers was 3.2%: 3.8% in men and 2.7% in women. Table 16 shows the prevalence by age groups stratified for sex.

Table 16. Prevalence of harmful alcohol consumption stratified for age and sex in 2021.

AGE	ALL	MEN	WOMEN
25-34	19.0	31.3	8.7
35-44	14.2	26.3	3.6
45-54	14.0	27.8	2.1
55-64	14.4	28.6	2.4
65-74	12.5	23.5	4.0
All*	15.4	26.3	4.5

*The prevalence for all is age and sex adjusted to the national population of Mauritius in 2008.

Harmful alcohol consumption was common, especially in men among whom one quarter reported at least three drinks per day and/or drinking more than 2–3 days per week. This was seen in all age groups.

In total, 98.7% of the participants reported how often they had alcohol: 54.5% reported that they had never used alcohol, 3.8% were ex-drinkers, and 9.7% used alcohol at least once per week. Of those drinking at least once per week, 60.8% consumed at least 3 units per day.

11.0 Physical Activity

11.1 Background

Self–reported data on physical activity (PA) was collected using the Global Physical Activity Questionnaire (GPAQ). This questionnaire asks about moderate and vigorous PA during work and leisure time and about commuting (walking and travelling) to and from work.

According to guidelines, physical activity can be presented as either metabolic equivalents (MET) or as minutes per day performing physical activity. MET is the ratio of a person's working metabolic rate relative to the resting metabolic rate. One MET is defined as the energy cost of sitting quietly and is equivalent to a caloric consumption of 1 kcal/kg/hour. WHO recommends 150 minutes of moderate-intensity physical activity per week or 75 minutes of vigorous-intensity physical activity per week or an equivalent combination of moderate- and vigorous-intensity physical activity achieving at least 600 METs per week. In this report, PA is presented as METs based on the sum of PA at work and during leisure time plus commuting (cycling or walking) to and from work, and as the sum of minutes per day spent on vigorous and/or moderate PA during leisure time plus transport to and from work.

11.2 Results

The age and sex adjusted prevalence of PA in 2021 are shown in Table 17. Altogether 14.0% and 38.8%, respectively, reported vigorous and moderate intensive PA at work, and 11.6% and 39.5%, respectively, reported vigorous and moderate intensive PA during leisure time. Nearly 62% reported that they used cycling and or walking for transport to work.

In 2021, 67% reported PA corresponding to 600 MET or more: 73.6% in men and 61.4% in women, and 40.2% reported PA during leisure time or during transport equal or more than 30 minutes per day: 46.9% in men and 34.6% in women. Men and women in younger age groups reported more PA compared with older people.

Table 17. The prevalence of participants that reported PA at work, during leisure time and for commuting to work.

	WORK VIGOROUS PA	WORK MODERATE PA	LEISURE VIGOROUS PA	LEISURE MODERATE PA	TRANSPORT PA
All	14.0	38.8	11.6	39.5	61.6
Men	23.4	42.4	17.6	39.3	61.9
Women	6.1	35.8	6.6	39.7	61.3

The prevalence for all is age and sex adjusted to the national population of Mauritius in 2008. PA=physical activity.

Table 18. The prevalence of participants that reported PA fulfilling the recommended level of PA (≥ 600 METs or 30 min PA per day) by age and sex.

	MET ≥ 600			PA ≥ 30 MINUTES		
Age	All	Men	Women	All	Men	Women
25-34	73.1	81.0	66.4	46.6	54.5	39.9
35-44	64.6	70.5	59.5	36.5	43.8	30.1
45-54	67.5	72.0	63.6	38.1	43.4	33.6
55-64	65.7	72.1	60.4	40.1	44.4	36.5
65-74	52.6	61.3	45.8	35.2	43.7	28.6
All*	67.0	73.6	61.4	40.2	46.9	34.6

*The prevalence for all is age and sex adjusted to the national population of Mauritius in 2008. MET= metabolic equivalents, PA=physical activity.

12.0 Chronic Kidney Disease

12.1 Background

The kidneys have several vital functions in the body like excretion of waste-products, and regulation of blood pressure, blood volume and its composition to mention a few. These functions are exerted by filtration through the glomerular capsules and active exchange over the tubular endothelium. “Kidney function” is thus a complex issue involving several functions and currently used kidney function tests measure only parts of this complex function. The glomerular filtration rate (GFR) is a measure of filtration and can be determined precisely with an Iohexol clearance test. This is however not possible in large epidemiological studies. Therefore, estimated GFR (eGFR) can be obtained by measuring endogenous substances in the blood whose circulating levels depend on the filtration rate in the kidneys. The two most used are creatinine and cystatin C. However, circulating levels of creatinine are affected by muscle mass and protein consumption, circulating levels of cystatin C by thyroid diseases. Normally, circulating albumin remains in the blood but the presence of albumin in the urine indicates that the pores of the glomerular capsule in kidneys are damaged. The presence of proteins (other than albumin) in the urine can indicate tubular damage. The albumin content in the urine is usually related to the creatinine concentration in urine and an albumin-creatinine ratio (ACR) above 3 mg/mmol indicates albuminuria, or alternatively, 2.5 mg/mmol for men and 3.5 mg/mmol for women.

In this report the Lund-Malmö formula was used for estimating GFR, as this formula does not include ethnicity. An eGFR less than 60 ml/min is considered as moderate kidney failure (chronic kidney disease (CKD) stage CKD3 to CKD5).

Atherosclerosis, diabetes, hypertension, various toxins including pollutants like cadmium are known determinants for reduced kidney function.

12.2 Results

The age and sex adjusted prevalence of kidney failure (<60 ml/min) was 3.9% in 2021: 3.7% in men and 4.1% in women. The prevalence was not different from 2015 when the corresponding prevalence was 4.9%: 4.7% in men, and 5.2% in women. The age and sex adjusted prevalence of albuminuria (ACR ≥ 3 mg/mmol) was 6.3% in 2021: 6.4% in men and 6.2% in women, and

with sex-specific cut off of 6.4%, 7.1% in men and5.8% in women. Only 1.7% were told that they had any kidney disease but 16.4% were afraid for being affected by kidney disease in the future.

Of those with diabetes, 16.3% had reduced kidney function: 17.6% in KDM and 12.5% in NDM, and 5.8% in people with pre-diabetes, had reduced kidney function. Of those with hypertension or previous CVD, 14.0% and 24.8%, respectively had reduced eGFR.

Of those with diabetes, 16.8% had albuminuria: 20.2% in KDM and 7.0% in NDM, and 6.7% in people with pre-diabetes. Of those with hypertension or previous CVD, 14.4% and 15.2%, respectively had albuminuria.

The prevalence of CKD3 to CKD5 in 2021 was similar to that in 2015. Reduced kidney function and micro-albuminuria are common in subjects with known CVD, hypertension, and diabetes.

13.0 Asthma

13.1 Background

Asthma is a reversible airway obstruction causing wheezing in the chest without any relation to infection. The cause is sometimes allergy, and the attacks can be life-threatening. Chronic obstructive pulmonary disease (COPD) is characterised by non-reversible damage to the airway producing obstructive symptoms, and the cause is very often smoking and/or other inhaled particles and pollutants. To diagnose these conditions correctly, spirometry is needed with challenge with an airway dilatator in order to distinguish between asthma and COPD. In this survey, we had only questionnaire data and the prevalence of asthma-like symptoms was measured using the European Community Respiratory Health Survey (ECRHS) screening questionnaire. Asthma-like symptoms were defined as wheezing or whistling in the chest at any time in the last 12 months in which breathlessness occurred during the wheezing episode, and these symptoms occurred in the absence of a cold. We also included those who reported current medication for asthma.

13.2 Results

Using the definition described above, the age and sex standardised prevalence of asthma was 7.5%: 6.8% in men and 8.0% in women (Table 19). In 2015, the corresponding prevalence was 8.9%, 8.0% and 9.7%, respectively.

The prevalence of asthma like symptoms were similar in all age-groups and ethnicities with the exception for Chinese participants. These differences should however be interpreted cautiously due to small numbers.

The prevalence was similar between non-smokers (7.3%), ex-smokers (9.0%) and smokers (8.3%).

Table 19. Age-specific prevalence of asthma stratified for sex and ethnicity.

AGE	ALL	MEN	WOMEN	INDIAN	CREOLE	CHINESE
25-34	7.8	7.1	8.4	6.3	15.0	5.9
35-44	6.3	5.0	7.5	6.8	4.6	0.0
45-54	8.1	7.2	8.8	8.1	9.3	0.0
55-64	7.5	7.8	7.4	7.8	9.0	1.6
65-74	8.4	9.2	7.7	9.3	9.9	2.6
All*	7.5	6.8	8.0	7.3	9.7	2.1

The prevalence for all is age and sex adjusted to the national population of Mauritius in 2008.

Considering the very high prevalence of smoking now and in previous surveys, it is recommended to include spirometry in future studies to better evaluate the disease burden caused by obstructive airway disease in Mauritius.

14.0 Retinal Photography

Retinal photos were taken in a subsample, mainly people with reduced glucose tolerance, and photos were coded by local expertise. Altogether 1,153 people were examined, and after

exclusion of those with non-codable photos (n=110) and those with other lesions (n=33, mainly lens opacities), 1,010 had their retinas examined. In total, 10.8% had any form of retinopathy in one or both eyes: 12.8% in people with diabetes, 2.3% in people with IGT, 9.3% in people with IFG, and 5.8% in those with normal glucose tolerance. Macula was evaluated in 855 people and any maculopathy in any eye was detected in 9%: 10.0% in people with diabetes, 3.7% in people with IGT, 9.7% in people with IFG, and 5.5% in those with normal glucose tolerance. As the numbers for IFG and IGT are small, the results should be interpreted cautiously.

15.0 Cardiovascular Disease Risk Factors

15.1 Background

CVD risk factors tend to occur simultaneously due to the combined effect of genetic susceptibility and lifestyle factors. In this report, the presence of the following risk factors was given 1 point each and then summarized, and each person could get between 0 to 6 points. The factors were glucose intolerance (DM, IGT, IFG), hypertension (≥140 and/or ≥90 and/or treatment), abdominal obesity (ethnic cut-offs), smoking (ongoing), serum total cholesterol (≥5.2 mmol/L), and albuminuria (sec-specific cut-offs). From previous studies (i.e. Interheart etc.) it is known that the presence of several risk factors increases the risk for CVD more than the sum of the separate risk factors.

15.2 Results

The age and sex adjusted prevalence of having any three risk factors was 76.9%: 77.5% in men and 76.4% in women. In contrast, 13.5% had none of the 6 risk factors: 10.7% in men and 15.7% in women.

This highlights that future interventions must address several risk factors simultaneously, and that the risk profile changes over time. This must be considered when planning future actions against NCDs.

16.0 Survey methods (Survey protocol and procedures)

16.1 Survey Design

The NCD 2021 Survey is a cross-sectional study based on a representative sample of the Mauritian adult population.

16.2 Sampling and Sample Size

Considering information from past surveys on the prevalence of diabetes, the degree of precision desired around the new prevalence estimates, and the cluster effect, a minimum sample size of 4000 participants was required for the study.

Mauritius is divided into nine districts and the number of participants drawn from each district was approximately proportional to the population size of each district. Ensuring that all the 9 districts of Mauritius were included in the sample while considering the ratio of urban/rural regions, 14 localities (excluding China Town/Ward IV) were randomly selected to be covered by the study.

The target population for the survey was Mauritian adults aged 20 to 74 years. Because of the heterogeneity of the Mauritian population and in order to obtain reliable estimates of the prevalence of the diseases being studied and their risk factors, it was necessary that participants be drawn from all over the nation to represent all socio-economic groups. Therefore, a two-stage cluster sampling has been used in the 2021 NCD survey.

After the selection of the 15 localities, a listing exercise was carried out within each region. The participants were then randomly selected from the sampling frame obtained through the listing exercise. The 15 localities included 2 clusters, namely Plaine Verte and China Town/Ward IV, which were listed to ensure that all ethnic groups are adequately represented in the sample. The details collected of each person within each of the enumerated households during the listing exercise include names, contact details, address, date of birth, gender and ethnic group. A total of 6,500 households was finally enumerated.

After the exercise of data capture, the listed individuals from the 15 clusters have been pooled together to obtain a master file. To ensure that the sample is representative of the Mauritian population, all the listed adults were grouped by ethnic group and sex and then sorted by age. A systemic sampling was carried out within each group.

A total of 4,305 participants were invited to participate in the survey. To obtain reliable comparable estimates of the parameters under study across the various NCD surveys that have been carried out, the main findings of the 2021 survey have been standardized using the 2008 population of Mauritius distributed by age-group and sex.

16.3 Response Rate

The target population for the NCD Survey 2021 was Mauritian adults aged 20 - 74 years. Of those invited to participate in the survey (n=4,305), 3,622 attended the survey sites and thus the overall response rate was 84.1%

16.4 Invitation and recruitment

In each household selected, the randomly chosen person was invited in writing, to attend the survey at a given date. They were asked to arrive at 06 30 hours and were asked to fast for at least 10 hours and to bring along any medications (If any).

Participants were tested at each of the sites. On-site testing commenced on 23 October 2021 and finished on 23 November 2021.

16.5 Training

Two teams of survey staff were recruited to administer the survey. All staff attended a two-day training workshop, which was conducted by the Principal Investigator / Project Manager, staff from the Ministry of Health and Wellness including Central Health Laboratory, Professor Jaakko Tuomilehto, Professor Stefan Soderberg and Mr Ville Stenback. Staff were briefed on the survey's background, objectives and methodology to ensure accurate and consistent data collection.

16.6 Physical examination

The physical examination procedures closely followed the study protocol 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. Local survey sites included social welfare centres, community centres, social halls, and schools. Survey activities at the testing site commenced at 06 30 hours and typically finished at 13 00 hours. 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 3 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.

16.7 Anthropometry

Height was measured to the nearest 0.1 cm without shoes using a stadiometer. Weight was measured without shoes and excess clothing to the nearest 0.1 kg using 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. Neck girth was measured in the midway of the neck, between mid-cervical spine and mid-anterior neck. In men with a laryngeal prominence (Adam's apple), it was measured just below the prominence. Measures were recorded to the nearest 0.1 centimetre (rounding up if necessary) and repeated following both initial recordings. If there was a variation greater than 2 cm between duplicate readings then a third was taken and recorded alongside the second. (In these cases the 2 most consistent readings were used in analyses).

16.8 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 M7). 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 also available. Three measurements were taken, with a 1 minute interval between the readings, and the mean of the closest two measurements was calculated.

16.9 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. Questions were asked in a standard manner using the appropriate language (usually Creole), and numbers recorded legibly in pencil in appropriate boxes. Specific instructions regarding completion of the questionnaire were given to the staff involved.

16.10 Biochemistry Report

BACKGROUND

As in all previous surveys and screening activities (1987, 1988, 1992, 1993, 1995, 1998, 1999, 2004, 2009 & 2015), there has been a significant involvement of the Biochemistry Department of the Central Health Laboratory of the Ministry of Health and Wellness.

Assays of specific markers in blood and urine of subjects were carried within the Total Quality Assurance schemes laid down, which include standardized specimen collection and storage, reliable analytical performance, and acceptable quality control programmes.

The main markers analysed in blood were glucose (fasting & 2hr post glucose load)), urea, high-density lipoprotein (HDL) cholesterol, cholesterol, triglycerides, uric acid, creatinine, ALT (SGPT), GGT, insulin and glycated haemoglobin (HbA1c). Creatinine and microalbumin were measured in spot urine samples. The methods of these assays are described below.

METHODS

Specimen handling

Blood samples were collected in appropriate tubes and stored in cool box on site until dispatched to the laboratory. Morning urine samples were also kept in cool box. Samples were transported to the laboratory in two batches to ensure shortest delay for analysis.

Specimen collection:

Participants were asked to present at respective sites in the morning following an overnight fast. Following registration, all subjects undertook the same range of procedures for specimen collection:

(a) venous blood collected into (1) 5 ml fluoride oxalate (2) 5 ml EDTA and (3) 3x5ml plain tubes;
(b) a random urine specimen collected in a 20 ml screw capped universal container;
(c) except for known diabetics and pregnant women, a second venous blood was collected 2 hours after the subject had taken a 75 g glucose solution (250 ml). This specimen was dispensed into 5 ml fluoride oxalate for glucose assay.

Specimen transport and processing

Blood and urine samples were placed in cool box on ice packs and transported to the laboratory at different intervals to ensure that samples are processed within two hours of blood collection.

In the laboratory, blood samples were centrifuged at 4000 rpm for five minutes, serum and plasma separated and aliquoted into respective collection tubes labelled for the purpose. Urine specimen were spun at 2000 rpm for 10 minutes and supernatant was aliquoted in a 5 ml plastic storage tube.

Sample aliquoting and storage

Plasma from the fluoride oxalate samples were aliquoted in respective labelled tubes and analysed for glucose immediately after processing.

Serum samples were transferred to labelled tubes as follows: (1) aliquot for routine biochemistry tests; (1) aliquot for insulin assay (1) aliquot in 5ml plastic tubes stored at -20˚C and (2) aliquots into cryovials for storage at -20˚C.

The EDTA tubes were analysed as primary samples for HbA1c test. An aliquot of the EDTA sample was transferred into cryovials for storage at -20 ˚C.

Urine samples were aliquoted as follows: (1) aliquot for microalbumin and creatinine assays and (1) aliquot stored frozen at -20˚C.

Blood glucose on site:

Fasting plasma glucose from finger prick samples was measured on-site using the HemoCue Glucose 201RT-*plasma equivalent* system (HemoCue, Sweden). This test was done mainly to ensure that the glucose tolerance test is administered to eligible participants according to criteria as per protocol.

Biochemistry Tests

The Biochemistry tests carried out at the Biochemistry Department of the Central Health Laboratory were:

In the blood samples glucose, urea, uric acid, creatinine, total cholesterol, HDL cholesterol, triglycerides, ALT (SGPT), Gamma GT, Insulin and HbA1C were measured. Microalbumin and creatinine were determined in urine specimen.

Assays were carried out on automated systems: (a) Abbott Architect C4000 (Abbott Diagnostics USA), (b) Beckman Coulter AU 680, (c) Abbott Architect i2000 (Abbott Diagnostics, USA), (d) Cobas Integra (Roche, France) and (e) Tosoh G8 HbA1c analyzer (Tosoh Biosciences, Japan). Calibration of all automated systems were performed prior and during the survey works.

Plasma Glucose

Plasma Glucose was measured by the glucose hexokinase method using reagents from Beckman Coulter (Ref OSR 6221), adapted on the Beckman AU680 automated system. Method calibrated using system calibrator, (Ref 66300).

Urea

Urea was measured by the Urease/Glutamate Dehydrogenase-UV Kinetic method using Biosystems reagents (Ref 11517 – Biosystems, Spain). The method was adapted on the Architect C4000 automated system and calibrated using clinical chemistry calibration sera level 2 and 3 (Ref 2350/2351 -Randox -UK)

Uric Acid

The Enzymatic Colorimetric Method (DIALAB reagents): Uric acid is oxidized to allantoin by Uricase. The generated hydrogen peroxide reacts with 4-aminoantipyrine and 2,4,6-tribromo-3-hydroxybenzoic acid (TBHBA) to quinoneimine and was adapted on the Architect C4000 automated system and calibrated using clinical chemistry calibration sera level 2 and 3 (Ref 2350/2351-Randox -UK).

Creatinine

Serum creatinine was measured using a kinetic alkaline picrate method, reagents from Abbott Diagnostics-USA (Ref 3L81) adapted on the Architect C4000 automated system and calibrated using clinical chemistry calibration sera level 2 and 3 (Ref 2350/2351-Randox -UK).

Creatinine in urine was measured using an Enzymatic colorimetric calibrated to IDMS, reagents from Creatinine Roche CREP Gen 2, cat no. 03263991190.

Total Cholesterol

Total cholesterol was determined by the enzymatic endpoint Cholesterol Oxidase/Peroxidase method (Biosystems Kit Ref COD 11506 – Biosystems Spain). The method was adapted on the Architect C4000 automated system and calibrated using clinical chemistry calibration sera level 2 and 3 (Ref 2350/2351-Randox -UK).

HDL Cholesterol

HDL Cholesterol was determined by the Ultra HDL (Abbott Ref 3K33-22), methodology used is the accelerator selective detergent. The method was adapted on the Abbott Architect C4000 automated system and calibrated using kit calibrator, Ref 1E68-03 HDL Calibrator.

Triglycerides

Triglycerides in the sample was determined by the enzymatic endpoint GPO-PAP method (kit Ref COD11529 - Biosystems Spain) The method was adapted on the automated system of Abbott Architect C4000 and calibrated using clinical chemistry calibration sera level 2 and 3 (Ref 2350/2351-Randox -UK)

ALT/SGPT

ALT/SGPT was measured using Biosystems reagents, IFCC method with tris buffer & pyridoxal phosphate. The method was adapted on the automated system of Abbott Architect C4000 and calibrated using clinical chemistry calibration sera level 2 and 3 (Ref 2350/2351-Randox -UK)

GGT

Gamma- Glutamyl Transferase was measured using Abbott reagents Ref. 7D65-22. The method was adapted on the automated system of Abbott Architect C4000 and calibrated using clinical chemistry calibration sera level 2 and 3 (Ref 2350/2351-Randox -UK).

Glycated Haemoglobin (HbA1C)

EDTA whole blood was processed and analysed using the HPLC cation exchange method on the Tosoh G8 HbA1c analyzer (Tosoh Biosciences-Japan). Method was calibrated using Tosoh HbA1c calibrator (ref 0018767). Tests were carried out on three G8 equipment in parallel and method correlation was carried out on a weekly basis to ensure result reliability.

Insulin

Serum Insulin was measured on the Abbott Architect i2000 Immunoassay System. The assay is based on the chemiluminescent microparticle immunoassay (CMIA). Reagents (Kit Ref 8K41) and calibrated using Architect insulin calibrators (Ref 8K41-02) both from Abbott Diagnostics-USA.

Microalbumin in Urine Samples

Procedure used for microalbumin was based on immunoturbidimetric assay using kit from Roche (Ref ALB-T TQ Gen2). The method was adapted on the Roche Cobas Integra

automated system and calibrated using Roche calibrator (C.f.a.s PUC Ref. 03121305) & using Precinorm PUC Roche as controls. Albumin: Creatinine ratio (ACR) was calculated and reported for all samples.

Protein stix

Urine samples with microalbumin level ≥ 3+ were reported accordingly. Every tenth sample was tested for presence of proteins using the Protein stix from Siemens (Ref 02614217).

QUALITY ASSURANCE

Quality assurance includes information on how and when to collect specimen and subject preparation, interpretation of test results, analytical performance and turnaround time.

Subject preparation and collection of specimen were carried out on-site, involving non-laboratory staff as per established protocol. This section will deal with quality assurance relating mainly to analytical performance.

Levey Jenning Charts

Quality assessment materials of two different levels (high and low) were run in each batch of tests. Initially, each type of the quality material was assayed repeatedly over two weeks prior to the analysis of NCD samples. The mean and SD for each analyte of interest were calculated and respective Levey Jenning Charts were constructed showing the mean value with -1SD, -2SD, - 3SD and + 1SD, + 2SD, and + 3SD. Results of subsequent analyses of the assessment material were plotted above the appropriate date of analysis. Not more than one in twenty values should fall outside the 2SD lines.

Westgard rules were applied (Westgard JO et al, 1981) and batch of tests had to be repeated if:

- One result exceeded a 3SD limit
- Both results exceeded the same 2SD limit
- Each result exceeded a different 2SD limit.
- The last four consecutive results on both materials exceeded the same 1SD limit
- The last ten consecutive results on both materials were on the same side of the mean.

Intra-Quality Control

Human assayed control from (i) Randox assayed chemistry control level 2 (Ref HE 1530) and level 3 (Ref HE 1532) (UK) were run daily for the following assays-glucose, urea, uric acid, creatinine, total cholesterol, HDL cholesterol, triglycerides SGPT & GGT. For HbA1C, Biorad Lyphochek Diabetes Bilevel controls were used (Ref 740). For urine microalbumin and creatinine, Roche Precinorm PUC control (Ref 03121313 122) was assayed. Biorad Lyphochek Immunoassay plus trilevel Control (Ref 370) was used for Insulin assay.

Within and between Batch Imprecision

Control samples were run twice in each batch, once at the beginning and once at the end. The same control samples were analysed between days. After several pairs of values the within batch and between batch variation were calculated.

Subject based Precision

Assayed sample from a particular day's workload was stored under standard conditions to be reintroduced on the following day's run. The between batch imprecision was calculated after each week of operation. This exercise was carried out on every tenth sample of the batch analysed on a day.

External Quality Assessment

The External Quality Assessment which is an ongoing scheme from the WHO collaborating Centre for Research and Reference for clinical chemistry (Birmingham Quality, Queen Elizabeth Medical Centre, Birmingham, United Kingdom) provides the overall performance of the laboratory on a monthly basis. The Biochemistry Department of Central Laboratory is a participant in the scheme since 1984.

The performance of the Laboratory is also monitored every month of the year through participation in the Biorad Immunoassay EQAS and the department participates in the EQA system of the Swiss Quality Control Centre (CSCQ) for HbA1c on a regular basis since 2007.

RESULTS

Validation of test results was done at four levels – (a) on test bench in the routine laboratory, (b) on test site in the special assay laboratory, (c) by the team responsible for result reporting and (d) final vetting by the Principal Clinical Scientist.

After validation for quality control rules as described above, all analytical results were entered on an Excel Spreadsheet. A print out of the sheet was cross-checked with the original result data by different operators. Wherever required, analyses were repeated. All raw data and transcribed data have been kept in appropriate files.

BIOCHEMISTRY DEPARTMENT

CENTRAL HEALTH LABORATORY, CANDOS

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