



MAURITIUS RESEARCH COUNCIL

WORKSHOP REPORT

CONSULTATIVE WORKSHOP
on the
Collaborative Research Programme on Diabetes
(CRPD)

7th March 2013

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EXECUTIVE SUMMARY

Given the high prevalence of Diabetes Mellitus in Mauritius, numerous initiatives to alleviate its burden have been undertaken by the relevant authorities in particular the Ministry of Health and Quality of Life. It has, however, been noted that there is a need for more involvement of the Research Community of Mauritius to these authorities in addressing the burden of Diabetes in the country. This need is being addressed through the setting-up of a Collaborative Research Programme on Diabetes (CRPD). The CRPD encourages a participatory and research-based approach of local and international stakeholders in the field of Diabetes to form a multi-disciplinary research platform. In line with the above, a first Consultative Workshop was organised to capture the valuable inputs of these stakeholders. This full-day workshop was attended by 18 different institutions including Public and Private Sector bodies, Universities, NGOs. Participants actively engaged in discussions spread over three sessions, each one focusing on one axis of diabetes research namely: (1) *Socio-Economic Dimension of Diabetes in Mauritius*; (2) *Traditional Remedies and Indigenous for Diabetes in Mauritius*; and (3) *Fundamental and Applied Research on Diabetes in Mauritius*. These three axes have been formulated prior to the workshop based on the contributions from the Ministry of Health and Quality of life, the Ministry of Tertiary Education, Science, Research and Technology and the University of Mauritius amongst others. The outcome of the Consultative Workshop is a list of research projects with the potential to be implemented in the short, medium and long term. It is envisaged that these projects be further prioritised during a second Consultative Workshop which will also aim at identifying interested parties for project implementation. The setting-up of a Diabetes Centre has also been proposed during the workshop.

This report gives a complete account of the workshop proceedings and presents the outcomes in greater detail.

1. Purpose of the report

This report presents the proceedings of the workshop held on the Collaborative Research Programme on Diabetes (CRPD) held 7th March 2013.

2. Background and Rationale

Mauritius is one of the countries in the world where there is the highest rate of patients with Diabetes. The Mauritian population, due largely to its genetic background, is highly at risk for developing diabetes. Nearly one out of two Mauritians between the ages of 25-74 is either Diabetic or pre diabetic¹.

Although a number of laudable and highly pertinent initiatives to alleviate the burden of this epidemic have been undertaken by the relevant authorities, in particular the Ministry of Health and Quality of Life, the University of Mauritius and the NGOs working in the field of Diabetes, there is still much to be done especially in the research sector.

In light of the above, the Council, under the aegis of the Ministry of Tertiary Education, Science, Research and Technology proposed to set up a Collaborative Research Programme on Diabetes.

3. Collaborative Research Programme on Diabetes(CRPD)

The main goal of this programme is to address the Diabetes epidemic from a research perspective, while emphasising a participatory approach and soliciting the contribution of all relevant stakeholders working in the field of Diabetes in Mauritius. The programme was subdivided into three themes namely:

- 1. Socio-Economic Dimension of Diabetes in Mauritius;*
- 2. Focus on Traditional Remedies and Indigenous for Diabetes in Mauritius;*
- 3. Fundamental and Applied Research on Diabetes in Mauritius.*

¹ Source: Ministry of Health and Quality of Life – 2009 NCD Survey

4. Official Launching of the Workshop

The workshop was officially launched by **Dr the Hon Rajeshwar Jeetah**, Minister of Tertiary Education, Science Research and Technology, and the **Hon Lormus Bundhoo**, Minister of Health and Quality of Life. This initiative of the Council received the full support of both Ministries.

4.1. Participants

Some 18 institutions including Public and Private Sector bodies, Universities, NGOs actively participated in this workshop and debated on the three themes.

5. Presentation by Ministry of Health and Quality of Life

This presentation was prepared and made by the Non-Communicable Diseases (NCDs) Department within the Ministry of Health and Quality of Life. It gave a broad overview of the evolution of many NCDs in Mauritius in recent years and showed resulting initiatives, interventions, and research projects either undertaken or managed by the Ministry. The summary that follows only provides an outline of the information provided mainly on Diabetes Mellitus (DM) and does not include information relevant to all related NCDs, with the exception of Cardiovascular Diseases (CVD) and Hypertension.

5.1. The state of NCDs in Mauritius

It was shown that, in general terms, the mortality rate (number of people dying) due to NCDs had decreased, as shown by the death rate per 100,000 from 2006 to 2011. This would indirectly suggest an improvement (decrease) both in terms of the prevalence of the disease and in terms of the health services provided.

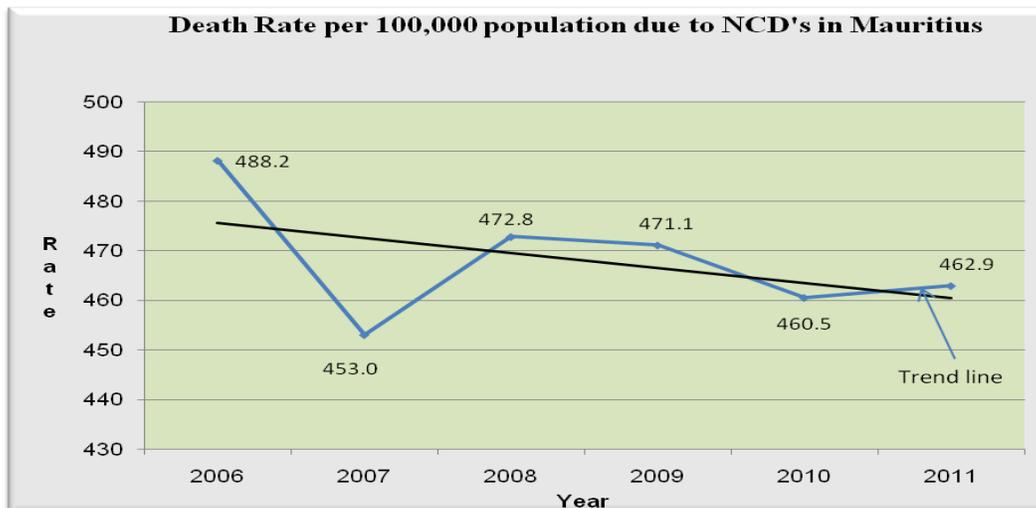


Figure 1: Mortality rate due to NCD in Mauritius

5.2. Situation of Diabetes Mellitus in Mauritius (1987-2009)

As pointed by the Ministry of Health, Mauritius is one of the rare countries in the world having so much data on DM, thanks to an excellent system for data capture. For instance since 1987 NCD Surveys are conducted almost every five years in collaboration with Baker IDI, Australia (Prof. Zimmet) and National Public Health Institute, Finland (Prof. Tuomilehto). Some of the main findings of the last survey conducted in 2009² showed that:

- 1 in 2 Mauritians (25-74 years old) has either DM or Impaired Glucose Metabolism (IGM);
- 172,400 people (25-74 years old) have DM in Mauritius;
- For every known case of diabetes, there is one newly diagnosed case;
- Prevalence of diabetes increased by over 60% since 1987 to 2009;
- From 1985 to 2000, prevalence increased by more than 200% (WHO estimates), and
- Prevalence of impaired glucose metabolism (being either IGT or IFG) was 24.2%.

² <http://health.gov.mu/English/Documents/ncd-2009.pdf>

It is important to note that this total estimate of 172,400 people (25-74 years old) gave Mauritius the 2nd highest prevalence of any country, at the time, after Nauru – according to the International Diabetes Federation Diabetes Atlas (2009). On the other hand, the findings of the national NCD surveys of Mauritius from 1987-2009 were the following:

- The Prevalence of T2D & IGT has continuously been among the highest in the world;
- The prevalence of T2D & IGT: increased with age, but are already high in young adults;
- There was no significant difference in prevalence between men and women;
- The prevalence of T2D & IGT was similar in various ethnic groups (Indian, African, Chinese); and
- The prevalence of Metabolic Syndrome was 36.3% and was observed as increasing with age for both genders.

5.3. Conclusions of the 2009 NCD survey

1. The Prevalence of Type 2 DM in Mauritius is extremely high. Half of those affected do not know that they have diabetes. Many are crippled by the complications of DM. Nearly every family in Mauritius is confronted directly or indirectly with suffering associated with DM.
2. High rate of DM and Pre-DM, coupled with those of obesity, dyslipidemia and
3. Hypertension constitute a significant threat in terms of future social and economic burden of cardiovascular disease and DM complications, both in relation to direct medical costs and to national productivity due to impact of those diseases on the workforce.
4. The high rates of DM and CVD risk factors represent a very large public health burden that require urgent measures both in terms of prevention and treatment.

5.4. Recommendations following the 2009 NCD Survey

- Risk factors for T2D such as obesity and inactivity are modifiable;
- Interventions for population – Transport, education, food supply and labelling, and town planning;
- Maternal health during pregnancy cannot be ignored in DM prevention activities;

- Evidence based management of DM, HBP, lipids---greatly reduce risk of CVD, kidney and eye diseases; and
- High level multi sectoral Health Promotion Committee to be set up.

5.5. Steps taken by the Ministry

The following provides a glimpse of some of the measures taken concurrently by the Ministry over the past few years to fight NCDs, which include DM.

5.5.1.Action Plans

- WHO Global Strategy for the Prevention and Control of Non-Communicable Diseases.
- National Strategy for Diet, Physical Activity and Health and the implementation of the Framework Convention on Tobacco Control.

5.5.2.Legislations

- Amendments to the Food Act and control of saturated fats in cooking oils.
- The sale of aerated soft drinks and unhealthy snacks has been banned in our educational institutions.
- Amendments to the Public Health Act (Alcohol & Tobacco).

5.5.3.National Service Framework for Diabetes Standards

The National Strategy against Diabetes developed by the Ministry is called the National Service Framework for Diabetes (NSFD). It aims to put people living with Diabetes at the heart of health care services and lays out the strategies for Diabetes prevention, the standards of Diabetes care, as well as the interventions required for them to be achieved. The NSFD comprises of the following standards:

- Standard 1 : Setting up of a National computerized diabetes register
- Standard 2 : Prevention of type 2 diabetes
- Standard 3 : Identification of people with type 2 DM

- Standard 4 : Empowering of people with diabetes
- Standard 5 : Clinical care of adults with type 2 diabetes
- Standard 6 : Clinical care of young with type 2 diabetes
- Standard 7 : Clinical care of people with type 1 DM
- Standard 8 : Management of diabetic emergencies
- Standard 9 : Care of DM people during hospitalization
- Standard 10: Diabetes and Pregnancy
- Standard 11: Effective surveillance of complications
- Standard 12: Management of long-term complications
- Standard 13: Multi-agency care
- Standard 14: Research and Training

5.6. Trends Observed in DM

It was pointed out that a general decreasing trend has been observed in regards to first attendances at Primary Health Care Centres between 2006 and 2011 due to both diabetes (from 25,156 to 15,868) and hypertension (from 29,464 to 17,775) respectively.

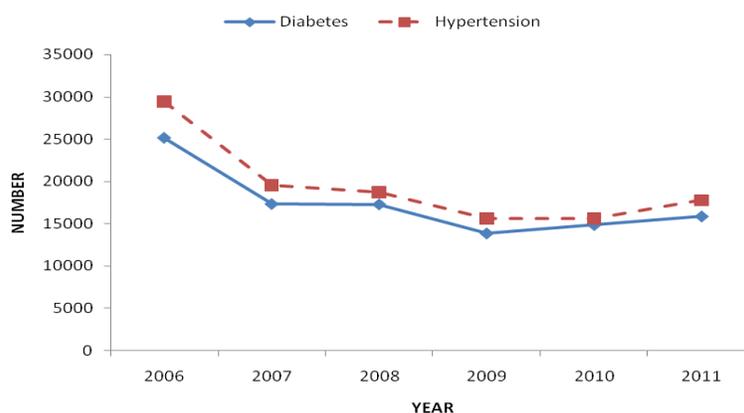


Figure 2: Attendances at Primary Health Care Centres between 2006 and 2011 for assistance for diabetes and hypertension related health problems

A general decreasing trend has also been observed in government general hospitals concerning admitted patients treated for cardiovascular diseases and diabetes and their related complications (as main conditions) from 15.1% in 2005 to 13.4% in 2011.

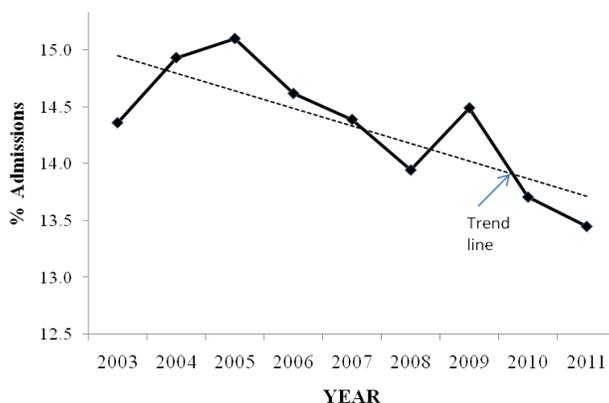


Figure 3: Percentage admission in Government General Hospitals due to Cardiovascular diseases and Diabetes from 2003 to 2011

5.7. Recent Research Projects initiated by the Ministry on DM

5.7.1. Mauritius Type 2 DM Prevention Study

Aim:

To evaluate the efficacy of diet and physical activity management in preventing or delaying development of T2D in high risk people (Impaired Glucose Tolerance (IGT) & Impaired Fasting Glucose (IFG)) and to assess the effect of the intervention programme on cardiovascular risk factors.

- 1200 subjects with IGT/IFG from Mauritius NCD survey 2009;
- 3-4 family members of each index subject will also form part of study;
- Sample size ; 4,000-5,000;
- Mean duration of 3 years/family; and
- Families will be allocated at random a standard or special diet-exercise management groups.

5.7.2. Mauritius Surveillance DM Project 2008

Outcomes:

- During follow up, 16% died of the initial cohort, and 44 % were classified as CVD deaths;
- The median follow up time was 15.1 years (0.1 – 20.8);
- Significant predictors for CVD death were previous CVD, creatinine, smoking, hypertension, total and central obesity, educational level, sex and ethnicity; and
- ECG changes associated with CVD deaths.

Conclusions:

- Post load glucose but not fasting glucose levels predicted CVD deaths; and
- Glucose intolerance strongly predicted CVD deaths, with a graded and increased risk from IGT and upwards. This pattern was seen in both men and women and in all ethnicities, although not always significant due to small numbers.

6. Consultative Workshop Sessions

In order to create a common platform for discussion amongst relevant stakeholders, three consultative sessions were scheduled. The main purpose of these sessions was to collect inputs from all the participants to create ownership in a common consolidated Diabetes Research Programme for Mauritius. During each session, previous and current research works were reviewed, but new avenues of Diabetes research were also explored. Each session covered one of the three themes and was presided by a chairperson. Following each session, which lasted about 1 hour and 30 minutes, a rapporteur was responsible for summing up the discussions.

6.1. Project Priorities Discussed During the Workshop

6.1.1. Theme 1: Fundamental and Applied Research on Diabetes in Mauritius

Diabetes Mellitus (DM) is group of diseases characterized by abnormally high levels of sugar (glucose) in the bloodstream; due to the body's impaired ability to produce or respond to insulin. There are two distinct types of DM: Type 1 (T1DM) and Type 2 (T2DM). Type 1 DM results from the auto-immune destruction of the Beta (Insulin Producing) cells found in pancreas³ whilst Type 2 DM arises due to insulin resistance or inadequate insulin secretion⁴. This unresponsiveness to insulin leads to an approximately 50% reduction in β cell mass in the later stages⁵, causing 20–30% of T2DM patients to initiate insulin therapy.

Both T1DM and T2DM are associated with long term complications such as blindness, kidney failure, cardiovascular diseases and neuropathy leading to amputations. A rigorous insulin regimen and tight glycaemic control have proven to reduce the risk of these complications in clinical trials. Conversely, even with the use of insulin, most patients with T1DM are unable to keep their glucose level in the normal range for a long term.

Recent advances in the understanding of the pathophysiology of Diabetes, has led to the development of new anti-diabetic drugs. However, drug therapy only provides relief or delays

³Gillespie K.M. (2006) *Type 1 diabetes: Pathogenesis and prevention*. CMAJ 175: 165–170.

⁴Ali M.A., Dayan C.M. (2009) *The importance of residual endogenous beta-cell preservation in type 1 diabetes*. Br J Diabetes Vasc Dis 9: 6

⁵Gallwitz B. (2008) *Managing the β -cell with GLP-1 in type 2 diabetes*. Br J Diabetes Vasc Dis 8(Suppl 2): 7.

the onset and development of diabetes and its related complications. There is still the need to address the root of the problem that causes pancreatic Beta cell dysfunction.

To address these issues researchers are exploring new avenues such as the transplantation of the whole pancreas or only the pancreatic islets^{6,7}. Clinical trials have shown that islet transplantation from cadaver donors yields a promising outcome as insulin independence with good glycaemic control was achieved and maintained in some patients for more than 2 years⁸. However, this avenue faces multiple challenges such as shortage of donors compared to the increasing number of diabetic patients and the very low yield of islet cells from cadaver tissue⁹. Some researchers believe that stem (precursor) cells from normal donors injected in Diabetic patients have the ability to replace the defective insulin producing cells of diabetic patients. However, the success rate of this intervention is poor since there is a high risk of destruction of the donor cells due to non self recognition phenomenon. Another strategy consists of using the patient's own stem cells (autologous stem cells) located in the bone marrow to cure limb ischemia induced wounds of diabetic patients. In this case the risks of rejection of the stem cells are null since they come from the same patient¹⁰.

Taking all these recent advances into account, members present in the first working session discussed the possible avenues of Fundamental and Applied Research on Diabetes in Mauritius. The Ministry of Health and Quality of Life (MoHQL) informed the discussion group on the various services offered to monitor diabetic and prediabetic patients round the island. These services include, among others, regular digital retinal scanning in all diabetes patients; specialized podiatry service to monitor pre-diabetic neuropathies; and access to a nutritionist for advice on a proper diet to be adopted by Diabetics and prediabetics. The MoHQL as well as the NGOs also offer patient education in view of helping them to better manage their disease.

⁶ Daneman D. **Type 1 diabetes**. Lancet. 2006;367:847–858. doi: 10.1016/S0140-6736(06)68341-4

⁷ Shapiro AM, Lakey JR, Ryan EA, Korbutt GS, Toth E, Warnock GL, Kneteman NM, Rajotte RV. **Islet transplantation in seven patients with type 1 diabetes mellitus using a glucocorticoid-free immunosuppressive regimen**. N Engl J Med. 2000;343: 230–238.

⁸ Gangemi, A., Salehi, P., Hatipoglu, B., Martellotto, J., Barbaro, B., Kuechle, J. B., Qi, M., Wang, Y., Pallan, P., Owens, C., Bui, J., West, D., Kaplan, B., Benedetti, E., and Oberholzer, J. (2008) *Am. J. Transplant.* **8**, 1250-1261

⁹ Tateishi K, He J, Taranova O, Liang G, D'Alessio AC, Zhang Y. **Generation of insulin-secreting islet-like clusters from human skin fibroblasts**. *J Biol Chem.* 2008 Nov 14;283(46):31601-7. doi: 10.1074/jbc.M806597200.

¹⁰ Voltarelli et al.; **Autologous Hematopoietic Stem Cell Transplantation for Type 1 Diabetes** Immunology of Diabetes V: Ann. N.Y. Acad. Sci. 1150: 220–229 (2008); doi: 10.1196/annals.1447.048

Numerous surveys have been carried out by the MoHQL to assess the baseline of Diabetes in Mauritius. The MoHQL, the University of Mauritius together with several international collaborators have published numerous peer reviewed papers looking at the impact, prevalence, and morbidity of the different types of Diabetes and prediabetes states in the different ethnic groups in Mauritius. The MoHQL has also created the National Diabetes Registry which could be made available to researchers.

However, the discussion group expressed their concern on the fact that there are still major gaps in research in Diabetes in Mauritius. The discussion group felt that there is scarcity of proper knowledge with respect to diabetes and Diabetes Research in Mauritius and recommended that the Research Community takes a more prominent role in assisting the MoHQL and other stakeholders actively working to alleviate the Diabetes burden in Mauritius. Strategic collaboration between clinicians, microbiologists, molecular biologists, computational scientists, and bioinformaticians are highly recommended in order to succeed in gathering momentum to push further research work in Diabetes in Mauritius.

The group proposed to use data already available through the numerous surveys carried out by the MoHQL and formulate research questions and devise research projects from there. The following projects were proposed and discussed by the members during the first discussion session. The discussion group recognized that the list of projects discussed here is not exhaustive and could further be expanded.

6.1.1.1. Projects Proposed

6.1.1.1.1. Autologous Bone Marrow Transplant as a potential cure for Diabetic Foot

The Apollo Bramwell Hospital located in Moka, Mauritius, have already performed autologous bone marrow transplantation in the foot of diabetic patients. Encouraging preliminary results were reported. However, a thorough scientific study would need to be carried out with proper cohort and the effects of the transplant on other diabetic symptoms have to be thoroughly investigated.

6.1.1.1.2. Evaluation of the Glycaemic index of typical Mauritian foods

One major concern expressed by the discussion group is the lack of a healthy menu with the correct glycaemic balance and adapted to typical Mauritian foods. Hence, it was proposed that a proper research be carried out to evaluate the glycaemic index of foods that commonly form part of the typical Mauritian Diet. Such information would significantly impact on the eating habits of Mauritians in general and especially the Diabetics and prediabetics.

6.1.1.1.3. Use of Biomarkers as predictors for Diabetes

It was suggested that earlier detection of diabetes related pathologies should be encouraged. It was pointed out that simplistic assumptions about the fidelity with which a biomarker reports on a disease process are sometimes incorrect and typically incomplete. For instance, uncertainties about the reliability of HbA1c as a pivotal biomarker to assess the efficacy of antidiabetes drug candidates have been reported¹¹. Hence it was proposed by the group to look into investigation and adoption of Genetic and other Biochemical markers to assess Diabetes in Mauritius. One possible avenue of research is to look into the gut microbiome. It has been reported that understanding the gut microbiome in healthy humans could potentially influence treatment and management of various important gastrointestinal and nutritional diseases (e.g. inflammatory bowel disease, diabetes, and obesity)¹². Another possible avenue for research could be the use of high powered digital imaging to detect retinal neuropathy at a very early stage.

6.1.1.1.4. Relationship between Diabetes and other diseases

- **Diabetes and Cancer**

The discussion group briefly discussed the need to further investigate on the link between the cancer and diabetes in Mauritius. Furthermore, it is known that the cell signaling kinase, Insulin Growth Factor and its Receptors are involved in various cancers¹³. Given the high genetic predisposition of the Mauritian Population for developing Diabetes, it could be interesting to

¹¹ E.J. Caveney, M.D. and O. J. Cohen, M.D.; "Diabetes and Biomarkers"; *Diabetes Sci Technol.* (2011); 5(1): 192-197

¹² S. Abubucker et al.; "Metabolic Reconstruction for Metagenomic Data and Its Application to the Human Microbiome"; *PLoS Comput Biol.* 2012; 8(6): e1002358.

¹³ Sarfstein R & Werner H; "Minireview: Nuclear Insulin and Insulin-like Growth Factor-1 Receptors: A Novel Paradigm in Signal Transduction"; *Endocrinology.* 2013 Mar 18. [Epub ahead of print]

investigate this avenue which could lead to discovery of new elements in the signaling pathway and eventually discovery of new drugs.

- **Diabetes and HIV**

During the discussions a representative from the Mauritius Prisons Department highlighted that HIV infected prisoners receiving the Highly Active Antiretroviral Therapy more prone to develop Diabetes Mellitus¹⁴. It has been reported that this therapy has changed HIV from an acute infection to a chronic infection with associated significant metabolic abnormalities. It was suggested that research could be carried out in this field to find possible solutions for HIV infected patients.

6.1.1.2. Concluding remarks and way forward

The list of projects listed above is the outcomes of the brainstorming session on Fundamental and Applied Research in Diabetes in Mauritius. Although this list of proposed projects is not exhaustive, it reflects the high quality of discussions held. For instance, the relationship between Diabetes Type II and Cardiovascular Diseases or Obesity at the molecular level in the Mauritian population at large could be investigated.

Given its genetic predisposition, low migration rate of the population and other related factors, Mauritius is unfortunately represents microcosm of Diabetes and related metabolic diseases. This unique situation paves the way for numerous opportunities of fundamental and applied research which could possibly reveal new paradigms for metabolic troubles, hence allowing for new and more efficient drug discovery.

¹⁴ Kalra S & Agrawal N; "Diabetes and HIV: Current Understanding and Future Perspectives"; **Curr Diab Rep.** 2013 Feb 28. [PMID: 23446780 - as supplied by publisher]]

6.1.2. Theme 2: Socio-Economic Dimension of Diabetes in Mauritius

Through its axis on the socio-economic dimension on Diabetes, the Council is aiming to adopt a multidisciplinary approach within the Social Sciences to tackle this major threat to national public health. Recently labelled as “the silent epidemic” by Social Scientists, it was estimated based on current trends, that the number of diabetic patients is expected to rise to 381 million people worldwide by 2025¹⁵. The social and economic consequences will be vast and far-ranging. It is hence thought that using Social Research Methods to qualify and quantify the extent of the local epidemic will help to reach a comprehensive understanding of the situation and the programmatic situation in the country. The purpose of adopting such an approach would hence be, through the use of questionnaires, interviews and other social research methods, to establish the current health outcomes of people with Diabetes, as per existing interventions. Ideally, this would provide the basis to develop innovative ways to prevent the development of Type 2 Diabetes.

With a view to achieve these objectives, the following projects were suggested and discussed during a special session chaired by Dr P Pugo-Gunsam from the University of Mauritius. The MRC also helped in the facilitation of these discussions.

6.1.2.1. Projects Proposed

6.1.2.1.1. The Cost of Diabetes to Individuals (Type 2)

As mentioned previously, Diabetes is a chronic illness with numerous severe complications such as blindness, kidney failure and is hence very costly to both the national health system and to individuals. As observed by the Ministry of Health, 85% of all lower limb amputations in Mauritius are attributed to complications due to diabetes¹⁶. The 2 broad categories of economic costs associated with diabetes are direct health care costs (medication devices, visits & hospitalisations), indirect health care costs (care in nursing homes & informal care by relatives) This particular project would be the opportunity to investigate the personal costs of Diabetes to

¹⁵The Economist Intelligence Unit (2009): The Silent Epidemic: An Economic Study of Diabetes in developed and developing countries

¹⁶ The Ministry of Health and Quality of Life website on Diabetes (2013): <http://www.gov.mu/portal/sites/diabetes/feet.htm>

patients and would focus mostly on direct health care costs, personal costs (perceived stigma, impact on mental health, potential loss of professional opportunities, productivity, impact on well-being, family life, etc), while looking at the diabetic patient's personal journey from the onset of the disease.

6.1.2.1.2. Assessing the Effectiveness of Health Education Campaigns for Diabetes in triggering Positive Behaviour Change in Mauritius

It was observed by those present that assessing the impact of policies aiming to address many health challenges was a must, especially when it comes to Diabetes and other related Non-Communicable Diseases. So as to narrow the focus of such broad research projects, it was also deemed important to assess the overall national health education policies and initiatives, as well as to look at the effectiveness of the education materials used in primary schools to promote positive behaviour change in children over the long-term. As pointed out by one of the participants, such studies would of course require a thorough understanding of the social and cultural dimension of diabetes, which could be achieved by looking at the Sociology of Health and Illness in Mauritius, over the past twenty-five years.

6.1.2.1.3. Study on the Impact of Primary Prevention Policies for Diabetes in Primary Schools (Type 2)

While the onset of Type 1 Diabetes cannot be prevented for genetic reasons, Type 2 diabetes, however, can be prevented in many cases by maintaining a healthy weight and being physically active as confirmed by studies in China, Finland and the United States¹⁷. Primary prevention of Diabetes includes the promotion and adoption of lifestyles to reduce the risks linked to a sedentary lifestyle. Such interventions usually aim to promote positive behaviour change linked to physical activity, adequate body weight management and establishing healthy eating patterns. The rationale of carrying out such a study would therefore be to investigate the effectiveness of health education materials and messages found in the primary school curriculum in triggering positive behaviour change in children. This could be done over a shorter to a longer period of time to:

¹⁷ International Diabetes Federation (2013)

- look at the short-term cognitive impacts and gains
- positive lifestyle and behaviour gains as teenagers.

6.1.2.1.4. Study on the Impact of Secondary Prevention Policies for Diabetes

Some of the suggestions received from participants focused on finding out the effectiveness of the most recent health education campaigns at national level, through the use of interviews and questionnaires. A case-control design could be adopted for the study. The following alternative interventions which could be investigated to complement this study are:

- assessing the impact of peer education on a pilot basis
- investigating the training needs of the health education workforce (government, NGOs etc) to improve outcomes of prevention exercises
- the targeted use of new social media to promote healthy behaviours in the Mauritian Population developing and collecting quality of life indicators to monitor the progress of health education campaigns

6.1.2.1.5. Study on the Impact of Tertiary Prevention & Management of Diabetes: Measuring Health Outcomes following the use of Telemedicine for Diabetic Patients

As discussed during this particular session, the government is currently proceeding according to the National e-Health Strategy: Health 2015 - Seamless Continuity of Care. It was agreed by all that in principle e-health, or in this case Telemedicine, allows patients in remote locations to access medical expertise quickly, efficiently and without travel. Telemedicine interventions can take many forms. They can be communicated from handheld hardware devices, Personal Digital Assistant (PDAs) devices, portable/laptop computers, emails or live streaming communication platforms to a remote Web Server¹⁸. This form of communication allows for the patient's electronic medical record to be stored, updated and analyzed while allowing for direct communication with health care providers to take place. A study focusing on the health outcomes of diabetic patients using such technology could adopt a case-control design to investigate the benefits of using telemedicine in managing diabetes. Such an approach would

¹⁸ Klonoff, D: "Using Telemedicine to Improve Outcomes in Diabetes - An Emerging Technology"

also enable local authorities to prioritize the introduction of these new technologies and their potential contribution to tertiary prevention by:

- removing overall barriers to routine care.
- providing an effective approach for coaching-education about the disease,
- improving compliance with medication and recommendations,
- supporting timely transmission,
- interpreting of patients' data for follow-up and enforcing preventive interventions for adequate glycaemic control.

6.1.2.2. Concluding Remarks & Way Forward

All were in agreement that the purpose of carrying out such research was to make findings which would ultimately aim to influence existing interventions and policies to reduce the impact of Diabetes in Mauritius. However, it was also mentioned during the discussion that Social Research methods and tools would not only be confined to investigating topics of a social nature but could also be used across other themes i.e. in “Traditional Medicine” and in “Fundamental and Applied Research.”

6.1.3. Theme 3: Focus on Traditional Remedies and Indigenous Knowledge for Diabetes in Mauritius

Traditional medicine, also known as indigenous/folk medicine or alternative medicine comprises the knowledge systems that developed within various societies before the era of modern medicine and passed on from generation to generation. The World Health Organization (WHO) defines traditional medicine as:

"the health practices, approaches, knowledge and beliefs incorporating plant, animal and mineral-based medicines, spiritual therapies, manual techniques and exercises, applied singularly or in combination to treat, diagnose and prevent illnesses or maintain well-being."¹⁹

The different practices of traditional medicine commonly known include Ayurveda, traditional Chinese medicine, acupuncture, traditional African medicine, amongst others. These practices date back to several centuries and the use of plants as medicines predates written human history. In India, Ayurveda medicine has used many herbs such as turmeric possibly as early as 1900 BC²⁰. Today, traditional medicine is widespread in some Asian and African countries where up to 80% of the population relies on traditional medicine for their primary health care needs¹⁹. However, the use of traditional remedies in therapeutic care is controversial and scientific research is necessary to prove the effectiveness of this form of alternative medicine. The WHO even notes that "inappropriate use of traditional medicines or practices can have negative or dangerous effects" and that "further research is needed to ascertain the efficacy and safety" of several of the practices and medicinal plants used by traditional medicine systems.¹⁰

The last consultative session discussed issues surrounding the use of traditional medicine in the treatment and management of Diabetes and proposed a list of relevant research projects. Below is a brief introduction to set the scene regarding the practice and use of traditional medicine which is gaining in popularity. This section is followed by the proposed list of research projects.

¹⁹ Fact sheet no. 134: Traditional medicine". World Health Organization. 2008-12-01. Retrieved 2009-05-02.

²⁰ Aggarwal BB, Sundaram C, Malani N, Ichikawa H (2007). "Curcumin: the Indian solid gold". Adv. Exp. Med. Biol. ADVANCES IN EXPERIMENTAL MEDICINE AND BIOLOGY 595: 1-75. doi:10.1007/978-0-387-46401-5_1. ISBN 978-0-387-46400-8. PMID 17569205.

6.1.3.1. Projects Proposed

6.1.3.1.1. Proper identification and in depth survey of indigenous plants of Mauritius believed to have anti-diabetic effects

It was suggested during the consultative session that the proper identification of plants believed to have a therapeutic effect on Diabetes, is a crucial exercise. Those plants known to have therapeutic effect against diabetes and used as an alternative to modern medicine or to complement synthetic drugs, have to be properly identified and then recorded. It was also proposed to use molecular techniques for the identification process.

A further research proposed within this last consultative session was a complete and rigorous ethnobotanical^{21, 22} survey medicinal (endemic and indigenous) plants commonly used for the impact on the progression of Diabetes Mellitus in Mauritius. This survey should provide comprehensive information about those anti-diabetic plant remedies.

6.1.3.1.2. Standardisation of recipes among practitioners and herbalists.

In general, herbalists have acquired the knowledge for the cultivation of herbs, diagnosis and treatment of conditions or dispensing herbal medication, and preparations of herbal medications. Lay herbalists and traditional indigenous medicine people generally rely upon apprenticeship and recognition from their communities in lieu of formal schooling. In Mauritius these aspects still needs to be clarified. It is also to be noted that adulteration, inappropriate formulation, or lack of understanding of plant and drug interactions have led to adverse reactions that are sometimes life threatening or lethal²³. It was, thus, proposed that, a proper standardisation of those plant recipes that are known to have therapeutic, be performed for Mauritian herbal concoctions believed to have an anti-diabetic effect.

²¹ Acharya, Deepak and Shrivastava Anshu (2008): *Indigenous Herbal Medicines: Tribal Formulations and Traditional Herbal Practices*, Aavishkar Publishers Distributor, Jaipur, India. ISBN 978-81-7910-252-7. pp 440.

²² Ethnobotany is the scientific study of the relationships between people and plants through the documentation, description and explanation of the complex relationships between cultures and the use of plants. Ethnobotany focuses primarily on how plants are used, managed and perceived across human societies.

²³ Elvin-Lewis, M. (2001). "Should we be concerned about herbal remedies". *Journal of Ethnopharmacology* 75 (2-3): 141-164. doi:10.1016/S0378-8741(00)00394-9. PMID 11297844.

6.1.3.1.3. In Depth Investigation on Traditional Alternative Medicines that are believed to control diabetes in Mauritius.

Traditional healers, herbalists and practitioners of alternative medicine possess an incredible knowledge of ancient and traditional remedies for Diabetes. It was, thus, proposed that interviews with practitioners should be conducted in order to extract valuable information on the potential remedies for Diabetes.

6.1.3.1.4. Comparative literature survey on plants used in Mauritius as antidiabetics

Subsequent to the ethnobotanical survey, it was proposed that, a comparative study with other surveys conducted in other countries, be performed. This exercise will serve to counter verify data collected locally and further increase knowledge about the use of the traditionally used plants.

6.1.3.1.5. Pharmacological screening of the endemic plants believed to have anti-diabetic properties.

A major issue identified during discussion was the absence of scientific information about most of those plants that are claimed to have anti-diabetic properties in Mauritius. Pharmacological screening of those plants species is crucial to ascertain their effectiveness in Diabetes treatment and management. Preclinical pharmacological and toxicological studies (both *in vitro* and *in vivo*) are needed to establish their therapeutic effectiveness and safety in human disease. In addition, clinical trials should be considered once the preclinical bill is passed.

6.1.3.2. Concluding remarks and way forward

The list of projects listed above is the outcomes of the brainstorming session on Traditional Remedies and Indigenous Knowledge for Diabetes in Mauritius. It is worth pointing out that this list is not exhaustive, and relevant research projects may be integrated at a later stage after further discussions.

7. Overall Outcomes

1. An extended and Multi-Disciplinary Research Platform on Diabetes regrouping major stakeholders working in the field of Diabetes in Mauritius was created. Basic partnerships between MRC and the institutions present were established aiming at looking into the implementation of some of the research projects.
2. A list of potential research projects was proposed by the participants.

8. Way Forward

This report is destined for the stakeholders present at this event for their views. A second workshop is envisaged to further prioritise the research projects listed and identify interested parties for implementation. One of the main suggestions which emerged from this workshop was the setting up of a Diabetes Research Centre.

Concurrently, **Prof McCarthy** from Oxford University, UK, after discussions with the **Hon Minister Jeetah**, Minister of Tertiary Education, Science, Research and Technology, suggested the need for a Centre for Diabetes Research in Mauritius. The Council is currently drafting a strategic plan for the implementation of the Diabetes Research Centre.

Similarly, it is worth pointing out that subsequent to the Consultative Workshop, several potential collaborators expressed their firm intention to participate in the research programme should the opportunity arise.

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The Council is thankful to all the Chairs who mediated the 3 Consultative Sessions namely:

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- Dr **P Pugo-Gunsam** for Theme 2
- Dr **F Mahomoodally** & Dr **A Deelchand** for Theme 3

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S.N.	Institutions
1	Agricultural Research and Extension Unit (AREU)
2	Appollo Bramwell
3	Association pour la Promotion de la Santé (APSA)
4	Australian Trade Commission (Austrade)
5	Beau Bassin Prison Hospital
6	Centre for Biomedical and Biomaterials Research (CBBR)
7	DYP Medical College (Medicine Department)
8	Mauritius Council of Social Service (MACOSS)
9	Mahatma Gandhi Institute (MGI)
10	Mauritius Institute of Education (MIE)
11	Mauritius Institute of Health (MIH)
12	Mauritius Oceanography Institute (MOI)
13	Ministry of Agro Industry and Food Security (MSIRI)
14	Ministry of Education and Human Resources
15	Ministry of Health and Quality of Life (MoHQL)
16	Ministry of Industry, Commerce and Consumer Protection
17	National Children's Council (NCC)
18	National Women's Council (NWC)
19	National Youth Council
20	SSR Medical College
21	T1 Diams
22	University of Mauritius (UoM)
23	World Health Organization (WHO)



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NCD Management Team from Ministry of Health and Quality of Life;

Prof D. Owens, Cardiff University, UK

Dr R Ramracheya from Oxford University, UK;

Dr S Sohur, Harvard University.

10. ANNEX

Peer Reviewed Papers on which the Ministry of Health and Quality of Life has collaborated. Copies of these papers are available upon request to the MoHQL.

1. Determinants of estimated insulin resistance and B-cell function in Indian, creole and Chinese Mauritians (24 July 1990)
2. High Prevalence of NIDDM and Impaired Glucose Tolerance in Indian, Creole and Chinese Mauritians (March 1990)
3. Prevalence and medical care of hypertension in four ethnic groups in the newly-industrialized nation of Mauritius (9 January 1991)
4. Plasma Triglycerides and Cardiovascular Risk in the Population of Mauritius with High Prevalence of Non-Insulin-Dependent Diabetes Mellitus
5. Abdominal Obesity and Physical Inactivity as Risk Factors for NIDDM and Impaired Glucose Tolerance in Indian, Creole, and Chinese Mauritians (April 1991)
6. The Relation of Physical Activity to Cardiovascular Disease Risk Factors in Mauritians (May 1991)
7. A Model Protocol for a Diabetes and Other Non Communicable Disease Field Survey
8. Insulin and blood pressure levels are not independently related in Mauritians of Asian Indian, Creole or Chinese origin (1993)
9. The Prevalence of coronary heart disease in the multi-ethnic and high diabetes prevalence population of Mauritius
10. Serum Insulin Distributions and Reproducibility of the Relationship between 2-Hour Insulin and Plasma Glucose Levels in Asian Indian, Creole and Chinese Mauritians

11. Serum Insulin and ECG Abnormalities Suggesting Coronary Heart Disease In The Population of Mauritius and Nauru: Cross-Sectional and Longitudinal Associations (25 June 1993)
12. Incidence of IDDM in Mauritian Children and Adolescents from 1986 to 1990
13. Is Hyperinsulinaemia a Central Characteristic of a Chronic Cardiovascular Risk Factor Clustering Syndrome? Mixed Findings in Asian India, Creole and Chinese Mauritians (November 1993)
14. Physical inactivity and glucose intolerance in the multiethnic island of Mauritius
15. Factors Associated With Impaired Vibration Perception in Mauritians With Normal and Abnormal Glucose Tolerance
16. Changes in population cholesterol concentrations and other cardiovascular risk factor levels after five levels after five years of the non-communicable disease intervention programme in Mauritius
17. Relationship of Insulin Resistance to Weight Gain in Nondiabetic Asian Indian, Creole, and Chinese Mauritians
18. Incidence, increasing prevalence, and predictors of change in obesity and fat distribution over 5 years in the rapidly developing population of Mauritius
19. Fall in total cholesterol concentration over five years in association with changes in fatty acid composition of cooking oil in Mauritius: cross sectional survey
20. Prevalence and Risk Factors for Diabetic Retinopathy in the Multiethnic Population of Mauritius
21. Is there a relationship between leptin and insulin sensitivity independent of obesity? A population-based study in the Indian Ocean nation of Mauritius (September 1997)

22. Do Leptin Levels Predict Weight Gain? – A 5-Year Follow-up Study in Mauritius (5 September 1998)
23. Diabetic neuropathy in Mauritius: prevalence and risk factors (4 September 1998)
24. Impaired Fasting Glucose or Impaired Glucose Tolerance (March 1999) What best predicts future diabetes in Mauritius?
25. Features of the Metabolic Syndrome Predict Higher Risk of Diabetes and Impaired Glucose Tolerance (September 2000)
26. Leptin and other components of the Metabolic Syndrome in Mauritius – a factor analysis (6 September 2000)
27. High incidence of Type 2 diabetes and increasing conversion rates from impaired fasting glucose and impaired glucose tolerance to diabetes in Mauritius
28. Increasing prevalence of Type 2 diabetes mellitus in all ethnic groups in Mauritius (February 2003)
29. Dietary Westernisation: conceptualization and measurement in Mauritius (December 2004)
30. Six years incidence and progression of diabetic retinopathy: Results from the Mauritius diabetes complication study (8 February 2006)
31. Leptin predicts the development of diabetes in Mauritian men, but not women: a population-based study
32. Mortality, all cause and CVD, over 15 years in multi-ethnic Mauritius: the impact of diabetes and intermediate forms of glucose tolerance (2010)
33. Effectiveness of green tea on humans predisposed to Type 2 diabetes: a randomized, controlled trial
34. Glucose-independent ethnic differences in hemoglobin A1c in people without known diabetes

32. Leptin predicts the development of diabetes in Mauritian men, but not women: a population-based study
33. Mortality, all cause and CVD, over 15 years in multi-ethnic Mauritius: the impact of diabetes and intermediate forms of glucose tolerance (2010)
34. Effectiveness of green tea on humans predisposed to Type 2 diabetes: a randomized, controlled trial
35. Glucose-independent ethnic differences in hemoglobin A1c in people without known diabetes
36. Minor and major ECG abnormalities predict premature CVD death in South Asians, Africans and Chinese
37. Obesity and risk of death among South Asian and Creole Mauritians and the influence of hip circumference
38. Explaining the increase of diabetes and glucose in Mauritius