

## INVESTIGATING THE IMPACT OF THE LOCAL HEALTH CARE SYSTEM IN CONTROLLING BLOOD GLUCOSE LEVELS AND PREVENTING COMPLICATIONS IN PATIENTS WITH TYPE 2 DIABETES

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### ABSTRACT

**Background:** Well structured local health care systems play a major role in controlling type 2 diabetes and complications of the patients attending clinics. **Objectives:** To determine if the local health-care system controls blood glucose levels and prevents complications in Trinidadian Type 2 diabetic subjects. This study also focused on assessing the structures that are established to monitor blood glucose levels of type 2 diabetics in the public health facilities. **Methods:** This was a retrospective study comprised 388 type 2 diabetic subjects. These participants were taken from four Regional Health Authorities in Trinidad. All ethnicities of both male and female participant of 18 years and above, diagnosed with type 2 diabetes mellitus for at least one year prior to participating in this study were included in our study.

**Results:** The mean and SD of fasting blood glucose of participants, over the 3 year monitoring period, was  $197 \pm 61.67$  and a standard error of  $\pm 3.13$ . The blood glucose levels of the participants did not change significantly over the period ( $p = 0.848$ ). Data showed that higher the fasting blood sugar values, the more complications a patient presented. Fasting blood sugar values were the standard for monitoring blood glucose levels, however HbA1c and other values, mandated under protocol were absent. **Conclusion:** Across all Regional health authorities in Trinidad, fasting blood sugar values were found to be out of

control and remained high. It was noted that the higher a patient's fasting blood sugar values, the more complications they presented.

**KEYWORDS:** Health care, Diabetes, Blood glucose.

## INTRODUCTION

Diabetes is a group of metabolic diseases where the person has hyperglycemia either due to insufficient insulin production or an inappropriate response to insulin or a combination of the two. This study focuses on type 2 diabetes mellitus. The untreated diabetes may manifest themselves in clinical complications like neuropathy, nephropathy, and blindness among other symptoms and may ultimately be life threatening.

Trinidad's local health care system is constructed in such a manner so as to facilitate the structured organization of people, institutions and resources to provide services to those in need of health care. Health care systems have been an important part in the public health response to type 2 diabetes mellitus and the complications that come along with it. Since the 1990s, managed care organizations (MCOs) started looking at system level solutions to improve diabetes outcomes and control expense in covered populations.<sup>[1]</sup> The local health care system examined in this study is headed by the Ministry of Health, which oversees the goings-on of the four Regional Health Authorities (RHAs) in Trinidad. Each RHA has at least one hospital and numerous health centers' under its jurisdiction. These institutions are the sites where blood glucose levels are detected if they are high, monitored, maintained at a normal level and complications of type 2 diabetes mellitus are aimed at being prevented. In Trinidad, diabetes is ranked the number two killer, behind cardiovascular disease (Hypertension increases the risk of coronary heart disease and is the largest risk factor for stroke, comprising nearly 50% of ischemic strokes and increases the chance of hemorrhagic stroke.).<sup>[2]</sup> Trinidad and Tobago has a population of 1.3 million people, with 150,000 people reported to have type 2 diabetes mellitus and 1000 new cases being reported every year.<sup>[3]</sup> With these alarming numbers, a review of Trinidad's diabetic health care system should be carried out to review its impact in controlling blood sugar levels.

## MATERIALS AND METHODS

The retrospective study was designed to ascertain the impact of the local health care system in controlling blood sugar levels and preventing complications in patients with type 2 diabetes in Trinidad. This study comprised 388 participants from each of the four Regional

Health Authorities in Trinidad. All ethnicities of both male and female participant of 18 years and above, diagnosed with type 2 diabetes mellitus for at least one year prior to participating in this study were included in our study.

One of the data collection instruments utilized for this study was a questionnaire that was designed specifically for this study. The questionnaire comprised mostly closed-ended questions with some open-ended ones. The questionnaires were distributed to consenting participants who met with both the inclusion and exclusion criteria. The other data collection instrument used in this study was a data-form.

### Statistical analysis

The ANOVAs test was used to determine if blood glucose and other clinical parameters such as BMI and blood pressure are significantly different over the three year period. Pearson's Chi Squared analyses and cross tabulations were used to deduce relationships between categorical variables such as incidence of complications and gender, ethnicity, service area and other aspects of the health care system's operational structure. Logistic regression analysis was done to detect the variables that have a significant impact on the incidence of complications.

### RESULTS

Our data indicates that patients attended appointments three times a year on average and measures of weight, pulse, random blood glucose and blood pressure control had been taken at each visit. Urinalyses to detect glycosuria and albuminuria were less commonly performed at the follow-up visits with almost 88% of patients having no proteinuria tests within the past 3 years.

The mean fasting blood glucose of participants, across all RHAs, over the 3 years investigated was 197 mg/dL with a standard deviation of  $\pm 61.67$  and a standard error of  $\pm 3.13$  (Table 1). During the three year period investigated, records showed that HbA1c tests were requested and performed in only 1% to 4.4% of all outpatients seen at these diabetic/chronic illness clinics across all RHAs (Table 2). There was also an observed relationship between the number of complications reported in a patient and the patient's mean fasting blood glucose (FBG) level wherein the mean FBG rose as the number of reported complications increased (Table 3).

BMI measurements, an important process indicator in the management of diabetes were not recorded in 98% of the patient notes. BMI measurement, which, as outlined in the CHRC guidelines should be a component of the physical examination at every follow-up appointment, was only recorded at all appointment patient in our study (Table 4). The percentage of patients across all regional health authorities with blood pressures exceeding the systolic pressure of 140 mmHg ranged from 14 % to 60% (Table 5).

## DISCUSSION

Our sample, comprising 1.6 times as many females as males, may exhibit differences in healthcare seeking behaviour at the diabetic outpatient clinics at local health centres. Given previous studies,<sup>[4]</sup> this attendance ratio probably inaccurately reflects the gender ratio for the population prevalence of type 2 diabetes mellitus, however, the reasons were unexamined as this was outside the scope of this study. Similar differences have been reported in several West Indian studies in the past, however.<sup>[5-8]</sup>

The average duration since diagnosis reported by the patients was 6-10 years. This is comparable to previous findings in a study done by Duff, O'Connoret al (2003) in Jamaica which reported a mean duration of diabetes in men of seven years and in women of 10.5 years.<sup>[7]</sup> Monitoring of glycaemic control in the local diabetic outpatient clinic setting was examined in the study by Mahabir and Gulliford wherein the proportion of patients with blood glucose measurements taken, increased from 33% in 1993 to 91% in 2003.<sup>[9]</sup> Our data from 2012 to 2014 shows that FBG was measured at every follow-up appointment in 100% of patients thereby representing an improvement in quality of care provided.

In investigating the quality of care available to diabetics, several studies have outlined 'process' measures and 'outcome' measures as indicators of quality of care.<sup>[10,11]</sup> In this study, we measured 'process' indicators—such as HbA1c testing, BMI measurements, proteinuria testing, and lifestyle advice—and placed them in context with the structure of the primary health care system. The outcome measures used in this study were fasting blood sugar over the last three years, the number of complications recorded in the last three years, and blood pressure over the last three years. In the last three years, our results showed that across all the regional health authorities, blood glucose among type 2 diabetics has been poorly controlled. Repeat measurements ANOVA analyses showed there were no significant differences between mean fasting blood glucose over time, suggesting that the blood glucose

remained consistently high—more than 190 mg/dl. This suggests that from all angles, blood glucose was poorly controlled in the sample population over the last three years.

According to the UK Prospective Diabetes Study (UKPDS), hyperglycaemia is the major contributor to complications like retinopathy, neuropathy, and nephropathy.<sup>[12]</sup> Our study found that the number of complications increased with the mean fasting blood glucose, suggesting that the lower the mean blood glucose, the less complications one is likely to have. These findings are consistent with those of the UKPDS which stated that there was indeed a relationship between hyperglycaemia and the risks of developing complications such that for every percent decrease in HbA1c (e.g. 10 to 9%) there was a 35% reduction in the possibility of developing complications. Our study suggests that robust measures are needed to monitor and control blood sugar, including regular HbA1c testing, to reduce the number of complications in type two diabetics.<sup>[13]</sup>

The Caribbean Health Research Council recommended that for diabetics, blood pressure should be recorded every visit and the target should be less than 130/80 mmHg.<sup>[14]</sup> In 1997, in the US, the National Committee for Quality Assurance (NCQA) and the ADA developed and launched the Diabetes Physician Recognition Program (DPRP) to recognize physicians and/or medical groups providing quality diabetes care.<sup>[15]</sup> Based on a points systems, the DPRP allocated five points to groups that had maintained at least 35% of patients below a blood pressure of 130/90 mmHg and ten points to groups that could maintain at least 65% of patients below a blood pressure below 140/80 mmHg. Using the DPRP's criteria, all of the RHAs, with the exception of NWRHA, will be unable to get a 10-point rating, since at many instances in the last three years, more than 35% of patients had a systolic blood pressure >140 mmHg.

**Table 1: Fasting Blood Glucose Levels and SD of Participants over a 3 year period**

	2012_1	2012_2	2012_3	2013_1	2013_2	2013_3	2014_1	2014_2
NWRHA	201±77	207±73	208±68	212±68	214±78	218±75	219±85	204±74
NCRHA	191±68	191±65	212±64	203±89	206±79	225±81	201±75	218±86
ERHA	189±84	195±91	205±91	191±71	203±86	191±76	179±68	182±72
SWRHA	180±79	193±83	185±76	185±79	183±9	184±80	197±84	182±80
Mean Across All RHAs	190±77	196±79	201±77	197±77	201±80	201±79	199±79	191±77

**Table 2: Frequency of HbA1c tests performed on participants over the 3 year period**

YEAR	FREQUENCY	PERCENT (%)
2012_1	17	4.4
2012_2	4	1.0
2012_3	4	1.0
2013_1	6	1.5
2013_2	6	1.5
2013_3	7	1.8
2014_1	12	3.1
2014_2	17	4.4

**Table 3: Relationship between number of complications and FBG value**

No. OF COMPLICATIONS	MEAN FBG	S.D.
0	176	55
1	180	54
2	215	65
3	222	46
4	228	43
5	274	41
6	342	24

**Table 4: Number of participants of BMI measurements taken over the last 3 years**

BMI measurements over the last 3 years	No. of patients
0 BMI measurements	379
1 BMI measurements	6
2 BMI measurements	0
3 BMI measurements	1
4 BMI measurements	1
5 BMI measurements	0
6 BMI measurements	0
7 BMI measurements	0
8 BMI measurements	1

**Table 5: Percentage of participants with a systolic blood pressure >140**

HTN	2012_1 (%)	2012_2 (%)	2012_3 (%)	2013_1 (%)	2013_2 (%)	2013_3 (%)	2014_1 (%)	2014_2 (%)
NWRHA	20	25	23	27	28	21	33	20
NCRHA	39	38	34	52	43	31	56	14
ERHA	39	56	56	50	49	52	52	60
SWRHA	48	41	43	39	45	46	54	39

These poor outcomes—poor blood glucose, increasing number of complications, and poor blood pressure control—are a result of the poor management of diabetes at primary health care facilities. In 2006, the Caribbean Health Research Council published revised guidelines geared to the culture, economic situation and health care systems in the Caribbean and are designed for managing diabetes in primary care.<sup>[14]</sup> Our study showed that the care given to patients fell short of these guidelines in several ways: (1) BMI was not determined on every visit; (2) HbA1c test was not done every three to six months, at minimum every six months; (3) Reviewing the results of self-monitoring of blood glucose (SMBG) was not part of a diabetic's visit.

Consequently, the structure of the health system which should incorporate the various guidelines of the CHRC in a logical, timely manner, does not allow for proper monitoring of blood glucose. Key elements—BMI measurements and HbA1c testing—are missing in the care a patient receives and therefore the health system is not effective in controlling blood glucose and preventing complications. Standardized and continuous reporting by multi-disciplinary healthcare providers<sup>[16]</sup> as well all self-monitoring and recording of various indicators of their condition by patients<sup>[17-19]</sup> should be promoted. Furthermore, our study has shown that the current structure has need of being modified for early detection of poor blood glucose control and development of eye and foot complications in patients and to provide an alternative course of treatment and management.

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#### **Ethical Approval**

The ethical approval was obtained from the ethics committee, The University of the West Indies, Trinidad.

#### **Competing interests**

None declared

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