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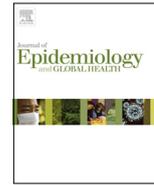
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Metabolic parameters and blood pressures achieved by diabetic patients at two health care facilities in south Trinidad

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KEYWORDS

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Abstract *Background:* Previous studies have demonstrated poor metabolic and blood pressure control in the diabetic population in Trinidad. The aim of this study is to compare baseline and follow-up metabolic parameters and blood pressures taken within a 16-month period to ascertain if there have been improvements.

Method: A retrospective chart review was conducted of diabetic patients at the Siparia and Erin health facilities in 2012. To be eligible, charts had to contain two point-of-care values of HbA1c, Total Cholesterol (TC), Triglycerides (TG), Low Density Lipoproteins (LDL), systolic and diastolic blood pressure (BP), and weight measurements taken within a 16-month period with at least an 8-month interval from the initial to the final testing. Comparisons were made with the Caribbean Health Research Council (CHRC) guidelines to determine clinical significance.

Results: 253 patients from Siparia and 68 from Erin were studied. At Siparia there was a statistically significant change in TG, LDL and diastolic BP, with TG levels actually worsening ($p < 0.05$). At Erin there was a statistically significant change in HbA1c, LDL and diastolic BP. At neither site did these changes achieve clinical significance. There were statistically significant differences between the means of HbA1c and systolic BP by age, but not by gender or ethnicity. On comparing the outcomes between the two health facilities, there were no statistically significant differences between them. When compared with the recommendations by the CHRC, only for the TC was the guideline level achieved.

Conclusion: Despite heavy investment in primary care centers, there continues to be little success in achieving metabolic and BP control for diabetic patients in Trinidad.

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1. Introduction

The epidemiologic transition from communicable to non-communicable disease (NCD) has been well documented in the English-speaking Caribbean [1,2]. Trinidad and Tobago (T&T) has been particularly affected by the NCDs. By 2000, diabetes mellitus, malignant neoplasm, and cerebrovascular disease accounted for 67% of all deaths in the country. Historically, there has been a steady recorded increase in the prevalence of diabetes in T&T, starting in the 1960s up until the present [3–5]. Most recently in 2012, the PAHO STEPS survey revealed that 20.5% of patients had a raised fasting blood glucose, defined as capillary whole blood value ≥ 6.1 mmol/L (110 mg/dl) or were currently on medication for raised blood glucose [6]. The death rate from diabetes in the country is ten times higher than in the United States of America, and the age-adjusted, gender-specific mortality rates from heart disease and all cardiovascular diseases rank among the highest in the Caribbean [7].

In T&T, health care services are provided free of charge via an extensive network of 104 government-funded health centers. These health centers provide a wide variety of services, including maternal and child health, prenatal care, immunizations, well-baby care and non-communicable disease (NCD) care, and although with the first four of these the evidence translates into outstanding results, the evidence also suggests that not enough is being done with regard to NCDs. What is the evidence for this last statement? Ezenwaka reported in 2001 that in a primary care population, 85% of diabetic patients had Hb A_{1c} > 7%, 31% had central obesity, 49% had diastolic BP >83 mmHg and 40% had total cholesterol/high density lipoprotein (TC/HDL) ratios >6 [8]. In a 2002 audit of 826 diabetics, 72% had poor glycemic control with random glucometer readings >200 mg%, and only 2% had glycosylated Hb levels taken. Additionally, 67% of documented lipid profiles were abnormal. Only 1% of hypertensive diabetics had adequate control [9]. In 2005 Mahabir and Gulliford reported that there was an improvement in the increased use of tests among diabetic-attending health offices and an increased recording of diet and exercise advice, yet despite this, “there were no changes in the control of blood glucose, blood pressure or body weight [10].” They also found that health offices with only one nurse or one physician showed poorer improvement of results and recording of processes of care [11]. More recently in studying charts of 646 diabetic persons’ recording of parameters as recommended by regional guidelines, waist circumference was never

measured, lipid profiles were available in only 51%, serum creatinine in 37.9%, and HbA_{1c} in <5% of patients. Patient advice on smoking, alcohol and exercise was recorded in only 12.2% of cases [12].

While the aforementioned studies generally used cross-sectional designs to determine the state of control achieved for NCDs, recent developments such as Point of Care testing (POCT) have made the collection of data for diabetics more standard at the health center. POCT testing started at health centers in south Trinidad in January 2011. This allows analysis of individual patients’ results over time.

This objective, therefore, was to determine if there is a difference in the values of HbA_{1c}, Total Cholesterol (TC), Triglycerides (TG), Low Density Lipoproteins (LDL), systolic and diastolic blood pressure (BP), and weight measured over a 16-month period in type 2 diabetic patients attending the Siparia District Health Facility and the Erin Health Center using POCT. And is there a difference in the level of control achieved between these different health facilities? Were there any differences between the different parameters by age, gender, or ethnicity? The final readings available at the health facilities were also compared with the recommendations of the Caribbean Health Research Council [13].

2. Methods

2.1. Study participants and setting

Siparia and Erin are two districts in the eastern St. Patrick County in south Trinidad. According to the 2010 census [14], the Siparia region, which contains both districts, has a population of 82,600.

Both districts have government-funded health services provided by the Siparia District Health Facility (DHF) and the Erin health centers (HC). Services at both these institutions include: Antenatal, Child Health, Chronic Disease, Dental Clinic, Dietitian, Dressings, Family Planning, Health Office, Pharmacy, Phlebotomy, and Postnatal. Additionally, the Siparia DHF provides treatment for sexually transmitted infections, radiology services and a 24-h accident and emergency service and several specialty services, including Dermatology, Diabetes, Oncology, Pediatric, Psychiatry, and Rheumatology Clinics. The DHFs are established as a central hub, with a network of health center facilities, of which the Erin health center is one such, to serve its respective catchment area. DHFs are open 24 h a day compared with daylight times for health centers.

The DHFs function as a traditional 'polyclinic' and are purposely constructed to offer a wide range of services both diagnostic and specialized. The out-reach specialist services and health centers are linked.

The patients attend the Chronic Disease Clinic at least once every four months. At these appointments, blood samples are taken from those who fasted for at least eight (8) hours. The samples are immediately analyzed for Glycosylated hemoglobin (HbA1c), fasting blood sugars (FBG), low density lipoproteins (LDL), triglycerides (TG), and total cholesterol (TC) using an auto analyzer, the Cholestech LDX [15]. This auto analyzer is calibrated every three months. These values are recorded and placed in the patients' medical records. The patients are triaged by a registered nurse or nursing assistant, and the blood pressure and weight are taken and entered into the patient's medical record.

The Siparia Health Center has computerized records from which the complete chronic disease population of approximately 1056 patients was identified. These records were examined and a chronic disease registry was created. The Erin Health Center has a chronic disease registry with approximately 240 patients. The charts of the entire population of diabetics in both health facilities were examined.

2.2. Inclusion and exclusion criteria

Charts were included for all diabetic patients who had two values of HbA1c, TC, LDL, TG blood pressure and weight measurements taken at the Health Center, and this would have been done within a 16-month period – January 1, 2011 to May 2012 – with at least an 8-month interval from the initial testing to the final testing.

2.3. Data processing and analysis

Data were grouped in categories of age, gender, ethnicity, HbA1c, TC, TG, LDL, systolic and diastolic BP, and weight. The initial and final value of the variables was recorded in Excel (2007), which was used to compute means, tabulate data and produce graphs. SPSS version 16 was used to perform the two-tailed paired *t*-test on the initial and final values of HbA1c, TC, TG, LDL, systolic and diastolic BP, and weight measurements. The One-way ANOVA test was used to analyze the final mean values of HbA1c, TC, TG, LDL, systolic and diastolic BP for the independent variables of age, gender and ethnicity.

2.4. Ethical application and issues

Approval to conduct this study was provided by the Ethics Committees of both the Faculty of Medical Sciences, The University of the West Indies, St. Augustine, Trinidad; and the South West Regional Health Authority (SWRHA).

3. Results

253 patients from a total of 430 type 2 diabetics (58.8%) satisfied the inclusion criteria at the Siparia Health Center and 68 of 98 (69.4%) type 2 diabetic patients at the Erin Health Center. See Table 1 for a description of the patients.

Tables 2–4 represent the comparison of the changes in common NCD parameters after 16 months of treatment at the two health facilities and between the facilities.

3.1. HbA1c

The initial mean of the HbA1c at the Siparia Health Center was 8.82% as compared with 9.48% at the Erin Health Center, but the final means were 8.63% and 8.73%, respectively (see Table 2). There was a statistically significant improvement in HbA1c levels at the Erin Health Center (see Table 3). However, at neither site did the final HbA1c reading reach the recommended CHRC guideline for control of diabetes of between 6% and 7%. Only 29.3% of patients achieved the CHRC standard of less than 7% for HbA1c.

3.2. Total Cholesterol (TC)

The mean of the initial TC at the Siparia Health Center was 194.25 mg/dl, and 195.80 mg/dl at the Erin Health Center. The mean of the final total cholesterol was 194.95 mg/dl, and 192.54 mg/dl with a mean difference of 2.41 mg/dl. The Caribbean Guidelines on Diabetes states that the total cholesterol should be controlled at less than 200 mg/dl. Only 22.7%, however, achieved the CHRC recommended level.

3.3. Triglycerides (TG)

The mean of initial triglycerides at the Siparia Health Center was 171.76 mg/dl, and 176.29 mg/dl at the Erin Health Center. The means of the final triglycerides were 189.93 mg/dl and 177.91 mg/dl, with a mean difference of 11.62 mg/dl.

The final triglyceride level of the patients of the Erin Health Center is better compared with the Siparia Health Center. The Caribbean Guidelines

Table 1 Profile of diabetic patients attending the Siparia District Health Facility (DHF) and the Erin Health Center in south Trinidad.

	Siparia Health Center N (%)	Erin Health Center N (%)
<i>Age groups</i>		
16–29	8 (3.2)	0 (0.0)
30–39	5 (1.9)	2 (2.9)
40–49	34 (13.4)	15 (22.1)
50–59	61 (24.1)	16 (23.5)
60–69	84 (33.2)	21 (30.9)
70–79	40 (15.8)	12 (17.6)
80–89	21 (8.3)	2 (2.9)
<i>Gender</i>		
Male	122 (48.2)	35 (52.3)
Female	131 (51.8)	33 (47.7)
<i>Ethnicity</i>		
Indo Trinidadians	148 (58.5)	39 (57.4)
Afro Trinidadians	86 (34.0)	28 (41.1)
Mixed Trinidadians	16 (6.3)	1 (1.5)
Chinese Trinidadians	3 (1.2)	0 (0.0)
Total	253 (100)	68 (100)

on Diabetes states that triglycerides should be controlled at less than 150 mg/dl. There was a statistically significant difference in TG levels at the Siparia Health Center, but this was for an increase in TG levels. A total of 45.5% of participants achieved the CHRC level for TG.

3.4. Low Density Lipoprotein (LDL)

The mean of the initial LDL at the Siparia Health Center was 122.93 mg/dl compared with 126 mg/dl at the Erin Health Center. The mean of the final LDL at both health centers was 116.77 mg/dl and 117.19 mg/dl, respectively, with a mean difference of 0.47 mg/dl. The Caribbean Guidelines on Diabetes states that LDL should be controlled at less than 70 mg/dl. The LDL values are above the recommended level at both of these health centers. Only 8.1% of patients achieved the CHRC recommended level.

3.5. Systolic Blood Pressure (SBP)

The mean of the initial systolic pressures at the Siparia Health Center was 151.12 mmHg, and 148.78 mmHg at the Erin Health Center. The mean of the final systolic pressures at the Siparia Health Center and the Erin Health Center was 148.85 mmHg and 148.88 mmHg, respectively,

showing that there was no significant difference in systolic pressures at these two health centers. The Caribbean Guidelines on Diabetes states that systolic pressure should be controlled at less than 130 mmHg; 30.2% achieved this level. The systolic pressures at both these health centers are above the recommended range.

3.6. Diastolic blood pressure (DBP)

The mean of the initial pressures at the Siparia Health Center was 85.84 mmHg, and 84.26 mmHg at the Erin Health Center. The mean of the final diastolic pressures at the Siparia Health Center and the Erin Health Center was 82.23 mmHg and 80.19 mmHg, respectively, showing that there was no significant difference in the diastolic pressures of these two health centers. The recommended value by the Caribbean Guidelines on Diabetes is less than 80 mmHg; 44.5% of patients achieved this level.

3.7. Weight

The mean of the initial weight at the Siparia Health Center was 75.95 kg, and 75.18 kg at the Erin Health Center. The mean of the final weight at the Siparia Health Center and the Erin Health Center was 77.75 kg and 74.76 kg, with a mean difference of 3.01 kg, respectively, showing that there were differences in the mean weight at these two health centers, but these did not achieve statistical significance.

3.8. ANOVA

One-way ANOVA testing showed no difference between means and the final mean values of the following parameters: HbA1c, TC, TG, LDL, systolic and diastolic BP for either gender or ethnicity. There was a statistically significant difference between means of HbA1c ($p < 0.032$) and systolic BP ($p < 0.005$) for different age categories, with older patients more likely to have a higher mean SBP, but lower mean HbA1cs.

4. Discussion

After 16 months, there was no difference between the selected variables monitoring NCDs within each health center or between the two health centers. Within the Siparia Health Center, there were statistically significant changes in TG (actually an increase in TG), LDL and diastolic BP. At the Erin Health Center there were statistically significant changes in LDL, HbA1c and diastolic BP. Further,

Table 2 Comparison of initial and final readings for relevant variables at the Siparia Health Center in Trinidad, West Indies.

Siparia Health Center N = 253	Initial	Final	Mean diff	Standard error mean initial	Standard error mean final	95% confidence interval	Degrees of freedom	t-Value	p-Value
HbA1c (%)	8.82	8.63	0.19	0.15	0.14	-0.03 to 0.41	252	1.69	0.092
Total cholesterol (mg/dl)	194.25	194.95	0.60	3.43	3.16	-6.25 to 5.27	252	-0.217	0.829
Triglycerides (mg/dl)	171.76	189.53	17.77	6.091	8.246	-30.591 to -4.90	252	-2.730	0.007
LDL (mg/dl)	122.93	116.77	6.16	2.801	2.569	1.578 to 10.801	252	2.644	0.009
Systolic BP (mmHg)	151.12	148.85	2.29	1.734	1.836	-1.342 to 5.880	252	1.237	0.217
Diastolic BP (mmHg)	85.84	82.23	3.61	1.036	1.069	1.471 to 5.746	252	3.325	0.001
Weight (kg)	75.95	77.75	1.80	1.078	2.358	-6.528 to 2.490	252	0.848	0.397

Table 3 Comparison of initial and final readings for relevant variables at the Erin Health Center in Trinidad, West Indies.

Erin Health Center N = 68	Initial	Final	Mean diff	Standard error mean initial	Standard error mean final	95% confidence interval	Degrees of freedom	t-Value	p-Value
HbA1c (%)	9.48	8.73	0.748	0.276	0.240	0.299 to 1.197	67	3.326	0.001
Total cholesterol (mg/dl)	195.80	192.54	3.26	5.73	6.06	-6.185 to 6.06	67	0.685	0.495
Triglycerides (mg/dl)	176.29	177.91	1.618	10.362	11.071	-5.509 to 29.392	67	0.163	0.871
LDL (mg/dl)	126.40	117.19	9.55	4.345	4.37	1.801 to 17.287	67	2.460	0.016
Systolic BP (mmHg)	148.78	148.88	0.10	3.182	3.861	-6.864 to 6.658	67	-0.030	0.976
Diastolic BP (mmHg)	84.26	80.19	4.074	1.764	1.988	0.128 to 8.019	67	2.061	0.043
Weight (kg)	75.18	74.76	0.421	1.930	1.981	-0.316 to 1.157	67	1.139	0.289

Table 4 Comparison of readings for relevant variables between Siparia and Erin Health Centers in Trinidad, West Indies.

Siparia vs. Erin Health Centers	Siparia final value N = 253	Erin final value N = 68	Mean diff	Standard Error Mean initial	Standard Error Mean final	95% confidence interval	Degrees of freedom	t-Value	p-Value
HbA1c (%)	8.63	8.73	0.10	0.1421	0.2406	-0.69 to 0.49	319	0.738	0.179
Total Cholesterol (mg/dl)	194.95	192.54	2.41	3.164	6.064	-15.869 to 11.147	319	-0.344	0.731
Triglycerides (mg/dl)	189.52	177.91	11.62	8.246	13.306	-22.48 to 45.74	319	0.670	0.503
LDL (mg/dl)	116.72	117.19	0.47	2.523	4.494	-10.187 to -9.733	319	0.088	0.930
Systolic BP (mmHg)	148.89	148.88	0.011	1.836	3.682	-7.902 to 7.934	319	0.003	0.998
Diastolic BP (mmHg)	82.23	80.19	2.038	1.069	1.988	-6.573 to 2.496	319	-0.884	0.377
Weight (kg)	77.76	74.76	3.00	2.351	2.004	-6.046 to 12.364	319	0.675	0.500

when compared with the recommended clinical guidelines for control of NCD parameters in diabetes from the 2006 CHRC guidelines [13], except for Total Cholesterol, the control achieved in this population was poor (see Table 5).

4.1. Local studies

Other local studies have also recorded difficulty in achieving diabetic control. A prospective study at another clinic of the South West Regional Health Authority conducted by Babwah [17] focused on 101 diabetic patients and produced a statistically significant reduction in HbA1c from a mean of 9.44–7.96% over a three-year period. This clinic used a patient-centered approach with a fixed physician providing care to a group of patients over an extended period of time. There was extensive education of the patients, and these patients volunteered to be part of this study; it would appear that they would be more motivated to look after their health. However, even after three years, metabolic control was not achieved (on average).

4.2. What added knowledge does this paper provide?

Mahabir and Gulliford, summarized above, reported on a comparison of diabetes care in health centers in Trinidad between 1996 and 2005 [10]. This paper adds another report on the quality of diabetic care in 2012. Unfortunately, this paper illustrates a continuing trend of poor control despite further investments in education, facilities and resources for the primary health care of diabetes.

4.3. What's next for the primary health care system in Trinidad?

The past failures of the NCD management in the Caribbean (and detailed in Section 1) are reflected once more in this current paper. The challenge to overcome is how to proceed? What attempts have been shown to work internationally? One possible solution might be performance-based payment incentives. This has been introduced in many health systems in the world; in 2004 an outcome and quality framework system was created as part of the medical practitioner's contract in the United Kingdom [18]. Financial rewards are given to physicians who achieve specific measurable outcomes. Since introducing this outcome and quality system, a large number of studies have shown many improvements in the management of patients with diabetes at the primary care level; also, major

Table 5 Comparison of metabolic, blood pressure and nutritional parameters in controlling diabetes from the CHRC guidelines and this study.

	CHRC guidelines (2006)	This study
Blood glucose		NA
HbA1c	<6.5%	8.63%
Total cholesterol (TC)	<200 mg/dl	194.95 mg/dl
HDL cholesterol (HDL)	>40 mg/dl	40.4 mg/dl*
LDL cholesterol (LDL)	<70 mg/dl	116.77 mg/dl
Fasting triglycerides (TG)	<150 mg/dl	189.53 mg/dl
Blood pressure	≤130/80 mmHg	151.12/85.84 mmHg
Body mass index	18.5–25 kg/m ²	NA
Waist circumference	<80 cm (F) or <94 cm (M)	NA

* Calculated from equation $HDL = TC - LDL - (TG/5)$ [16].

improvements in the clinical outcome measuring HbA1c, cholesterol, and blood pressure were observed in these studies. Some studies found that practices with a large patient number size had the highest quality of care scores. In these practices, doctors have a fixed number of patients assigned to them individually, and these patients are seen by the same doctor always [19,20].

Another possibility is movement toward a more patient-centered model. It has been argued that the health centers in Trinidad have informational and management continuity, but a paucity of relational continuity [21]. This means that for the individual physician every visit is potentially a new patient with the attendant uncertainty that such visits entail. Making individual primary care physicians responsible for the care of a fixed group of patients can be the next stage in the evolution of the system.

4.4. Future studies

With the availability of POCT and easier access to results in the health centers, papers such as this should become more commonplace. It is only through this type of exercise that researchers will be able to gauge impact, be it failure or success.

4.5. Limitations of this study

A large number of patients' records were excluded because of lack of laboratory values on HbA1c, LDL, TG, and TC; also some records had missing BP and weight values. Heights were not generally recorded and so BMI could not be calculated; 207 diabetic patients were excluded from this study because of incomplete results. It is uncertain what the impact of these patients

would have had on the final result. The time period used in this study was 16 months (January 2011–May 2012). This was the period where laboratory testing was being done and values were available, and although testing was done, much of the population was not tested on a regular basis. Being a retrospective study, there were no provisions for obtaining other important parameters, such as height to calculate BMI and waist circumferences, and to look at before/after changes with attendance at the clinics.

There was no controlling of external or historical factors which could interfere with the success of the patients. It must be assumed that the same quality of measurements both in the clinics and in the labs was present throughout the study.

Only the parameters at the population level were studied, whereby the effects on individual patients may be diluted by the mass effect. Patients with longer standing diabetes may have better or worse control and so dilute the overall effect. The ANOVA analysis did suggest that older patients had better HbA1c controls.

5. Conclusion

Despite continuing investment in primary care centers, there is limited success in achieving metabolic and BP control for patients with type 2 diabetes in Trinidad.

Contributorship

Both authors contributed equally to the paper's conceptualization, ethics approval applications, data analysis, initial drafting, final drafts and editing, and both approved the final version. GB was primarily involved in the data collection.

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Conflict of interest

The authors report that they have no conflict of interest.

Data sharing

There are no additional data to be shared.

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