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# **A longitudinal analysis of Type 2 Diabetes Data from the Macarthur Division of General Practice**

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# 1 Executive Summary

The Macarthur Division of General Practice (MDGP) is an urban Division in South-West Sydney. Since 1995 the Division has captured diabetes clinical data from general practice in CARDIAB (an electronic diabetes register) to support GPs with patient management through recalls, audits, identification of high-risk patients, quality improvement activities, program planning and development. This report shows results from a study that undertook an analysis of data captured in CARDIAB from 1995 to 2004.

The **aim** of this study was to undertake a longitudinal analysis of data captured in CARDIAB to investigate how general practices in the MDGP have managed patients with Type 2 diabetes from 1995 to the end of 2004. The study had three main objectives to investigate:

- the change in quality and quantity of data contained in the MDGP diabetes register;
- the quality of diabetes care for patients with Type 2 diabetes; and
- the clinical health outcomes of patients with Type 2 diabetes.

## Data quality

There was variation in the quality of the data collected over the 10 years. Data on demographics, diabetes history and participation in the Division Diabetes Program was recorded reliably each year throughout the 10 year period. Blood glucose treatment was recorded well but contained in a number of variables so was not included in this analysis as it requires further interpretation. Treatments for hypertension and dyslipidaemia, risk factors and other aspects of management such as physical examinations and pathology were incomplete.

## Registration and evaluation

| Diabetes Type | No of records | No of patients | % of patients |
|---------------|---------------|----------------|---------------|
| Type 1        | 788           | 177            | 6.4           |
| <b>Type 2</b> | <b>9,731</b>  | <b>2,430</b>   | <b>88</b>     |
| Previous GDM  | 2             | 1              | 0.04          |
| IFG           | 36            | 23             | 0.8           |
| IGT           | 155           | 102            | 3.7           |
| Unknown       | 13            | 6              | 0.2           |
| Missing       | 1,407         | 35             | 1.3           |
| Totals        | 12,132        | 2,774          | 100.0         |

GDM= Gestational Diabetes Mellitus; IFG=Impaired Fasting Glucose; IGT= Impaired Fasting Glucose

In 2001, there was a sharp increase in the number of new patients with diabetes evaluated as well as an increase in the number of new GPs registering patients. This coincides with the introduction of the Diabetes SIP incentive and the new care planning items. In 2004, there were 1,915 patients with Type 2 diabetes over the age of 25 years that had an evaluation

record. This represents 20% of the estimated population with Type 2 diabetes and 40% of the population diagnosed with Type 2 diabetes.

### **Quality of Care**

Trends emerging from the data show variability in the quality of care provided throughout the time period. Factors that may have contributed to this include a “dilution effect” of data contained in the register (particularly relevant between 1995 – 1999), as new GPs and patients were added to the register. In addition, reduced recording of clinical information by practitioners may have also attributed to the variation in the quality of care provided.

There was an increase in the recording of HDL from 1995 to 2001, foot examinations rose sharply in the first two years but gradually decreased by 2004. There was a decrease in the recording of blood pressure, HbA1c and Total Cholesterol from over 70% in 1995 to less than 50% in 2004. The decrease in 2002 may be the result of a true reduction in the quality of care provided or be the result of reduced recording of this information by clinicians. The recording of BMI was poor and remained low throughout the period.

### **Health outcomes**

Overall, most health outcomes were not achieved. However, trends emerging from the data show improvements in health outcomes where a measurement was recorded.

There were significant improvements in HbA1c, Systolic and Diastolic blood pressure results between 1995 and 2004. Significant improvements in HbA1c, total Cholesterol, HDL and LDL (excluding Triglycerides) levels were also found between 2000 and 2004 which corresponded with implementation of the Diabetes SIP.

Health outcome improvements were found for those patients with a longer duration of diabetes. Diastolic blood pressure and total Cholesterol reduced as the duration of diabetes increased. HbA1c increased for the first 10 years of having diabetes and then reduced. This is despite evidence that increases in the duration of diabetes and a patients’ age are associated with worsening physiological measures of control<sup>1</sup>. BMI followed the pattern of decreasing with age.

Targets for health outcomes were achieved for diastolic blood pressure in 2001, systolic blood pressure in 2004 and HDL throughout the study period. No other health outcomes analysed reached the recommended targets. More intensive management is needed for HbA1c, Total Cholesterol, LDL, and in particular BMI (mean was above 30kg/m<sup>2</sup> for all years) as the means were above the targets for every year. Continued effort needs to also be placed on improving systolic blood pressure management as the target was only achieved in 2004.

Analysis of a cohort of patients from this data will be needed to investigate the cause of changes in quality of care and health outcomes.

## 2 Background

### Diabetes in Australia

In Australia, the AusDiab survey found that type 2 diabetes affects over 7.4% of the total population aged over 25 years<sup>2</sup>. Almost a million Australians have diabetes, but half of these people are unaware of it. In terms of expenditure, diabetes is a costly disease, associated with substantial morbidity and mortality, especially if undetected or poorly controlled. McCarty et al (1996), estimated that the direct annual health care costs of diabetes in Australia, was as high as \$1.4 billion in 1995, and will reach \$2.3 billion by 2010. In 1996, recognizing its personal and public health impact, the Australian Health Ministers made diabetes one of the five top National Health Priority Areas<sup>3</sup>.

Cardiovascular disease (CVD) is the number one killer of Australians. Evidence shows that diabetes is a major CVD risk factor<sup>4,5</sup>. People with diabetes are two to four times more likely to develop CVD<sup>6</sup>, with about 65% of persons with diabetes dying from CVD<sup>7</sup>. In addition, people with Type 2 diabetes have high rates of other CVD risk factors such as hypertension, dyslipidaemia and obesity, etc. The risk of developing CVD increases when diabetes is present with these risk factors. Poor control of diabetes also contributes to a higher risk of developing CVD and to the risk of microvascular complications including diabetic retinopathy and renal disease.

Diabetes affects an increasing number of people in Australia and the burden of serious complications and their sequelae can be considerable both for the individual concerned and the health service in general. However many aspects of diabetic complications can be limited, preventable in some instances, with good management of the condition including education to change lifestyle risk factors, monitoring of blood pressure, blood levels of glycaemia and lipids, monitoring complications and providing appropriate therapy.

### CARDIAB and Division Diabetes Programs

CARDIAB is a Division-based electronic diabetes register. It has been used by Divisions since 1994 (its development was initiated by Macarthur Division of General Practice) to support patient management through recalls, audits, identification of high risk patients, quality improvement activities and program planning and development<sup>8,9</sup>. Harris et al 2002,<sup>10</sup> found that GPs who used Division-based electronic diabetes registers were more likely to provide better quality patient care than those who did not.

The National Divisions Diabetes Program (NDDP) was established in 1996 to develop a co-ordinated national approach to diabetes care in Australian general practice. It involved a network of individuals and organisations with an interest in general practice diabetes care. The program helped to inform the policy underpinning the National Integrated Diabetes Program (NIDP) established in 2001, to develop in conjunction with the National Diabetes Data Working Group, an agreed minimum clinical data set for diabetes in general practice,

Divisions were able to use the clinical dataset to inform and support GPs to provide better quality of care for their patients with diabetes.

### **The Macarthur Division of General Practice**

Divisions of General Practice (DGP) are local organisations of general practitioners that play an important part in the quality improvement of care delivered in general practice as well as helping to integrate general practice with the rest of health system.

The Macarthur Division of General Practice (MDGP) is an urban division in south-west Sydney. It was established in 1993 and by 2005 had 170 GP members across 90 practices. The estimated population of the MDGP area in 2005 was 234,578<sup>11</sup>. It has a high young population with 40% being under the age of 25 years. The population is relatively disadvantaged with a higher proportion of indigenous people (2.3%), single parent families (13.5%), unemployment, (1.2% at June 2003) and lower levels of education participation compared with Sydney and NSW.

In 1995, the MDGP began collecting diabetes clinical data from general practice and capturing it in CARDIAB. The Division employed a Diabetes Educator from 1994 to 2005 to provide various services and activities for member GPs and their patients including:

- diabetes assessment and education (patients);
- identification of patients at high risk;
- case management, assistance with care planning and the Diabetes Incentive Payments;
- six monthly audits and feedback to GPs;
- peer review
- patient recall and reminders;
- ongoing professional development for GPs; and
- training in patient assessment and education for the Aboriginal Health Workers at the Tharawal Aboriginal Corporation.

The MDGP also implemented a Healthy Eating, Activity and Lifestyle Program to reduce overweight and obesity and increase physical activity in 1999. Diabetes patients from the Divisions Diabetes Program are often referred to the lifestyle program for risk factor monitoring, physical activity classes and education to assist with self management

### **Why do this study?**

To date, there has not been a longitudinal review of the change in diabetes care and the impact of a Division Diabetes Program conducted in Australia. MDGP was the first DGP to use CARDIAB in 1995. This study will examine process and outcome changes of general practice care for patients with diabetes, captured in this unique database over 10 years from 1995 to 2004.

## **3 Aim and objectives**

### **3.1 Aim**

To investigate how general practices in the MDGP have managed diabetes between 1995 to the end of 2004.

### **3.2 Objectives**

- To investigate (over a ten year time span):
- changes in the quality and quantity of data collected in the Division based diabetes register
- the quality of diabetes care for patients with Type 2 diabetes; and
- the clinical health outcomes of patients with Type 2 diabetes.

## 4 Methods

### 4.1 Ethics approval

The MDGP agreed to the extraction of de-identified data from CARDIAB. Patient and GP consent is routinely obtained by the Division for patient registration into CARDIAB to use the data to support GP clinical management for quality improvement, research and planning.

Ethics approval was obtained from the University of NSW Human Research Ethics Committee to extract and analyse de-identified data from the MDGP' CARDIAB register.

### 4.2 Data collection and management

A total of 10 years (1995-2004) of de-identified data were extracted from the MDGP CARDIAB register into an MS Access database. Data for 144 variables were extracted using an updated version of the electronic tool used in the Divisions' Diabetes and CVD Quality Improvement Program (DDCQIP).

A number of variables were unable to be extracted due to technical difficulties and therefore, were not included in the analysis. These included date of foot examination, foot deformity, current foot ulcer, active foot lesions, foot deformities, visual acuity and retinal examination results, ophthalmic examination in last two years, microalbumin and referrals/attendances<sup>i</sup>.

Other variables, not included in the extraction and subsequent analysis included (for each patient) the number of reviews per year, number of blood pressures recorded each year, results of the first blood pressure recording for each year, retinal examination date and if the patient had hypertension and/or dyslipidaemia<sup>ii</sup>. It was thought the last two variables would be picked up with the date first diagnosed with hypertension and dyslipidaemia. However, this information had not been entered into CARDIAB at the Division.

The data extracted for each year were joined into one table in MS Access using the unique *Patient Identification* number and the *Year Evaluated*. An initial cleaning was conducted in MS access then the data were exported into SPSS for final cleaning and analysis.

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<sup>i</sup> These problems were fixed for the subsequent extraction of data at Southern Highlands DGP.

<sup>ii</sup> These variables were added for the proceeding extraction at the Southern Highlands DGP.

The data cleaning was conducted in the Centre for Primary Health Care and Equity<sup>12</sup>. All the missing and invalid data were identified based on the following criteria:

- Sex=unknown
- Male = Pregnant or GDM
- Female < 15 or > 50 = Pregnant or GDM,
- DOB>2005 or Year of diagnosis or Year of evaluation
- YearDx>YearEval
- Duration of diabetes>age
- On Insulin Since Year < Date of Diagnosis or DOB
- Type 1 and Rx = Diet or Tablets
- Type 1 and On Insulin Since Year >= 3 years after Date of Diagnosis
- Age at diagnosis < 18 and Diabetes status=type 2
- Diastolic BP > Systolic BP
- Systolic <70 mmHg or >240 mmHg or Diastolic <40 mmHg or >130 mmHg
- Age >14 and Height < 1.0 Metres or > 2.0 Metres
- Age >14 and Weight < 30 Kg or > 180 Kilograms
- Age < 14 and Height >2.0 metres or Age <14 and Weight> 180 Kg
- Weight < 20 Kg and height >1.5 Metres or Weight > 50kg and Height < 1.0 Metres
- Total cholesterol >30 or <0.4 mmol/l
- HDL cholesterol >2.5 or <0.4 mmol/l
- Triglycerides >50 or <0.5 mmol/l
- HbA1c >50 or <2.1

Those data identified as missing or invalid were sent back to the MDGP for cross checking and verification by Division staff.

### 4.3 Criteria used in this study

GPs can receive reimbursement from the Health Insurance Commission (HIC) if they implement a cycle of care over a 12 month period for patients with diabetes as part of the National Integrated Diabetes Program (NIDP). The Royal Australian College of General Practitioners (RACGP) has set goals to be used as a guide for the management of diabetes<sup>13</sup>. The following table lists the criteria used in our study for analyzing the quality of care and health outcomes.

**Table 1: Recommendations for Quality of Care and Targets**

|                | <b>NIDP (Process)</b> | <b>RACGP (Intermediate outcome)</b>  |
|----------------|-----------------------|--|
| HbA1c          | once per year         | ≤7 %   |
| Blood lipids   | once per year         | TC < 4.0 mmol/L<br>LDL < 2.5 mmol/L<br>HDL > 1.0 mmol/L<br>TG < 2.0 mmol/L |
| Ht/wt/waist    | every 6 months        | BMI < 25 kg/m <sup>2</sup>   |
| Blood pressure | every 6 months        | < 130/80* mm Hg  |

\*NHMRC Evidence-based Guidelines for the Management of Type 2 Diabetes, 2004.

HbA1c- glycosylated haemoglobin, TC- total cholesterol, HDL- high density lipoprotein cholesterol, LDL- low density lipoprotein cholesterol, TG-total triglycerides, BP- blood pressure, BMI- body mass index.

### 4.4 Statistical methods:

SPSS version 14.0 was used to analyze the data. Continuous variables were shown as mean ± standard deviation (SD) and categorical variables as frequencies (%). Comparison was conducted by independent t-test between two groups. Significant level was set at  $\alpha = 0.05$ .

## **5 Results**

### **5.1 Quality of data**

There were 12,132 patient records extracted from CARDIAB between 1995 to 2004. Each record included 144 variables. These variables were divided into 7 main groups:

Demographics; Diabetes history; Risk factors; Physical examinations; Pathology tests; Complications; Treatment; Referral and Attendance; and Division program.

Data on demographics, diabetes history and participation in the Division Diabetes Program was recorded reliably for every year within the ten year time period. Treatments for hypertension and dyslipidaemia, risk factors and other aspects of management such as physical examinations and pathology were missing. Blood glucose treatment was recorded well but contained in a number of variables so was not included in this analysis as it requires further interpretation. No complications had been recorded.

The main reasons for variables being poorly recorded or having high missing/invalid/unknown values are likely to be:

- Patient information had not been requested / recorded on the registration or review forms completed by GPs
- Patient information was recorded incorrectly
- Patient information was not provided by GPs to the MDGP

Due to the inconsistencies in data routinely recorded in the dataset we have focused our analysis on the majority of variables that were reliably recorded across the 10 years period and for LDL data reliably recorded during the last six years.

### **5.2 Registration and evaluation**

#### **5.2.1 Patient information**

There were 12,132 diabetes evaluation records for 2,774 patients from 1995 to 2004 in MDGP CARDIAB database.

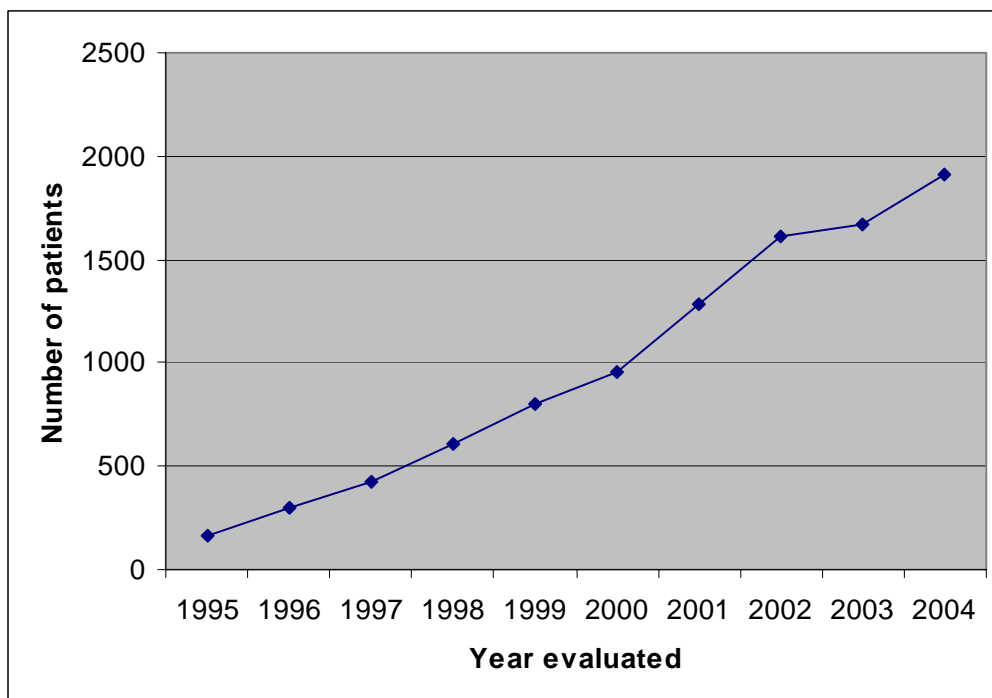
Table 2 shows there were 2,430 patients with Type 2 diabetes with evaluation records over the study period. This represents 88% of all patients registered in CARDIAB. Patients diagnosed with Type 1 diabetes represent 6.4% of all patients. The number of patients with Type 2 diabetes is consistent with prevalence estimates. The number of patients with Type 1 is slightly lower than the expected estimate of 10%.

**Table 2: Patients and Records by Diabetes type**

| Diabetes Type | No. of records | No patients  | % of patients |
|---------------|----------------|--------------|---------------|
| Type 1        | 788            | 177          | 6.4           |
| <b>Type 2</b> | <b>9,731</b>   | <b>2,430</b> | <b>88</b>     |
| Previous GDM  | 2              | 1            | 0.04          |
| IFG           | 36             | 23           | 0.8           |
| IGT           | 155            | 102          | 3.7           |
| Unknown       | 13             | 6            | 0.2           |
| Missing       | 1,407          | 35           | 1.3           |
| <b>Totals</b> | <b>12,132</b>  | <b>2,774</b> | <b>100.0</b>  |

Figure 1 and Table 3 show that the number of patients with Type 2 diabetes evaluated each year gradually increased over the 10 years, with the largest increase between 2000 and 2002.

**Figure 1: Patients with Type 2 Diabetes Evaluated each year**

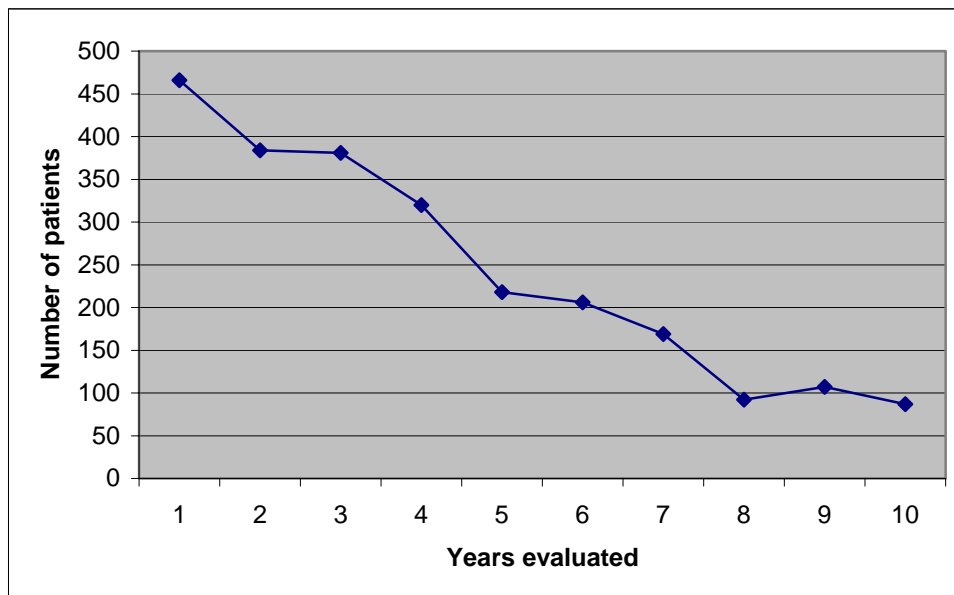


**Table 3: Patients with Type 2 Diabetes evaluated each year**

| Year         | N    | %    |
|--------------|------|------|
| 1995         | 164  | 1.7  |
| 1996         | 301  | 3.1  |
| 1997         | 421  | 4.3  |
| 1998         | 609  | 6.3  |
| 1999         | 804  | 8.3  |
| 2000         | 960  | 9.9  |
| 2001         | 1279 | 13.1 |
| 2002         | 1610 | 16.5 |
| 2003         | 1668 | 17.1 |
| 2004         | 1915 | 19.7 |
| <b>Total</b> | 9731 | 100  |

The largest proportion of patients with Type 2 diabetes registered in CARDIAB had evaluation records for one year only. There was a reduction in the number of patients with evaluations as the number of years in the program increased.

**Figure 2: Patients with Type 2 Diabetes by Number of Years Evaluated**



**Table 4: Patients with Type 2 Diabetes by Number of Years Evaluated**

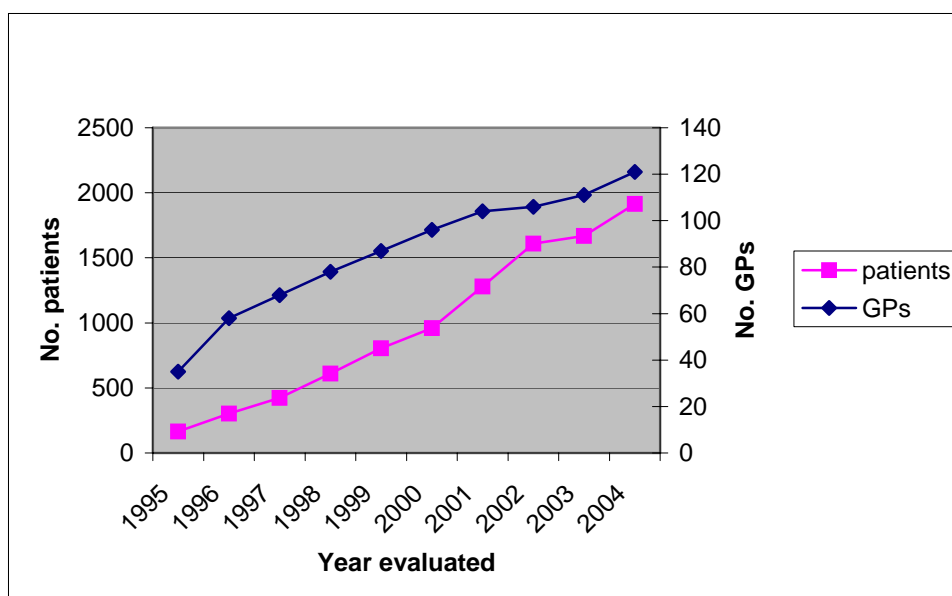
| Years in program | No. of Type 2 individual patients | % in years evaluated |
|------------------|-----------------------------------|----------------------|
| 1                | 466                               | 19                   |
| 2                | 384                               | 15.8                 |
| 3                | 381                               | 15.7                 |
| 4                | 320                               | 13.2                 |
| 5                | 218                               | 9.0                  |
| 6                | 206                               | 8.5                  |
| 7                | 169                               | 7.0                  |
| 8                | 92                                | 3.8                  |
| 9                | 107                               | 4.4                  |
| 10               | 87                                | 3.6                  |
| <b>TOTAL</b>     | <b>2430</b>                       | <b>100%</b>          |

### 5.2.2 GP information

There were 350 GPs who registered patients with Type 2 diabetes. This ranged from 35 to 121 GPs across the 10 years from 1995 and 2004.

Figure 3 shows that the number of GPs reviewing patients with Type 2 diabetes increased each year, particularly in the first 3 years. By 2004, 121 GPs registered patients, representing 71% of the Division's GP membership.

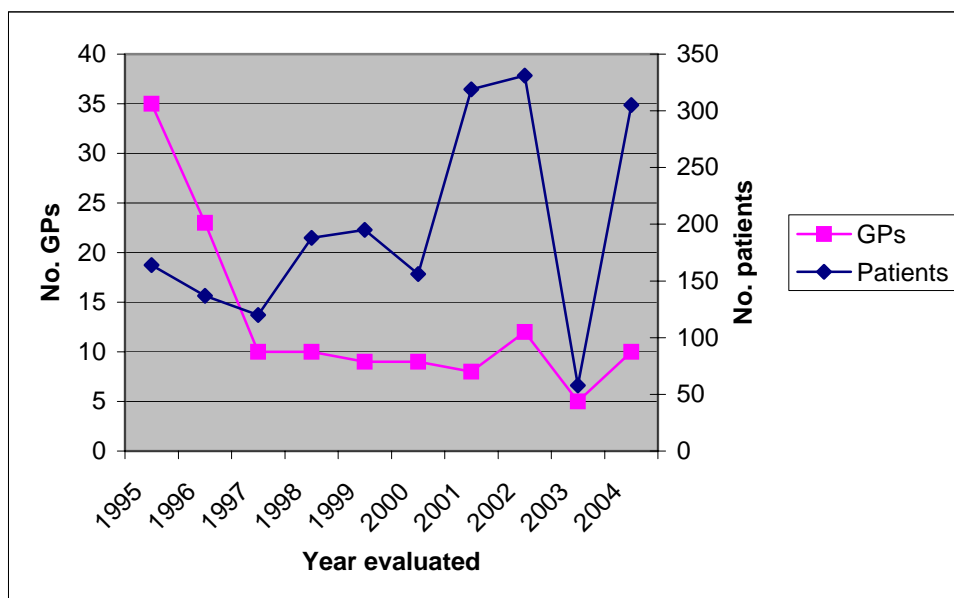
**Figure 3: Patients with Type 2 Diabetes Evaluated and GPs in Each Year**



In 2001, there was a sharp increase in the number of new patients evaluated as well as an increase in the number of new GPs evaluating patients. (Figure 4 and Table 5). This coincides with the introduction of the Diabetes SIP incentive and the new care planning items. In the financial year between 2001 and 2002 the Diabetes Educator reviewed 414 care plans<sup>14</sup>.

In 2003, there was a sharp decline in the number of new patients evaluated and the number of GPs registering patients. However, in 2004, the number of both patients and GPs had increased to almost pre 2003 levels. This could be due to a concerted effort by the Division to focus on identifying high risk patients for care planning and SIP reports.

**Figure 4: Numbers of GPs and Patients with Type 2 Diabetes Evaluated Each Year**



**Table 5: Number of GPs and patients With Type 2 diabetes evaluated by year**

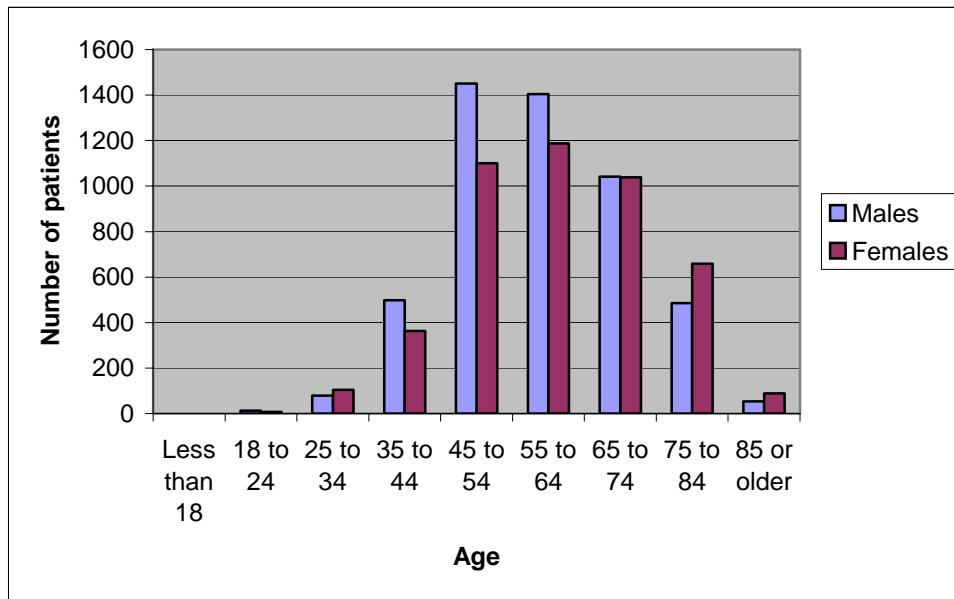
| Year           | No. of GPs | Increase in no. GPs | No. of patients | Increase in no. patients |
|----------------|------------|---------------------|-----------------|--------------------------|
| 1995           | 35         | 35                  | 164             | 164                      |
| 1996           | 58         | 23                  | 301             | 137                      |
| 1997           | 68         | 10                  | 421             | 120                      |
| 1998           | 78         | 10                  | 609             | 188                      |
| 1999           | 87         | 9                   | 804             | 195                      |
| 2000           | 96         | 9                   | 960             | 156                      |
| 2001           | 104        | 8                   | 1,279           | 319                      |
| 2002           | 106        | 12                  | 1,610           | 331                      |
| 2003           | 111        | 5                   | 1,668           | 58                       |
| 2004           | 121        | 10                  | 1,915           | 305                      |
| <b>Total *</b> | <b>864</b> | <b>131</b>          | <b>9,731</b>    | <b>1,973</b>             |

\*Includes multiple counts for GPs and patients registered for more than one year.

### 5.3 Demographics:

There were slightly more males than females evaluated over all years. The majority of patients were between 45 and 64 years of age. The age range for males was 18 to 90 years (mean 58.4) and for females 19 to 95 years (mean 60.5).

**Figure 5: Distribution of Patients with Type 2 Diabetes by Age and Sex**



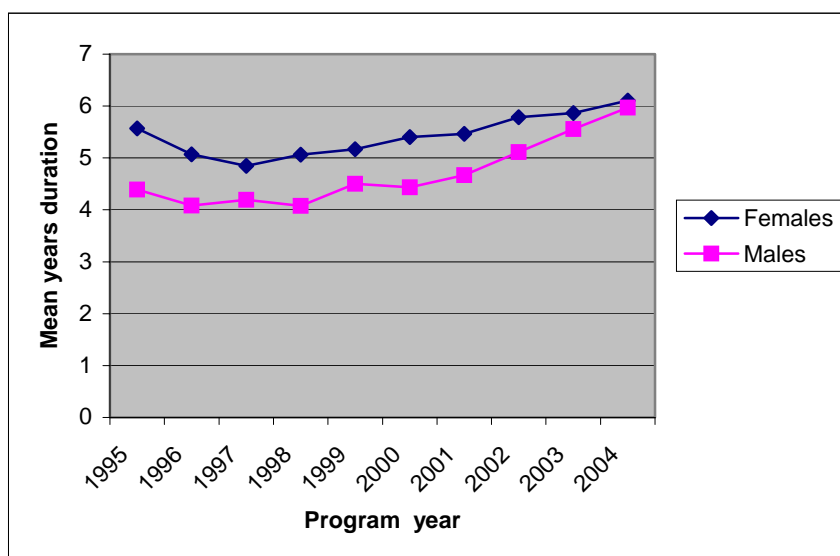
**Table 6: Distribution of Patients with Type 2 Diabetes by Age and Sex**

| Age (yrs)           | Male        |             | Female      |             | All         |              |
|---------------------|-------------|-------------|-------------|-------------|-------------|--------------|
|                     | N           | %           | N           | %           | N           | %            |
| <b>Less than 18</b> | 0           | 0           | 0           | 0           | 0           | 0.0          |
| <b>18 to 24</b>     | 12          | 0.1         | 7           | 0.07        | 19          | 0.2          |
| <b>25 to 34</b>     | 79          | 0.8         | 104         | 1.1         | 183         | 1.9          |
| <b>35 to 44</b>     | 498         | 5.2         | 363         | 3.7         | 861         | 9.0          |
| <b>45 to 54</b>     | 1451        | 15.2        | 1101        | 11.5        | 2552        | 26.7         |
| <b>55 to 64</b>     | 1404        | 14.7        | 1188        | 12.4        | 2592        | 27.1         |
| <b>65 to 74</b>     | 1041        | 10.9        | 1038        | 10.8        | 2079        | 21.7         |
| <b>75 to 84</b>     | 485         | 5.1         | 659         | 6.9         | 1144        | 11.9         |
| <b>85 or older</b>  | 53          | 0.5         | 88          | 0.9         | 141         | 1.5          |
| <b>Total</b>        | <b>5023</b> | <b>52.5</b> | <b>4548</b> | <b>47.5</b> | <b>9571</b> | <b>100.0</b> |

The estimated population of people over the age of 25 years with Type 2 diabetes in the MDGP is 9,333<sup>15</sup>. In 2004, there were 1,915 patients with Type 2 diabetes over the age of 25 years registered in CARDIAB. This represents 20% of the estimated population in the MDGP area with Type 2 diabetes (diagnosed and undiagnosed) and 40% of the population diagnosed with type 2 diabetes according to the AusDiab study<sup>16</sup>.

Figure 6 and Table 7 shows that the mean duration of diabetes for males and females declined in the first few years and then increased each year after 1998 for males and 1997 for females. The trend in duration of diabetes for males between 1995 and 2004 was significant (P=0.015) but was not significant for females (P=0.416).

**Figure 6: Mean Duration of Diabetes by Sex in Type 2 Diabetes**

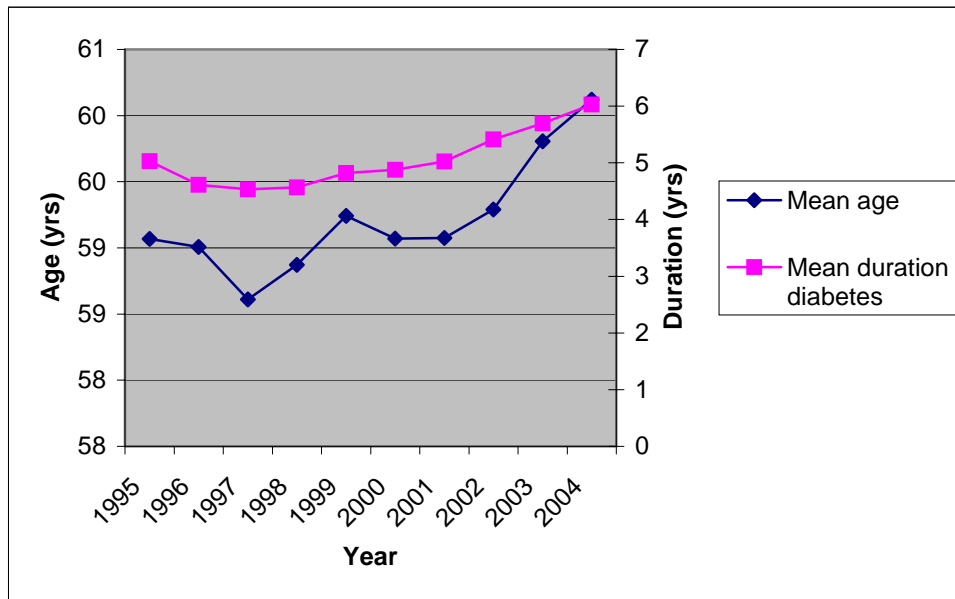


**Table 7: Mean Duration Of Diabetes By Sex**

| YearEval     | Males       |             |             | Females     |             |             |
|--------------|-------------|-------------|-------------|-------------|-------------|-------------|
|              | Mean        | N           | SD          | Mean        | N           | SD          |
| 1995         | 4.39        | 86          | 5.57        | 5.67        | 72          | 5.12        |
| 1996         | 4.08        | 155         | 5.07        | 5.88        | 134         | 5.07        |
| 1997         | 4.19        | 213         | 4.85        | 5.56        | 196         | 4.93        |
| 1998         | 4.07        | 293         | 5.06        | 5.59        | 298         | 4.90        |
| 1999         | 4.50        | 375         | 5.17        | 5.76        | 406         | 4.94        |
| 2000         | 4.44        | 428         | 5.40        | 5.83        | 502         | 4.86        |
| 2001         | 4.67        | 551         | 5.47        | 5.64        | 679         | 4.84        |
| 2002         | 5.11        | 690         | 5.78        | 5.82        | 848         | 4.93        |
| 2003         | 5.56        | 738         | 5.87        | 5.64        | 859         | 5.26        |
| 2004         | 5.97        | 856         | 6.11        | 5.83        | 975         | 5.35        |
| <b>Total</b> | <b>5.04</b> | <b>4385</b> | <b>5.61</b> | <b>5.74</b> | <b>4969</b> | <b>5.10</b> |

While the mean age for patients fluctuated across the 10 years the trend in age was to increase, but not significantly (P=0.302). The mean duration of diabetes increased significantly over the same period (P=0.031).

**Figure 7: Mean Age and Duration of Diabetes by Year for Type 2 Patients**

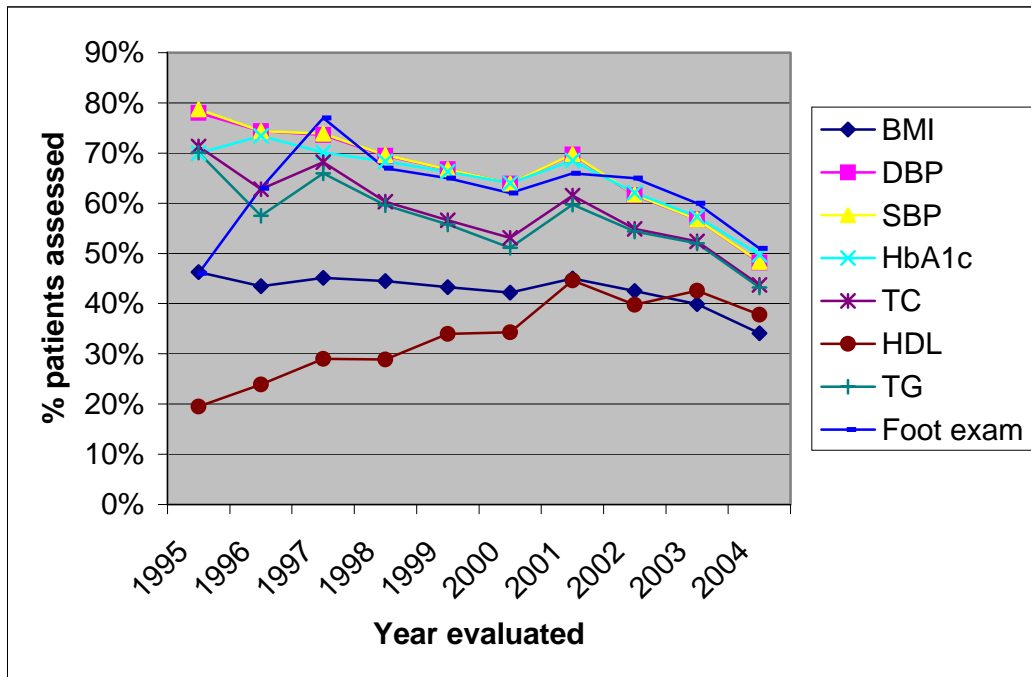


## 5.4 Quality of care

### 5.4.1 HbA1c, Lipids, Blood pressure, Foot examinations, BMI

Figure 8 and Table 8 show the proportion of patients with at least one assessment record for each of the quality of care indicators. There was an increase in the recording of HDL from 1995 to 2001. Foot examinations rose sharply in the first two years from 46% to 77% but then gradually decreased to 51% in 2004. There was a decrease in the recording of blood pressure, HbA1c and total cholesterol from over 70% in 1995 to less than 50% in 2004. The decrease to 2002 may be because of a true reduction in quality of care or due to inconsistencies in practitioner recording of clinical information. During the first 5 years there may also have been a dilution effect as new GPs and patients were added to the register. The recording of BMI was poor and remained low throughout the study period.

**Figure 8: Percentage of Patients with Type 2 Diabetes Assessed Once In the Year for Quality Of Care Indicators**



**Table 8: Number and % of Patients with type 2 diabetes assessed once in the year for quality of care indicators**

|                   | 1995  | 1996  | 1997  | 1998  | 1999  | 2000  | 2001  | 2002  | 2003  | 2004  |
|-------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| <b>BMI</b>        | 76    | 131   | 190   | 271   | 348   | 405   | 575   | 684   | 665   | 653   |
|                   | 46.3% | 43.5% | 45.1% | 44.5% | 43.3% | 42.2% | 45.0% | 42.5% | 39.9% | 34.1% |
| <b>DBP</b>        | 128   | 224   | 310   | 423   | 537   | 613   | 891   | 992   | 947   | 923   |
|                   | 78.0% | 74.4% | 73.6% | 69.5% | 66.8% | 63.9% | 69.7% | 61.6% | 56.8% | 48.2% |
| <b>SBP</b>        | 129   | 224   | 311   | 424   | 537   | 613   | 893   | 993   | 948   | 924   |
|                   | 78.7% | 74.4% | 73.9% | 69.6% | 66.8% | 63.9% | 69.8% | 61.7% | 56.8% | 48.3% |
| <b>HbA1c</b>      | 116   | 221   | 295   | 416   | 533   | 614   | 876   | 1000  | 956   | 951   |
|                   | 70.0% | 73.4% | 70.1% | 68.3% | 66.3% | 64.0% | 68.5% | 62.1% | 57.3% | 49.7% |
| <b>TC</b>         | 117   | 189   | 287   | 367   | 455   | 510   | 786   | 884   | 874   | 837   |
|                   | 71.3% | 62.8% | 68.2% | 60.3% | 56.6% | 53.1% | 61.5% | 54.9% | 52.4% | 43.7% |
| <b>HDL</b>        | 32    | 72    | 122   | 176   | 273   | 329   | 570   | 640   | 711   | 724   |
|                   | 19.5% | 23.9% | 29.0% | 28.9% | 34.0% | 34.3% | 44.6% | 39.8% | 42.6% | 37.8% |
| <b>TG</b>         | 115   | 173   | 278   | 363   | 449   | 491   | 764   | 876   | 867   | 828   |
|                   | 70.1% | 57.5% | 66.0% | 59.6% | 55.8% | 51.1% | 59.7% | 54.4% | 52.0% | 43.2% |
| <b>Foot exam.</b> | 75    | 191   | 298   | 410   | 527   | 583   | 841   | 1045  | 996   | 985   |
|                   | 46%   | 63%   | 77%   | 67%   | 65%   | 62%   | 66%   | 65%   | 60%   | 51%   |

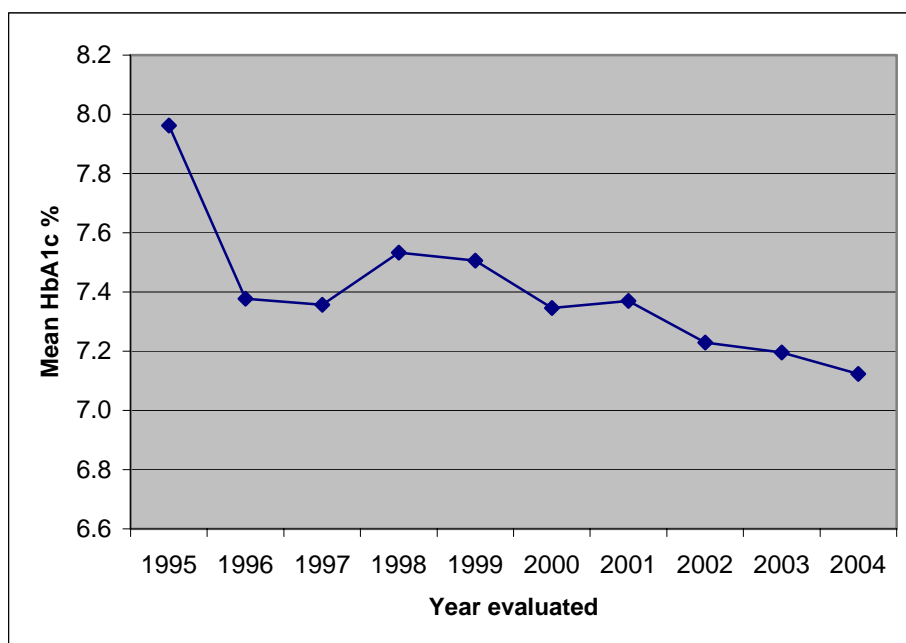
## 5.5 Health Outcomes

The health outcomes for HbA1c, BMI, blood pressure and lipids were analysed. Health outcomes for foot examinations were not included as results were not available from the data extraction.

### 5.5.1 HbA1c

Figure 9 and Table 9 show a significant decline in mean HbA1c between 1995 and 2004 ( $P=0.000$ ). There was an initial decline from 1995 to 1996. This was probably due to dilution effects caused by the registration of new patients. Even so, the trend for HbA1c to decline between 1996 and 2004 was also found to be significant ( $P=0.011$ ). The small decline of 0.23 in HbA1c between 2000 and 2004 was also significant and coincided with the introduction of the Diabetes SIP ( $P=0.002$ ). This decline is despite an increase in the average duration of diabetes for these patients which would be expected to be associated with an increase in HbA1c<sup>17</sup>. (Figure 10 and Table 10)

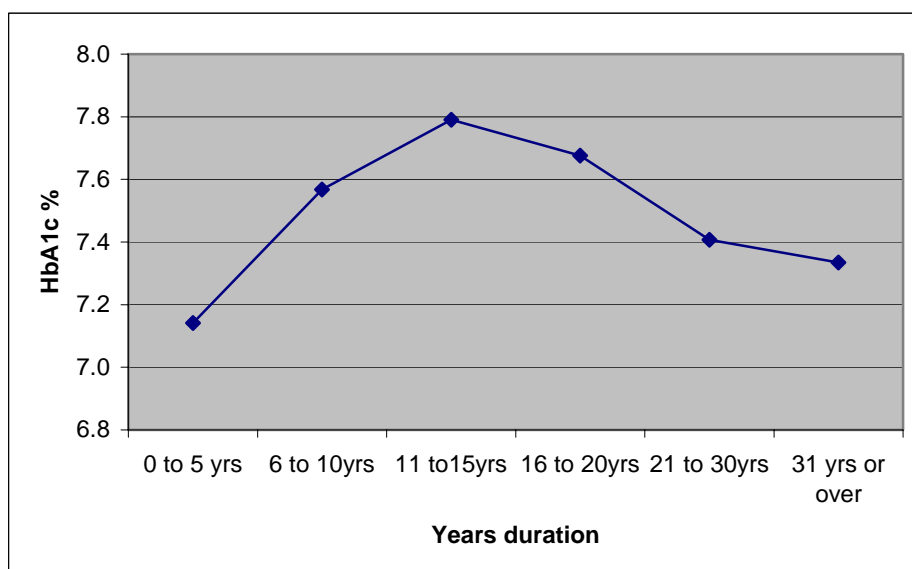
**Figure 9 Trend in Mean HbA1c Over 10 Years for Patients with Type 2 Diabetes**



**Table 9: Trend in Mean HbA1c Over 10 Years for Patients With Type 2 Diabetes**

| YearEval     | Mean        | N           | SD          |
|--------------|-------------|-------------|-------------|
| 1995         | 7.96        | 116         | 1.83        |
| 1996         | 7.38        | 221         | 1.38        |
| 1997         | 7.36        | 295         | 1.47        |
| 1998         | 7.53        | 416         | 1.53        |
| 1999         | 7.51        | 533         | 1.44        |
| 2000         | 7.35        | 614         | 1.40        |
| 2001         | 7.37        | 876         | 1.42        |
| 2002         | 7.23        | 1000        | 1.38        |
| 2003         | 7.20        | 956         | 1.37        |
| 2004         | 7.12        | 951         | 1.32        |
| <b>Total</b> | <b>7.31</b> | <b>5978</b> | <b>1.42</b> |

**Figure 10: Trend in Mean HbA1c by Duration of Type 2 Diabetes**



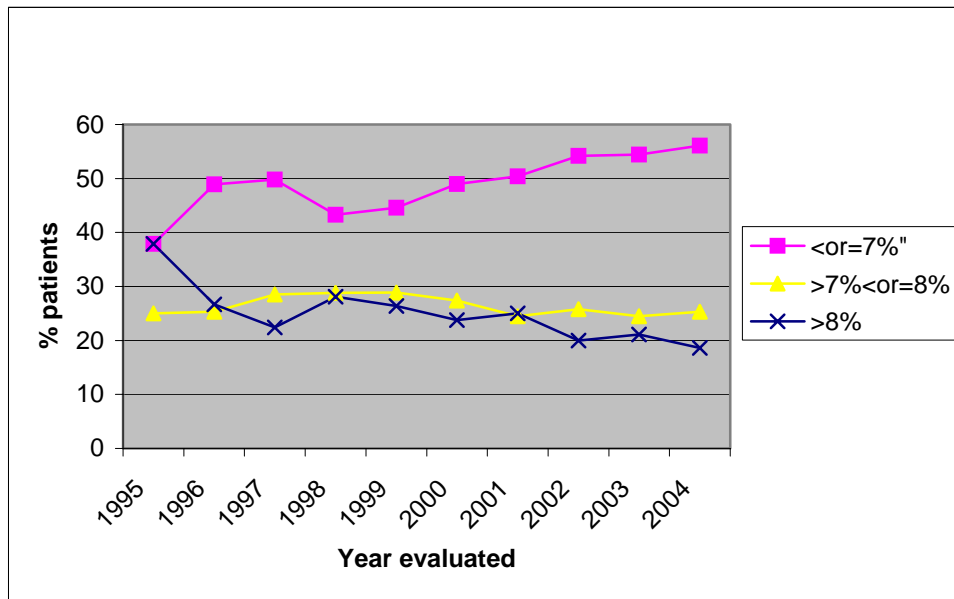
**Table 10: Trend in mean HbA1c by duration of diabetes**

|                    | 0 to 5 yrs | 6 to 10yrs | 11 to 15yrs | 16 to 20yrs | 21 to 30yrs | 31 yrs or over |
|--------------------|------------|------------|-------------|-------------|-------------|----------------|
| <b>Mean HbA1c</b>  | 7.14       | 7.57       | 7.79        | 7.67        | 7.41        | 7.33           |
| <b>SD</b>          | 1.41       | 1.39       | 1.35        | 1.31        | 1.25        | 1.13           |
| <b>No. records</b> | 3666       | 1239       | 540         | 193         | 107         | 20             |

Figure 11 and Table 11 show that over the study period, more patients met the HbA1c target of  $\leq 7\%$ . The exception being in 1995 when there was the same proportion of patients with an HbA1c  $> 8\%$ . This may be due to GPs initially registering more complex patients.

The proportion of patients meeting the HbA1c target increased by 18.3% over the study period from 37.9% to 56.2%. The proportion of patients with HbA1c  $> 8\%$  reduced from 37.9% to 18.6%, while the proportion between  $> 7\% \leq 8\%$  increased by 1.2%.

**Figure 11: % Patients with Type 2 Diabetes within HbA1c Ranges Over 10 Years**



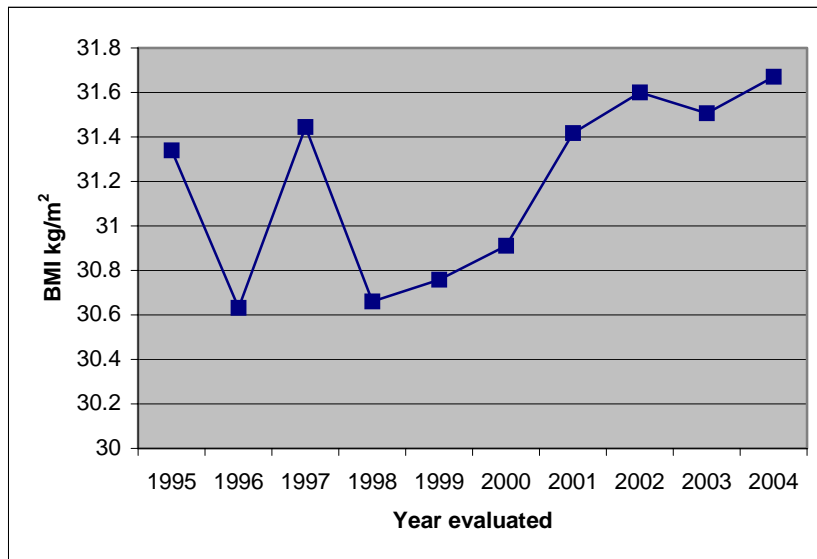
**Table 11: % Patients with Type 2 Diabetes within HbA1c Ranges**

| Year evaluated   | ≤ 7%        |      | >7% ≤ 8%    |      | >8%         |      |
|------------------|-------------|------|-------------|------|-------------|------|
|                  | N           | %    | N           | %    | N           | %    |
| 1995             | 44          | 37.9 | 28          | 24.1 | 44          | 37.9 |
| 1996             | 107         | 48.4 | 55          | 24.9 | 59          | 26.7 |
| 1997             | 146         | 49.5 | 83          | 28.1 | 66          | 22.4 |
| 1998             | 179         | 43.0 | 120         | 28.8 | 117         | 28.1 |
| 1999             | 238         | 44.7 | 154         | 28.9 | 141         | 26.5 |
| 2000             | 301         | 49.0 | 167         | 27.2 | 146         | 23.8 |
| 2001             | 442         | 50.5 | 215         | 24.5 | 219         | 25.0 |
| 2002             | 542         | 54.2 | 258         | 25.8 | 200         | 20.0 |
| 2003             | 520         | 54.4 | 234         | 24.5 | 202         | 21.1 |
| 2004             | 534         | 56.2 | 241         | 25.3 | 177         | 18.6 |
| <b>Total No.</b> | <b>3053</b> |      | <b>1555</b> |      | <b>1371</b> |      |

### 5.5.2 BMI

There was an increase in the mean BMI of 1.0 kg/m<sup>2</sup> over the study period. There was no significant change in the mean BMI between 1995 and 2004 (P=0.99) or between 2000 and 2004 during the time the Diabetes SIP was introduced (P=0.076). The BMI target of <25kg/m<sup>2</sup> was not achieved in any year. The fluctuations in BMI in the first 4 years were probably due to dilution effects caused by registration of new patients. (Figure 12 and Table 12)

**Figure 12: Trend in Mean BMI Over 10 Years for Patients with Type 2 Diabetes**

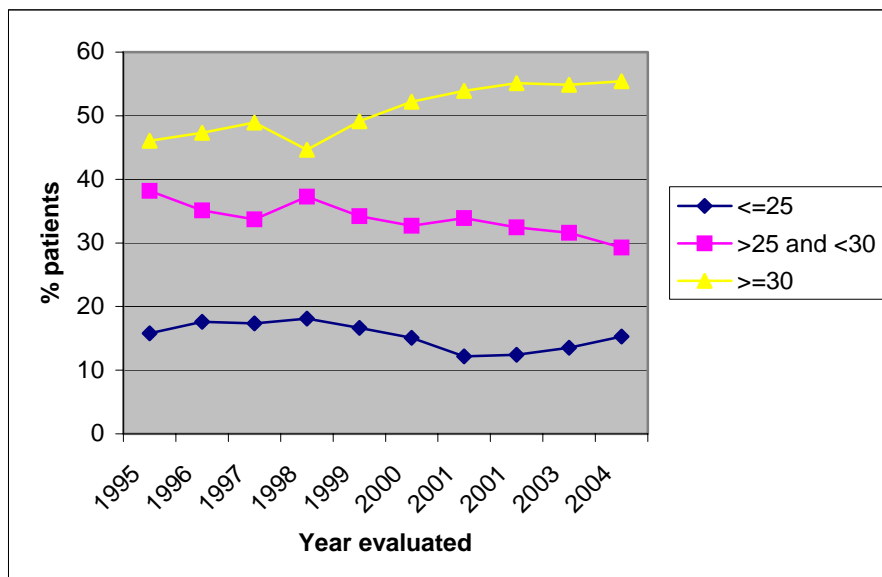


**Table 12: Mean BMI by Year Evaluated For Patients with Type 2 Diabetes**

| YearEval     | Mean  | N    |
|--------------|-------|------|
| 1995         | 30.30 | 76   |
| 1996         | 30.63 | 131  |
| 1997         | 31.44 | 190  |
| 1998         | 30.66 | 271  |
| 1999         | 30.76 | 348  |
| 2000         | 30.91 | 405  |
| 2001         | 31.42 | 575  |
| 2002         | 31.60 | 684  |
| 2003         | 31.51 | 665  |
| 2004         | 31.67 | 653  |
| <b>Total</b> | 31.30 | 3998 |

The majority of patients had a BMI  $\geq 30\text{kg/m}^2$  for all years and this increased over the study period. Only a small proportion of the patients evaluated each year had a BMI  $\leq 25\text{kg/m}^2$  (Figure 13 and Table 13).

**Figure 13: Patients in BMI Ranges by Year Evaluated**

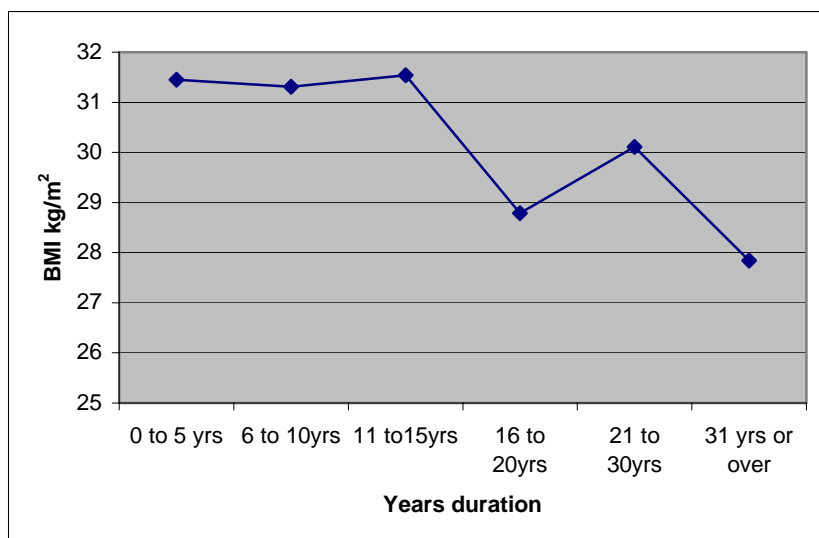


**Table 13: Patients in BMI Ranges by Year Evaluated**

|             | $\leq 25\text{kg/m}^2$ |      | $>25$ and $<30\text{kg/m}^2$ |      | $\geq 30\text{kg/m}^2$ |      |
|-------------|------------------------|------|------------------------------|------|------------------------|------|
|             | N                      | %    | N                            | %    | N                      | %    |
| <b>1995</b> | 12                     | 15.8 | 29                           | 38.2 | 35                     | 46.1 |
| <b>1996</b> | 23                     | 17.6 | 46                           | 35.1 | 62                     | 47.3 |
| <b>1997</b> | 33                     | 17.4 | 64                           | 33.7 | 93                     | 48.9 |
| <b>1998</b> | 49                     | 18.1 | 101                          | 37.3 | 121                    | 44.6 |
| <b>1999</b> | 58                     | 16.7 | 119                          | 34.2 | 171                    | 49.1 |
| <b>2000</b> | 61                     | 15.1 | 132                          | 32.7 | 211                    | 52.2 |
| <b>2001</b> | 70                     | 12.2 | 195                          | 33.9 | 310                    | 53.9 |
| <b>2001</b> | 85                     | 12.4 | 222                          | 32.5 | 377                    | 55.1 |
| <b>2003</b> | 90                     | 13.5 | 210                          | 31.6 | 365                    | 54.9 |
| <b>2004</b> | 100                    | 15.3 | 191                          | 29.2 | 362                    | 55.4 |

Figure 14 and Table 14 show that BMI reduced as duration of diabetes and age increased, however the target BMI was never achieved. BMI followed the pattern of decreasing with age.

**Figure 14: Trend in Mean BMI by Duration of Type 2 Diabetes**



**Table 14: Trend in Mean BMI by Duration of Type 2 Diabetes**

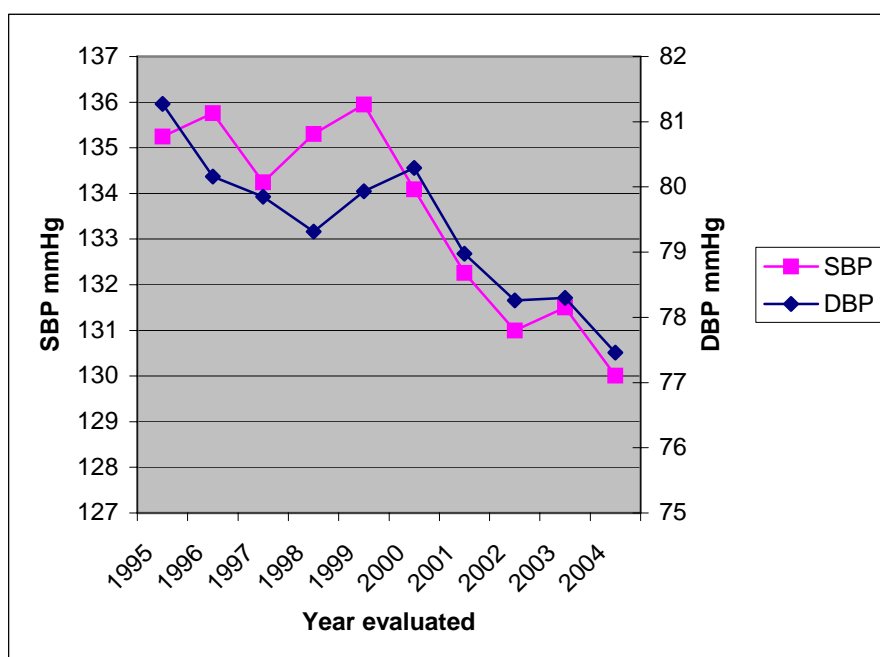
|            | 0 to 5 yrs | 6 to 10 yrs | 11 to 15 yrs | 16 to 20 yrs | 21 to 30 yrs | 31 yrs or over |
|------------|------------|-------------|--------------|--------------|--------------|----------------|
| <b>BMI</b> | 31.45      | 31.31       | 31.54        | 28.78        | 30.11        | 27.84          |
| <b>SD</b>  | 1.41       | 1.39        | 1.35         | 1.31         | 1.24         | 1.13           |
| <b>No.</b> | 3666.00    | 1239.00     | 540.00       | 193.00       | 107.00       | 20.00          |

### 5.5.3 Blood Pressure

Figure 15 and Table 15 show a general trend of blood pressures decreasing over the study period by 5mmHg for systolic BP and 3mmHg for diastolic BP. When comparing 1995 with 2004 there was a significant reduction for both mean systolic and diastolic blood pressures (P=0.000). Between 2000 and 2004 when the Diabetes SIP was introduced, there was also significant reductions for mean systolic BP (P=0.000) and mean diastolic BP (P=0.000).

Across the 10 years, the target for systolic blood pressure of 130mmHg was achieved in 2004 and the target for diastolic blood pressure of 80mmHg was achieved in all years except 1995.

**Figure 15: Trend in Mean BP Over 10 Years for Patients with Type 2 Diabetes**



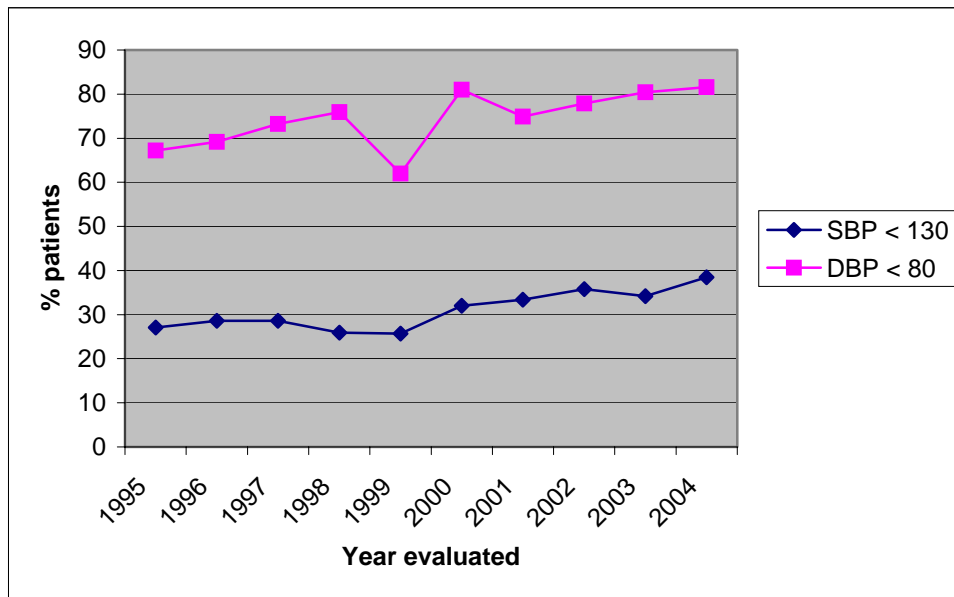
**Table 15: Trend in Mean BP for Patients with Type 2 Diabetes**

| Year | SBP |      | DBP |      |
|------|-----|------|-----|------|
|      | N   | Mean | N   | Mean |
| 1995 | 129 | 135  | 128 | 81   |
| 1996 | 224 | 136  | 224 | 80   |
| 1997 | 311 | 134  | 310 | 80   |
| 1998 | 424 | 135  | 423 | 79   |
| 1999 | 537 | 136  | 537 | 80   |
| 2000 | 613 | 134  | 613 | 80   |
| 2001 | 893 | 132  | 891 | 79   |
| 2002 | 993 | 131  | 992 | 78   |
| 2003 | 948 | 132  | 947 | 78   |
| 2004 | 924 | 130  | 923 | 77   |

Figure 16 and Table 16 show there was an increase in the proportion of patients with a blood pressure recorded that met the systolic BP target of <130mmHg and the diastolic BP target of <80mmHg over the study period . Between 36.3% and 50% more patients achieved the target for diastolic BP than systolic BP each year.

There was an unexplained drop in the proportion of patients meeting the diastolic target and a small reduction in those meeting the systolic target in 1999. After 2000 the proportion of patients meeting the diastolic target increased at a gradual rate. There was a similar trend in the proportion of patients achieving the systolic target but with a small drop of 1.6% in the year 2003.

**Figure 16: % of Patients with Type 2 Diabetes Meeting BP Targets**

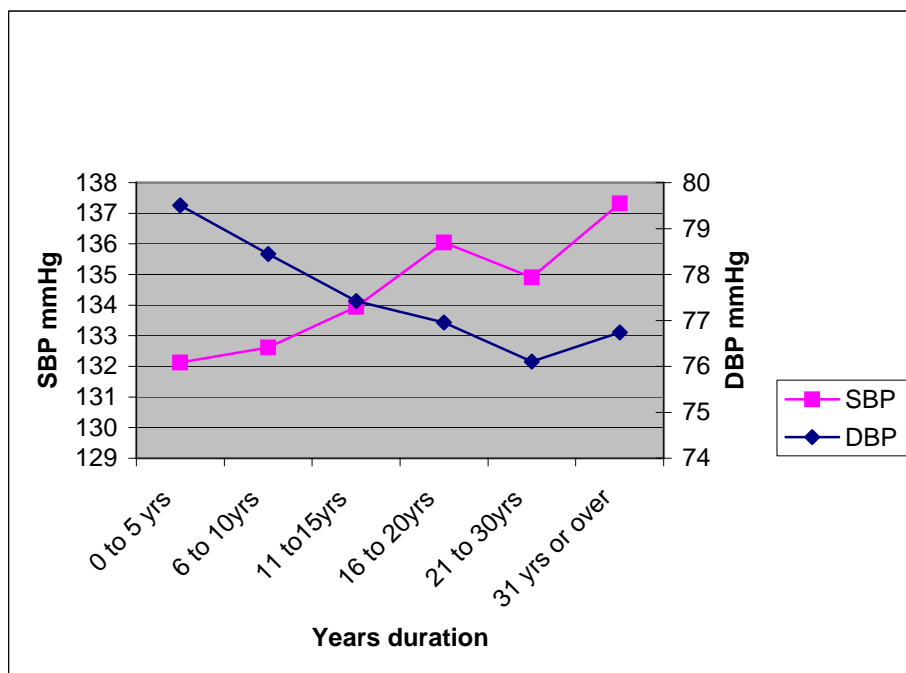


**Table 16: % of Patients with Type 2 Diabetes Meeting BP Targets**

|              | DBP<80 |      | SBP<130 |      |
|--------------|--------|------|---------|------|
|              | N      | %    | N       | %    |
| <b>1995</b>  | 86     | 67.2 | 35      | 27.1 |
| <b>1996</b>  | 155    | 69.2 | 64      | 28.6 |
| <b>1997</b>  | 227    | 73.2 | 89      | 28.6 |
| <b>1998</b>  | 321    | 75.9 | 110     | 25.9 |
| <b>1999</b>  | 381    | 62.0 | 138     | 25.7 |
| <b>2000</b>  | 434    | 81.0 | 196     | 32.0 |
| <b>2001</b>  | 667    | 74.9 | 298     | 33.4 |
| <b>2002</b>  | 773    | 77.9 | 298     | 35.8 |
| <b>2003</b>  | 761    | 80.4 | 324     | 34.2 |
| <b>2004</b>  | 753    | 81.6 | 356     | 38.5 |
| <b>Total</b> | 2080   |      | 1965    |      |

Figure 17 and Table 17 show Systolic BP increased with the duration of diabetes. This trend was not significant (P=0.07). The target of 130mmHg was not achieved in any of the various groupings for duration of diabetes. Diastolic BP reduced as duration of diabetes increased. This trend was significant when nil years was compared with 20 years duration of diabetes (P=0.01).

**Figure 17: Trend in Mean BP by Duration of Type 2 Diabetes**



**Table 17: Trend in Mean Blood Pressure by Duration of Type 2 Diabetes**

|                 | 0 to 5 yrs |      | 6 to 10yrs |      | 11 to 15yrs |      | 16 to 20yrs |      | 21 to 30yrs |      | 31 yrs or over |      |
|-----------------|------------|------|------------|------|-------------|------|-------------|------|-------------|------|----------------|------|
|                 | mmHg       | SD   | mmHg       | SD   | mmHg        | SD   | mmHg        | SD   | mmHg        | SD   | mmHg           | SD   |
| <b>Mean SBP</b> | 132        | 15.1 | 133        | 14.6 | 134         | 14.9 | 136         | 13.6 | 135         | 15.0 | 137            | 13.3 |
| <b>Mean DBP</b> | 80         | 8.7  | 78         | 8.2  | 77          | 8.2  | 77          | 7.8  | 76          | 8.1  | 77             | 8.0  |

### 5.5.4 Lipids

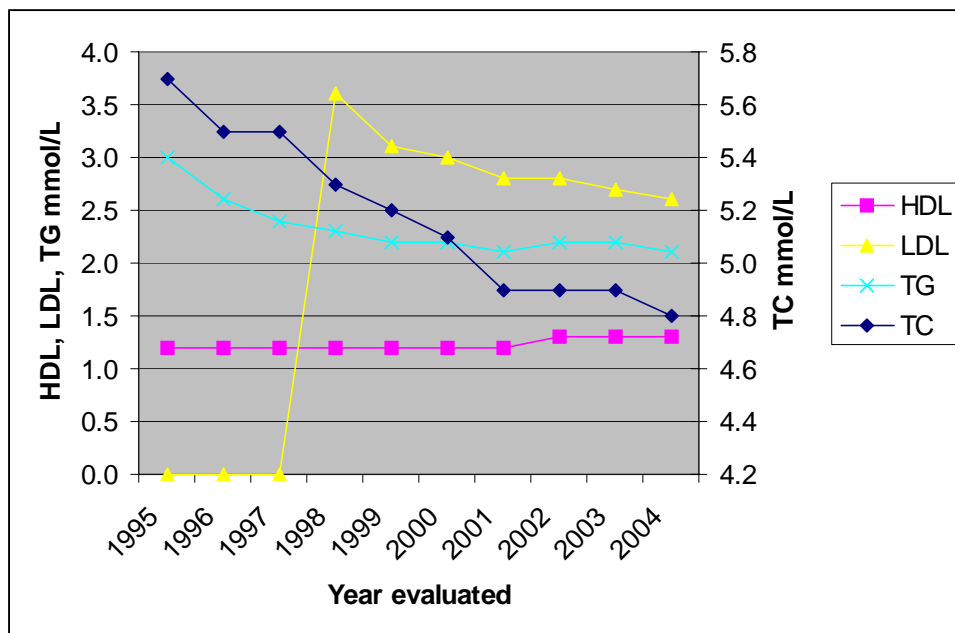
Figure 18 and Table 18 show that between 1995 and 2004, mean Total Cholesterol and mean Triglycerides reduced significantly (TC: P=0.00; TG: P=0.00). Mean Total Cholesterol dropped by 0.9mmol/L. The target of <4mmol/L was not achieved during any year throughout the study period. The mean Triglycerides reduced by 0.91 mmol/L. The target of <2.0mmol.L for mean Triglycerides was not achieved in any year.

Comparing 1995 to 2004, mean HDL increased slightly by 0.1mmol/L (P=0.147). The target of mean HDL>1 mmol/L was achieved in each year.

LDL records were not captured until 1999 so the results are only available for 1999 to 2004. However, from 1999 to 2004, there was a significant reduction in mean LDL from 3.14mmol/L to 2.63mmol/L (P=0.00). This was achieved even with a five-fold increase in the number of patients with LDL results over the six years. The target of <2.5mmol/L for mean LDL was not achieved in any of these years.

Comparing mean results for lipids in 2000 with 2004, significant trends were found for Total Cholesterol (P=0.000), HDL (P=0.000) and LDL (P=0.000) but not for Triglycerides (P=0.257). The Diabetes SIP was implemented in November 2001, during this time period.

**Figure 18: Trend in Mean Lipids Over 10 Years for Patients with Type 2\***



\* LDL results only shown from 1999 as records prior to this were not recorded

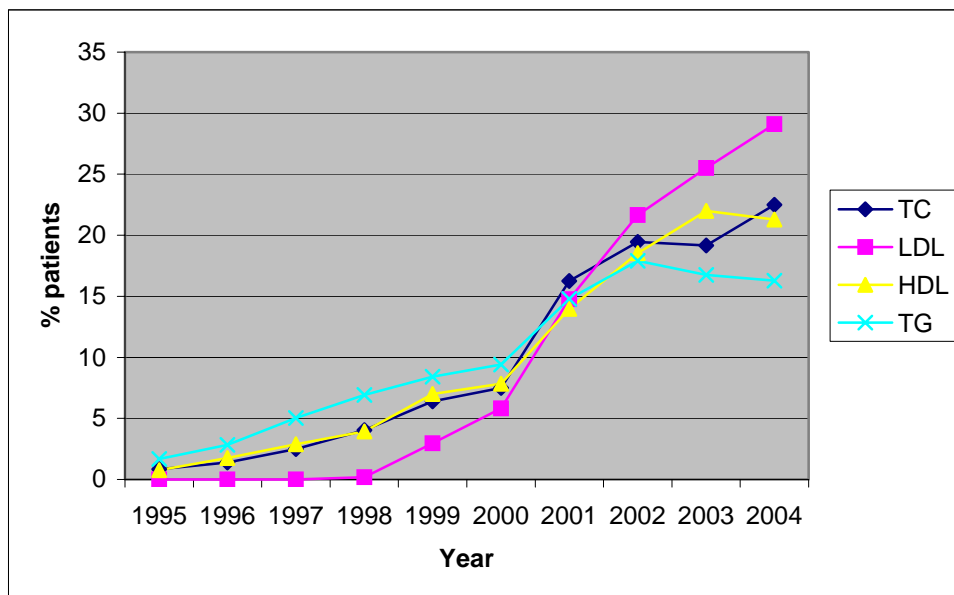
**Table 18: Trend in Mean Lipids Over 10 Years for Patients with Type 2**

| Year Eval | TC  |      |     | HDL* |      |     | LDL |      |     | TG  |      |     |
|-----------|-----|------|-----|------|------|-----|-----|------|-----|-----|------|-----|
|           | N   | Mean | SD  | N    | Mean | SD  | N   | Mean | SD  | N   | Mean | SD  |
| 1995      | 117 | 5.7  | 1.2 | 32   | 1.2  | 0.3 | 0   | .    | .   | 115 | 3.0  | 3.0 |
| 1996      | 189 | 5.5  | 1.1 | 72   | 1.2  | 0.3 | 0   | .    | .   | 173 | 2.6  | 3.0 |
| 1997      | 287 | 5.5  | 1.2 | 122  | 1.2  | 0.5 | 0   | .    | .   | 278 | 2.4  | 1.7 |
| 1998      | 367 | 5.3  | 1.1 | 176  | 1.2  | 0.6 | 10  | 3.6  | 1.2 | 363 | 2.3  | 1.7 |
| 1999      | 455 | 5.2  | 1.0 | 273  | 1.2  | 0.4 | 117 | 3.1  | 1.0 | 449 | 2.2  | 1.3 |
| 2000      | 510 | 5.1  | 1.1 | 329  | 1.2  | 0.4 | 207 | 3.0  | 1.0 | 491 | 2.2  | 1.3 |
| 2001      | 786 | 4.9  | 1.0 | 570  | 1.2  | 0.3 | 441 | 2.8  | 0.9 | 764 | 2.1  | 1.3 |
| 2002      | 884 | 4.9  | 1.1 | 640  | 1.3  | 0.4 | 568 | 2.8  | 0.9 | 876 | 2.2  | 1.9 |
| 2003      | 874 | 4.9  | 1.1 | 711  | 1.3  | 0.4 | 642 | 2.7  | 0.9 | 867 | 2.2  | 1.5 |
| 2004      | 837 | 4.8  | 1.0 | 724  | 1.3  | 0.4 | 682 | 2.6  | 1.0 | 828 | 2.1  | 1.2 |

\*Target achieved each year

Figure 19 and Table 19 show that the proportion of patients meeting lipid targets each year was low. There was an increase in the proportion of patients meeting lipid targets after 2000 when the Diabetes SIP was introduced and continuing through to the end of 2004.

**Figure 19: % Patients Meeting Lipid Targets Each Year**

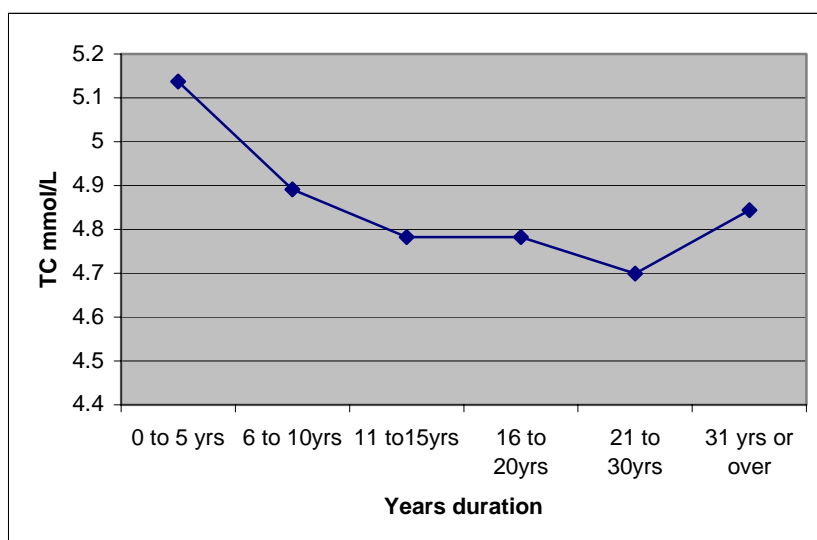


**Table 19: Percentage of Type 2 Patients Meeting Lipid Targets Each Year**

|              | TC  |        | LDL  |        | HDL  |        | TG   |        |
|--------------|-----|--------|------|--------|------|--------|------|--------|
|              | N   | %      | N    | %      | N    | %      | N    | %      |
| <b>1995</b>  | 6   | 0.83   | 0    | 0      | 19   | 0.77   | 48   | 1.68   |
| <b>1996</b>  | 10  | 1.39   | 0    | 0      | 43   | 1.75   | 81   | 2.83   |
| <b>1997</b>  | 18  | 2.50   | 0    | 0      | 71   | 2.89   | 144  | 5.03   |
| <b>1998</b>  | 29  | 4.03   | 2    | 0.18   | 97   | 3.94   | 198  | 6.92   |
| <b>1999</b>  | 46  | 6.39   | 33   | 2.95   | 172  | 6.99   | 241  | 8.42   |
| <b>2000</b>  | 54  | 7.50   | 65   | 5.82   | 193  | 7.85   | 269  | 9.40   |
| <b>2001</b>  | 117 | 16.25  | 165  | 14.77  | 344  | 13.98  | 423  | 14.79  |
| <b>2002</b>  | 140 | 19.44  | 242  | 21.67  | 456  | 18.54  | 512  | 17.90  |
| <b>2003</b>  | 138 | 19.17  | 285  | 25.51  | 541  | 21.99  | 479  | 16.74  |
| <b>2004</b>  | 162 | 22.50  | 325  | 29.10  | 524  | 21.30  | 466  | 16.29  |
| <b>Total</b> | 720 | 100.00 | 1117 | 100.00 | 2460 | 100.00 | 2861 | 100.00 |

Figure 20 and Table 20 show that total cholesterol reduced as duration of diabetes increased. This trend was not significant (P=0.310).

**Figure 20: Trend in Total Cholesterol by Duration of Diabetes**



**Table 20: Trend in Mean Total Cholesterol by Duration of Diabetes**

|           | Duration of diabetes |            |             |             |             |                |
|-----------|----------------------|------------|-------------|-------------|-------------|----------------|
|           | 0 to 5 yrs           | 6 to 10yrs | 11 to 15yrs | 16 to 20yrs | 21 to 30yrs | 31 yrs or over |
| TC mmol/L | 5.14                 | 4.89       | 4.78        | 4.78        | 4.70        | 4.84           |
| SD        | 1.10                 | 1.034      | 1.18        | 0.97        | 0.89        | 0.77           |
| No.       | 3291.00              | 1079.00    | 475.00      | 159.00      | 98.00       | 16.00          |

## **6 Limitations of study**

Data analysis and reporting of results have been limited by a number of variables outside the control of the researchers. These include changes in Diabetes management guidelines during the study period and the variability in the quantity and quality of the data contained in the Divisions register.

### **Guideline changes**

Guideline targets changed and became stricter over time. The guideline targets produced in 2004 were used in the analysis. This may lead to an underestimation of the proportion of patients meeting the health outcome target.

### **Data quality**

In some fields there are many missing/invalid /unknown values in the extracted records (eg: risk factors - smoking, alcohol and physical activity; complications; treatment other than diabetes management). In some cases there was too little data to analyse, and these have been excluded in this study. In other cases, high levels of missing /invalid/unknown values may lead to an underestimation of the actual values.

### **Study design**

Our study is a repeated cross sectional study rather than a cohort study. Our data is extracted from one Division over time. In each year, some new patients joined the program while at the same time some registered patients dropped out because they moved outside the Division or died. Therefore, analysis of a cohort of patients from this data will be needed to investigate the cause of changes in quality of care and health outcomes.

## 7 Conclusions

Key conclusions are:

- Trends show variable changes in Quality of Care possibly affected by dilutional effects and practitioner recording practices.
- In 2000 to 2004, during the time the Diabetes SIP incentive and the new care planning items were introduced, there were significant improvements in mean HbA1c, Total Cholesterol, HDL and LDL in those who had a measurement recorded. This is regardless of the increase in the number of patients evaluated.
- There were improvements in Diastolic BP, Total Cholesterol and HbA1c as duration of diabetes increased despite evidence that increases in duration and age are associated with worsening physiological measures of control.
- More intensive management is needed for HbA1c, Total Cholesterol, LDL, and particularly BMI (mean was above 30kg/m<sup>2</sup> for all years) as the means were above the recommended targets for every year. Continued effort needs to also be placed on improving Systolic Blood Pressure as the target was only achieved in 2004.
- Analysis of a cohort of patients from this data will be needed to investigate the cause of changes in quality of care and health outcomes.

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