

Diabetes in CMDHB and northern region: Estimation using routinely collected data

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Key points

- The aim of this report was to provide a timely estimate of the prevalence of diabetes in the populations of CMDHB and the northern region. This enables better understanding of the diabetes epidemic in CMDHB and the northern region more generally, and informs decisions around future diabetes service provision.
- Retrospective, cross-sectional analyses used data from three different routinely collected administrative data sources to evaluate the magnitude of diabetes in CMDHB and three other district health boards (DHB's) in the northern region and to examine patterns of pharmaceutical, laboratory test and medical/surgical inpatient service utilisation
- Almost 27,000 people in CMDHB were identified as diabetes cases in 2006-2007, out of a reconstructed population of around 427,000 people for CMDHB. Within the entire northern region (made up of CMDHB, Northland DHB, Auckland DHB and Waitemata DHB), 78,000 diabetes cases were identified in a reconstructed population of almost 1.4 million people
- The age- and sex-standardised prevalence of diabetes in CMDHB was 7.1% in 2006-2007, compared with an age- and sex-standardised prevalence of 5.2% in the remaining three northern DHB's. The difference of 1.9% was statistically significant. Age- and sex-standardised prevalence estimates were similar using both the reconstructed population and census 2006 population estimates as denominators
- Consistent with other studies demonstrating inequity in the distribution of diabetes by ethnicity in New Zealand, the prevalence of diabetes was highest in Maaori and Pacific CMDHB residents. Pacific women had the highest prevalence of diabetes of any group in CMDHB, with an age-standardised prevalence of 15.0%. Women of Other ethnicity had the lowest prevalence of any group, with an age-standardised prevalence of 4.0%
- Of the 27,000 diabetes cases in CMDHB, 83% had at least two HbA1c monitoring tests in 2006-2007 (52% had four or more), 92% had at least one lipid monitoring test (and 81% had two or more), while 78% had claims for at least one urinary microalbumin test in the two-year period
- Sixty-one percent of diabetes cases had regular subsidy claims in CMDHB for drugs that affect the renin-angiotensin system in 2006-2007, 64% had regular claims for lipid modifying agents, 18% had regular claims for insulin and 56% had regular claims for the drug metformin
- 11,800 medical/surgical hospital discharges in 2007 had principal or secondary diagnosis codes for diabetes and this constituted 17% of discharges in CMDHB. Average length of stay for discharges with diabetes diagnosis codes was about 50% longer than those without diabetes codes. The hospital discharge rate for diabetes cases was 2.5 times that of the total reconstructed CMDHB population

Table of contents

KEY POINTS	III
TABLE OF CONTENTS	IV
LIST OF TABLES.....	V
LIST OF FIGURES.....	VI
LIST OF ABBREVIATIONS.....	VII
INTRODUCTION	1
<i>Aims and objectives.....</i>	<i>1</i>
<i>Rationale for study.....</i>	<i>1</i>
<i>The reconstructed population</i>	<i>2</i>
<i>Comments on ethnicity and deprivation.....</i>	<i>2</i>
<i>Note on diabetes categorisation.....</i>	<i>3</i>
METHODS.....	4
DATA.....	4
PRIVACY	4
GENERALISABILITY OF ESTIMATES IN CMDHB.....	5
DECISION RULES	6
STATISTICAL ANALYSES	7
RESULTS.....	8
PREVALENCE	8
<i>Crude prevalence estimates</i>	<i>8</i>
<i>Standardised prevalence estimates</i>	<i>9</i>
SOCIAL AND DEMOGRAPHIC CHARACTERISTICS.....	11
<i>Age distribution.....</i>	<i>11</i>
<i>Sex.....</i>	<i>12</i>
<i>Distribution of ethnicity</i>	<i>13</i>
<i>Deprivation</i>	<i>14</i>
LABORATORY UTILISATION	15
<i>Electrolytes, glucose and creatinine</i>	<i>15</i>
<i>Glycosylated haemoglobin (HbA1c).....</i>	<i>16</i>
<i>Lipid studies.....</i>	<i>19</i>
<i>Microalbumin.....</i>	<i>20</i>
<i>Cost</i>	<i>21</i>
PHARMACEUTICAL UTILISATION.....	22
<i>Diabetes medications</i>	<i>23</i>
<i>Blood pressure-lowering agents</i>	<i>26</i>
<i>Lipid modifying agents.....</i>	<i>28</i>
<i>Other medications.....</i>	<i>30</i>
<i>Cost</i>	<i>30</i>
<i>Adherence</i>	<i>31</i>
HOSPITAL SERVICE UTILISATION	32
<i>Hospital admissions</i>	<i>33</i>
<i>Procedures.....</i>	<i>34</i>
<i>Ischaemic heart disease</i>	<i>35</i>
<i>Cerebrovascular disease (stroke)</i>	<i>35</i>
DIABETES IN PREGNANCY	36
DISCUSSION.....	38
<i>Monitoring and medication for diabetes in CMDHB.....</i>	<i>39</i>
<i>Comparison with Known Diabetes.....</i>	<i>40</i>
<i>Cost of diabetes care.....</i>	<i>41</i>

<i>Strengths and weaknesses</i>	42
<i>Recommendations for further analysis</i>	44
REFERENCES	45

List of tables

TABLE 1 AGE IN YEARS, SEX AND ETHNICITY OF DIABETES CASES IDENTIFIED WITHIN THE RECONSTRUCTED CMDHB POPULATION FOR 2006-2007	8
TABLE 2: CRUDE PREVALENCE OF DIABETES IN RECONSTRUCTED NORTHERN DHB POPULATIONS IN 2006-2007	9
TABLE 3: CRUDE PREVALENCE OF DIABETES IN NORTHERN DHB POPULATIONS USING IDENTIFIED DIABETES CASES AND AVERAGED CENSUS DENOMINATOR OF 2006-2007 CALENDAR YEARS	9
TABLE 4: PREVALENCE OF DIABETES IN CMDHB RECONSTRUCTED 2006-2007 POPULATION, STRATIFIED BY AGE (IN YEARS), SEX AND ETHNICITY	10
TABLE 5: AGE- AND SEX-STANDARDISED PREVALENCE OF DIABETES IN FOUR DHB'S OF NORTHERN REGION, USING 2006-2007 RECONSTRUCTED POPULATION DENOMINATOR.....	10
TABLE 6: AGE- AND SEX-STANDARDISED PREVALENCE OF DIABETES IN FOUR DHB'S OF NORTHERN REGION, USING CENSUS 2006 ESTIMATE DENOMINATOR	11
TABLE 7: AGE-STANDARDISED PREVALENCE OF DIABETES IN CMDHB BY ETHNICITY AND SEX, 2006-2007	11
TABLE 8: PROPORTION OF DIABETES CASES IN CMDHB RECONSTRUCTED POPULATION IN 2006-2007 WHO HAD CLAIMS FOR AT LEAST EITHER ONE OR TWO FASTING LIPID TESTS.....	19
TABLE 9: CLAIMS FOR COMMUNITY LABORATORY TESTING BY DHB, PER PERSON FOR DIABETES CASES AND THOSE WITHOUT DIABETES, BY DHB IN 2007 (EXCL. GST)	22
TABLE 10: SPECIFIC THERAPEUTIC GROUP CATEGORIES AND CHEMICAL NAMES OF MEDICATIONS FOR WHICH ANALYSIS OF PHARMACEUTICAL UTILISATION WAS UNDERTAKEN	23
TABLE 11: PROPORTION OF DIABETES CASES IN CMDHB AND THREE OTHER DHB'S IN NORTHERN REGION WITH 2+ SULFONYLUREA CLAIMS IN TWO YEARS	26
TABLE 12: PROPORTION OF DIABETES CASES IN CMDHB AND THREE OTHER DHB'S IN NORTHERN REGION WITH CLAIMS FOR BLOOD PRESSURE-LOWERING MEDICATION	28
TABLE 13: PROPORTION OF DIABETES CASES IN CMDHB AND NORTHERN REGION WITH TWO OR MORE CLAIMS FOR LIPID MODIFYING AGENTS IN 2006-2007	28
TABLE 14: UNADJUSTED COST OF COMMUNITY PHARMACEUTICAL SUBSIDY CLAIMS BY DHB, PER PERSON, FOR RECONSTRUCTED DHB POPULATIONS AND DIABETES CASES WITHIN THOSE POPULATIONS IN 2007 (EXCL. GST).....	30
TABLE 15: NUMBER OF DIABETES CASES IN NORTHERN REGION WITH DATA ON 'TOTAL DAYS SUPPLY' AND REGULAR CLAIMS FOR DIABETES (AND RELATED) MEDICATIONS IN 2007, TOGETHER WITH MEAN DAYS SUPPLIED PER MEDICATION AND PROPORTION WITH >80% MEDICATION ADHERENCE	32
TABLE 16: CRUDE AND AGE- AND SEX-STANDARDISED HOSPITAL DISCHARGE RATES FOR CMDHB AND NORTHERN REGION (EX. CMDHB) FOR 2007.....	33
TABLE 17: CRUDE AND AGE-STANDARDISED HOSPITAL DISCHARGE RATES BY ETHNICITY FOR DIABETES CASES IN CMDHB, 2007	33
TABLE 18: PROPORTION OF DIABETES CASES IN CMDHB WHO HAD MEDICAL/SURGICAL HOSPITAL ADMISSIONS IN 2007, BY ETHNICITY	34
TABLE 19: CRUDE AND AGE- AND SEX-STANDARDISED MAJOR SURGICAL PROCEDURE RATES FOR CMDHB AND NORTHERN REGION (EX. CMDHB) FOR 2007.....	34
TABLE 20: CRUDE AND AGE-STANDARDISED MAJOR SURGICAL PROCEDURE RATES BY ETHNICITY FOR DIABETES CASES IN CMDHB, 2007	35
TABLE 21: CRUDE HOSPITAL DISCHARGE RATES FOR ISCHAEMIC HEART DISEASE IN CMDHB IN 2007, BY ETHNICITY	35
TABLE 22: CRUDE HOSPITAL DISCHARGE RATES FOR CEREBROVASCULAR DISEASE IN CMDHB IN 2007, BY ETHNICITY	36
TABLE 23: ABSOLUTE NUMBERS OF WOMEN WITH DIAGNOSIS CODES FOR PRE-EXISTING DIABETES IN PREGNANCY IN NORTHERN REGION, BY ETHNICITY IN 2006-2007 RECONSTRUCTED GROUP	37
TABLE 24: ABSOLUTE NUMBERS OF WOMEN WITH DIAGNOSIS CODES FOR NEW DIABETES IN PREGNANCY IN NORTHERN REGION, BY ETHNICITY IN 2006-2007 RECONSTRUCTED GROUP.....	37
TABLE 25: DIFFERENCE IN COST OF MEDICAL/SURGICAL HOSPITAL DISCHARGES, COMMUNITY LABORATORY AND PHARMACEUTICAL CLAIMS FOR THOSE WITH AND WITHOUT DIABETES IN CMDHB IN 2007	41

TABLE 26: AGE- AND SEX-STANDARDISED COST OF MEDICAL/SURGICAL DISCHARGES, COMMUNITY AND PHARMACEUTICAL CLAIMS FOR THOSE WITH AND WITHOUT DIABETES IN CMDHB IN 2007	41
TABLE 27: TABLE OF STUDY STRENGTHS AND WEAKNESSES	43

List of figures

FIGURE 1: AGE DISTRIBUTION OF 2006-2007 RECONSTRUCTED CMDHB POPULATION COMPARED WITH AGE DISTRIBUTION IN 2006 OFFICIAL CENSUS ESTIMATE	5
FIGURE 2: COMPARISON OF GENDER BETWEEN RECONSTRUCTED 2006-2007 CMDHB POPULATION AND OFFICIAL 2006 CENSUS ESTIMATE	6
FIGURE 3: DISTRIBUTION OF PRIORITISED ETHNICITY IN 2006-2007 CMDHB RECONSTRUCTED POPULATION COMPARED WITH 2006 OFFICIAL CENSUS POPULATION ESTIMATE	6
FIGURE 4: AGE DISTRIBUTIONS OF DIABETES CASES IN CMDHB AND OF THE ENTIRE RECONSTRUCTED CMDHB POPULATION FOR 2006-2007	12
FIGURE 5: AGE DISTRIBUTIONS OF DIABETES CASES IN THE NORTHERN REGION (EX. CMDHB) AND OF THE RECONSTRUCTED NORTHERN REGION (EX. CMDHB) POPULATION FOR 2006-2007	12
FIGURE 6: PROPORTION OF FEMALES IN DIABETES CASES IDENTIFIED WITHIN EACH DHB, COMPARED WITH PROPORTION OF FEMALES IN RECONSTRUCTED DHB POPULATIONS FOR 2006-2007	13
FIGURE 7: ETHNIC COMPOSITION OF THE DIABETES CASE GROUP AND RECONSTRUCTED 2006-2007 POPULATION WITHIN EACH OF THE FOUR NORTHERN DHB'S	14
FIGURE 8: MEAN NZDEP2006 DECILE OF CAU FOR CMDHB RESIDENTS IDENTIFIED AS DIABETES CASES COMPARED WITH CMDHB RESIDENTS IN 2006-2007 RECONSTRUCTED POPULATION	14
FIGURE 9: MEAN NZDEP2006 DECILE OF CAU FOR NORTHERN REGION (EX. CMDHB) RESIDENTS IDENTIFIED AS DIABETES CASES COMPARED WITH GENERAL NORTHERN REGIONAL RECONSTRUCTED POPULATION IN 2006-2007	15
FIGURE 10: FREQUENCY OF ELECTROLYTE TESTING AMONGST DIABETES CASES IN CMDHB RECONSTRUCTED POPULATION, 2006-2007	15
FIGURE 11: FREQUENCY OF SERUM CREATININE TESTING AMONGST DIABETES CASES IN CMDHB RECONSTRUCTED POPULATION, 2006-2007	16
FIGURE 12: CUMULATIVE FREQUENCY OF HbA1c TESTING OVER TWO-YEAR PERIOD IN DIABETES CASES IN FOUR NORTHERN DHB'S, 2006-2007	16
FIGURE 13: PROPORTION OF DIABETES CASES WITH TWO OR MORE HbA1c TESTS OVER TWO-YEAR PERIOD, 2006-2007, BY ETHNICITY AND DHB (NORTHERN REGION)	17
FIGURE 14: PROPORTION OF DIABETES CASES IN CMDHB THAT HAD ≥ 4 HbA1c TESTS IN TWO YEARS, BY ETHNICITY, 2006-2007	18
FIGURE 15: MEAN NZDEP2006 DEPRIVATION DECILE IN CAU BY FREQUENCY OF HbA1c TESTING IN CMDHB DIABETES CASES, 2006-2007	18
FIGURE 16: MEAN NZDEP2006 DEPRIVATION DECILE IN CAU BY FREQUENCY OF FASTING LIPID TESTING IN CMDHB DIABETES CASES, 2006-2007	19
FIGURE 17: PROPORTION OF DIABETES CASES IN CMDHB WITH EITHER 1+ OR 2+ URINARY MICROALBUMIN SCREENING TESTS IN TWO YEARS (2006-2007), BY ETHNICITY	20
FIGURE 18: MEAN NZDEP2006 DEPRIVATION DECILE IN CAU BY FREQUENCY OF URINARY MICROALBUMIN TESTING IN CMDHB DIABETES CASES, 2006-2007	21
FIGURE 19: DISTRIBUTION OF DOLLAR VALUE OF LABORATORY CLAIMS BY AGE GROUP FOR DIABETES CASES AND THOSE WITHOUT DIABETES IN RECONSTRUCTED CMDHB POPULATION, 2007	22
FIGURE 24: PROPORTION OF DIABETES CASES WITH TWO OR MORE CLAIMS FOR INSULIN IN TWO YEARS IN CMDHB AND NORTHERN REGION, BY ETHNICITY	24
FIGURE 25: ABSOLUTE NUMBERS OF DIABETES CASES WITH REGULAR INSULIN CLAIMS IN CMDHB AND NORTHERN REGION BY AGE GROUP	24
FIGURE 26: PROPORTION OF DIABETES CASES WITH TWO OR MORE CLAIMS FOR METFORMIN IN TWO YEARS IN CMDHB AND NORTHERN REGION, BY ETHNICITY	25
FIGURE 27: PROPORTION OF DIABETES CASES WITH TWO OR MORE CLAIMS FOR METFORMIN IN TWO YEARS BY MEAN NZDEP2006 DECILE FOR AREA OF RESIDENCE	25
FIGURE 20: PROPORTION OF DIABETES CASES WITH TWO OR MORE CLAIMS FOR AGENTS THAT AFFECT RENIN-ANGIOTENSIN SYSTEM IN TWO YEARS (2006-2007)	27
FIGURE 21: PERCENTAGE OF DIABETES CASES WITH TWO OR MORE CLAIMS FOR RENIN-ANGIOTENSIN AGENTS BY DEPRIVATION LEVEL FOR CMDHB AND THREE OTHER NORTHERN DHB'S	27
FIGURE 22: PROPORTION OF DIABETES CASES WITH TWO OR MORE CLAIMS FOR STATINS IN TWO YEARS (2006-2007) IN CMDHB AND NORTHERN REGION	29

FIGURE 23: PERCENTAGE OF DIABETES CASES WITH TWO OR MORE CLAIMS FOR LIPID MODIFYING AGENTS BY DEPRIVATION LEVEL FOR CMDHB AND THREE OTHER NORTHERN DHB'S	29
FIGURE 28: DISTRIBUTION OF DOLLAR VALUE OF PHARMACEUTICAL CLAIMS BY AGE GROUP FOR DIABETES CASES AND THOSE WITHOUT DIABETES IN THE RECONSTRUCTED CMDHB POPULATION, 2007	31
FIGURE 29: COMPARISON OF AGE STRUCTURE OF DIABETES CASES IN RECONSTRUCTED POPULATION WITH THAT OF CASES IDENTIFIED IN KNOWN DIABETES DATABASE.....	40
FIGURE 30: COMPARISON OF ETHNICITY OF DIABETES CASES IN RECONSTRUCTED POPULATION WITH THAT OF CASES IN KNOWN DIABETES GROUP FOR CMDHB	40

List of abbreviations

ACE	Angiotensin converting enzyme
ACR	Albumin-creatinine ratio
ADA	American Diabetes Association
ADHB	Auckland District Health Board
AR-DRG	Australian Refined Diagnosis Related Group
CAU	Census Area Unit
CI	Confidence interval
CCM	Chronic Care Management
CMDHB	Counties Manukau District Health Board
df	Degrees of freedom
DHB	District Health Board
GDM	Gestational diabetes mellitus
GIS	Geographic information system
GTPS	General Transaction Processing System
HbA1c	Glycosylated haemoglobin
ICD-10-AM	International Classification of Diseases, 10 th edition, Australian Modification
IHD	Ischaemic heart disease
LBD	Let's Beat Diabetes
LOS	Length of stay
NDHB	Northland District Health Board
NDSA	Northern DHB Support Agency
NHI	National Health Index
NIC	Net ingredient cost
NMDS	National Minimum Data Set
NZDep2006	New Zealand Index of Deprivation (2006)
NZGG	New Zealand Guidelines Group
NZHIS	New Zealand Health Information Service
NZHS	New Zealand Health Survey
TG	Therapeutic group
WDHB	Waitemata District Health Board

Introduction

Diabetes is a common metabolic disorder, characterised by hyperglycaemia¹. It is associated with a range of complications, including macrovascular disease (such as coronary heart disease, stroke and peripheral vascular disease) and microvascular disease (such as retinopathy [eye disease], kidney disease and peripheral vascular disease)². Diabetes is a leading cause of morbidity and mortality in New Zealand^{3,4}. In the New Zealand Health Strategy, diabetes is one of three disease priority areas and one of 13 population health objectives⁵.

Diabetes is common in the population served by Counties Manukau District Health Board (CMDHB) and it places particular health burden on Maaori and Pacific communities. The 2002/03 New Zealand Health Survey (NZHS) estimated the age-standardised prevalence of self-reported diabetes in those aged ≥ 15 years in CMDHB to be 5.0%, compared with a national self-reported prevalence of 4.1%⁶. The prevalence of diabetes was 9.5% in those of Maaori ethnicity and 7.2% in those of Pacific ethnicities surveyed in the NZHS. Initial results from the 2006/07 NZHS indicate that around 26,400 adults in CMDHB have diabetes (8.2% crude prevalence for adults aged ≥ 15 years)⁷. The Let's Beat Diabetes (LBD) 2006-2007 benchmark survey of 2,520 people in CMDHB found an age-standardised, self-reported diabetes prevalence of 7.0% in those aged ≥ 16 years⁸. In this LBD study, the age-standardised prevalence for Maaori was 6.2%, while for Pacific people it was 14.6%.

Aims and objectives

The aim of the analyses described in this report is to provide a timely estimate of the prevalence of diabetes in CMDHB and three other northern district health boards (DHB's) using routinely collected health care data. This will enable better understanding of the diabetes epidemic in CMDHB and the northern region more generally and inform decisions around future diabetes service provision.

The aim of this report is addressed through the following research objectives:

- Describe the prevalence of diabetes in CMDHB and northern region and describe the diabetes population according to socio-demographic variables such as age, sex, ethnicity and deprivation
- Explore and describe the laboratory monitoring of individuals identified as having diabetes (hereafter described as 'diabetes cases') and identify any inequities (by ethnicity and deprivation) that may exist in laboratory monitoring
- Examine and describe dispensing patterns amongst diabetes cases and identify any inequities in claims for subsidised medications, by ethnicity and deprivation
- Review hospital service utilisation amongst diabetes cases in the study period

Rationale for study

The Known Diabetes project undertaken in CMDHB towards the end of 2007 identified a 'super set' of CMDHB residents with diabetes who had accessed services such as hospital care, retinopathy screening and chronic care management (CCM)⁹. Around 23,000 people with diabetes had been identified within this database by May 2008¹⁰. While the Known Diabetes database has an important role in understanding health care utilisation within DHB services, it also has certain draw-backs. Cases in the Known Diabetes database are collected from patient data that is up to ten years

old, meaning that a proportion of individuals in the database may no longer reside within CMDHB ('residential churn'). Also, the Known Diabetes database gives only limited insight into care of diabetes in the community setting, outside the limits of formal DHB data collection.

The data used in the current report is recent (covering calendar years 2006 and 2007) and has a community focus, utilising subsidy claims for community laboratory testing and claims for retail pharmaceutical dispensing. This allows a timely, 'whole of community' perspective to analysis of diabetes in CMDHB and the northern region which is not available from other sources of routinely collected data.

The reconstructed population

The reconstructed population is discussed further in the Methods section. Records of subsidy claims for pharmaceuticals dispensed at community pharmacies were combined with records of claims for laboratory investigations and with data from hospital events in the National Minimum Data Set (NMDS) to create a 'reconstructed' set of data related to around 1,390,000 people in the four DHB's of the northern region – Northland DHB (NDHB), Waitemata DHB (WDHB), Auckland DHB (ADHB) and CMDHB. Individuals were included in the reconstructed population for analysis if they had a health event recorded in the two years from January 2006 to December 2007. Data was not available for those who did not have hospital events recorded in NMDS, or did not have claims made for subsidised pharmaceuticals or laboratory tests (with National Health Index [NHI] numbers documented) during the study period. The reconstructed study population formed the denominator for most of the analyses described in this report.

Comments on ethnicity and deprivation

A detailed summary of the requirements for collection, recording and output of ethnicity data by the health and disability sector is provided by the Ministry of Health document *Ethnicity Data Protocols for the Health and Disability Sector*¹¹. Each individual in the reconstructed population had up to three ethnicity codes recorded at Statistics New Zealand Level 2, consistent with recording requirements for the health and disability sector. In this report, ethnicity is grouped into four categories – Maaori, Pacific, Asian and Other – formerly Statistics New Zealand Level 0. Pacific ethnicity includes all of the Polynesian and Melanesian Pacific ethnicities (but Fijian Indians). South, East and Southeast Asian ethnicities are included in the Asian category. In keeping with New Zealand health data conventions, Arab (and other Middle Eastern) ethnicities, Afghani ethnicities and ethnicities of former Soviet Union countries are not included in the Asian category. The Other category is mainly made up of individuals of European ethnicities, although it does include all other ethnicities, for example African and South American ethnicities.

This report presents ethnicity data by prioritised ethnicity, whereby individuals are categorised into only one ethnic group, according to a prioritised schedule. The idea behind this system is that there are instances where individuals need to be allocated to only one ethnic group in analysis of socio-demographic data. Where this need exists it is important to identify groups of policy importance and ensure that groups of small size are not lost in amongst the dominant NZ European ethnic group. Consistent with the standard prioritisation protocol recommended by the Ministry of Health¹¹, ethnicity is prioritised in the following order: Maaori, Pacific, Asian, Other.

Domicile codes in the reconstructed population are linked to the Census Area Unit (CAU) associated with an individual case (rather than to the individual meshblock in which the case resides). Average NZDep2006 scores for the CAU in which the case resides are applied to each individual as a measure of deprivation. This is only a crude indicator of deprivation, as the score given to an individual is frequently the average for an area that may contain several thousand people (as opposed to meshblocks, which contain a median of 87 people). Such population-weighted scores will frequently disguise heterogeneity of deprivation within CAU's.

Note on diabetes categorisation

Within the available data (except for NMDS), it was not possible to categorise diabetes further into groups such as type I and type II diabetes (although it is recognised that this distinction is important at an individual level). For practical purposes therefore, all types of diabetes mellitus were aggregated together in the single category 'diabetes'.

In this report 'diabetes' refers to diabetes mellitus in all its acknowledged forms.

Methods

Data

The ‘reconstructed population’ referred to above, was composed of three primary sets of routinely collected data – pharmaceutical claims data, laboratory claims data and data from the National Minimum Data Set (NMDS). NMDS data extended back to 1990, while the pharmaceutical and laboratory claims data was collected over the 30 month period from July 2005 through to December 2007. A data collection for all four DHB’s in the northern region was created by selecting all individuals in the three sets of routinely collected data who had health care events recorded in the two-year period January 2006 to December 2007 (inclusive). In other words, individuals appeared in the final reconstructed data set if they:

- Were dispensed a pharmaceutical product on the New Zealand Pharmaceutical Schedule ^{12 13} for which a reimbursement claim was made (and an NHI number was recorded for the claim - around 94% of laboratory and pharmaceutical claims had NHI numbers recorded)
- Undertook a community laboratory investigation for which a reimbursement claim was made (and an NHI number was recorded), or
- Appeared in NMDS through experience of a hospital event during the two years.

Available mortality data was used to remove deceased people from the reconstructed population. Inclusion in the reconstructed population required documentation of an NHI number in claims records and residence within the geographic boundaries of the four northern DHB’s at the time of the most recent recorded health event.

Pharmaceutical reimbursement claims data was extracted from Pharmhouse, the national pharmaceutical subsidy data collection held by the New Zealand Health Information Service (HZHIS) and Pharmac. The Pharmhouse data warehouse contains claim and payment data from pharmacists for the dispensing of subsidised prescriptions that have been processed within the HealthPAC General Transaction Processing System (GTPS) ¹⁴. Pharmaceutical claims data for this analysis were obtained by the Regional Decision Support Team at NDSA (Northern DHB Support Agency) and passed on to CMDHB. Like the pharmaceutical claims data, laboratory claims data were also sourced from NZHIS, via NDSA. This data came from the Laboratory Claims Data Warehouse (Labs), rather than Pharmhouse. The purpose of the Labs database is to allow the Ministry of Health and DHB’s to monitor primary care test subsidies ¹⁵. Labs also contains information from claims and payments processed by the HealthPAC GTPS ¹⁵. NMDS is a national collection of discharge information from public and private hospitals ¹⁶. NZHIS has provided CMDHB with NMDS data for the northern region. Analysis of discharge data in this report generally refers to medical and surgical inpatient discharges, rather than from other services such as psychiatric services. Finally, the NZHIS Mortality Collection is a complete set of national data, in which the underlying cause of death for all deaths registered in New Zealand is classified according to ICD-10-AM criteria ¹⁷. This data was used to remove deceased individuals from the reconstructed populations.

Privacy

NHI key codes (also known as HCU codes) for all individuals in the reconstructed population were encrypted by the Analytical Services team at NZHIS. The encryption

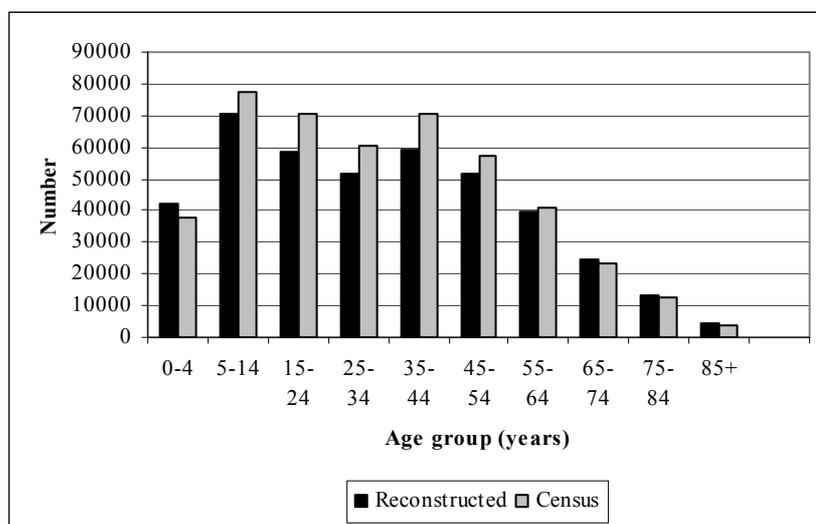
process is designed to maintain the anonymity of individuals within routinely collected data used for epidemiological analyses, by de-identifying unit record data¹⁸. Only aggregated results are reported in this document and no contact with individuals was undertaken. Ethical approval for this analysis was therefore not required.

Generalisability of estimates in CMDHB

The reconstructed CMDHB population contained 427,000 individuals, all of whom had some form of contact with the health care system recorded in one or more of the contributing data sets between January 2006 and December 2007. By way of comparison, the official Counties Manukau population estimate for the March 2006 national census was 455,000. The missing 28,000 people (6.2% of census population) probably consisted of individuals who either had no NHI numbers recorded in pharmaceutical or laboratory claims data or who had no encounter with the health system during the two years. The age, sex and ethnicity characteristics of the reconstructed CMDHB population differed somewhat from those found in 2006 national census estimates. However, there was sufficient similarity between the two populations for the analyses in this report to be generalised to the broader population.

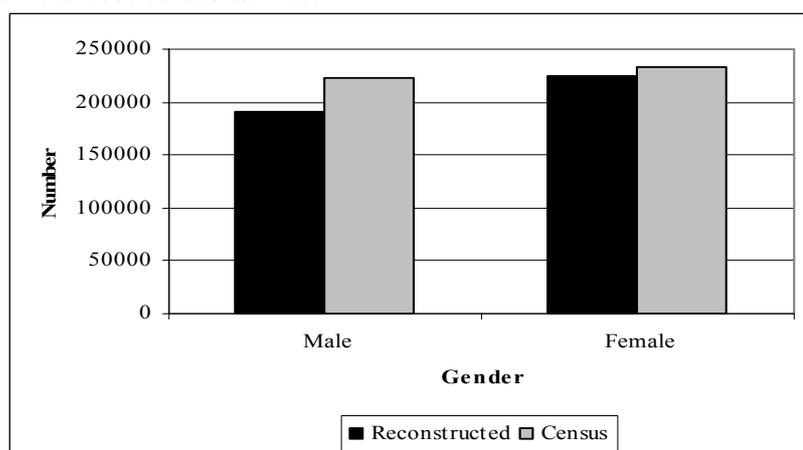
The age distribution of the reconstructed CMDHB population followed a generally similar trend to the census population, although notably fewer individuals in younger age groups were identified in the reconstructed population (Figure 1). In the older age groups (55 years or older), the two populations tracked reasonably closely together.

Figure 1: Age distribution of 2006-2007 reconstructed CMDHB population compared with age distribution in 2006 official census estimate



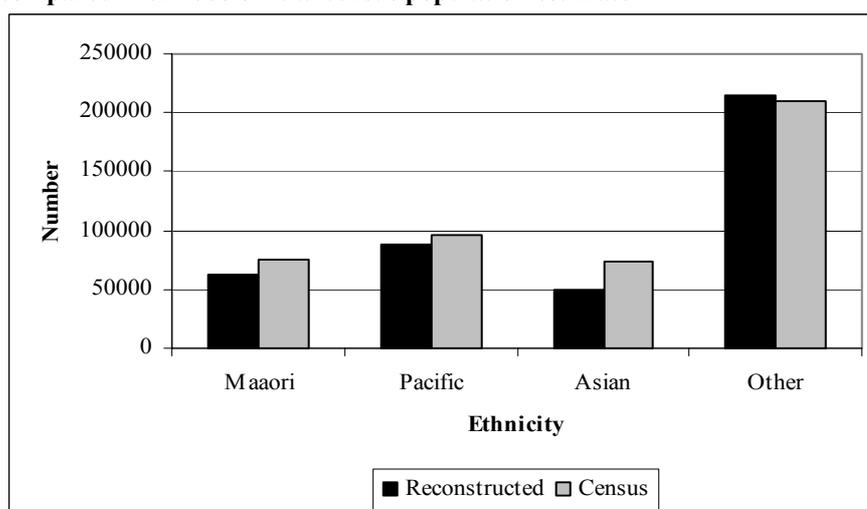
While the number of females in the reconstructed CMDHB population was similar to that found in official estimates from the 2006 census, there were fewer males identified in the reconstructed population (Figure 2).

Figure 2: Comparison of gender between reconstructed 2006-2007 CMDHB population and official 2006 census estimate



Maaori, Pacific and Asian ethnicities were all under-represented in the reconstructed CMDHB population, while those of Other ethnicity were slightly over-represented (Figure 3), possibly due to differences in how individuals approach health services compared with the census, or differences in how data is captured by the two systems.

Figure 3: Distribution of prioritised ethnicity in 2006-2007 CMDHB reconstructed population compared with 2006 official census population estimate



Decision rules

The following rules were used to identify individuals with diabetes in CMDHB and the northern region (very similar rules were originally developed by Mr Craig Wright, Senior Advisor (statistics and epidemiology), Public Health Intelligence, Ministry of Health):

- Three or more HbA1c (or fructosamine) test claims within the two-year consecutive period January 2006 – December 2007
- Two or more community pharmaceutical dispensing claims for therapeutic group (TG) level 2 categories ‘Diabetes’ and ‘Diabetes management’ between January 2006 and December 2007
 - For those aged < 25 years, only claims from category ‘Diabetes’ were used

- Principal or secondary diagnosis of ICD-10-AM E10-E14 ‘Impaired glucose regulation and diabetes mellitus’, or the codes O24.0 to O24.3 which cover pre-existing diabetes (type I, type II and unknown type) in pregnancy, from 1990 onwards (with health event of any kind identified in data in 2006-2007)
- Any individual with the following AR-DRGs: K60A & B (Diabetes with and w/o catastrophic or severe complications), and K01Z (Diabetic foot procedures) , from 1990 onwards (with health event of any kind identified by DHB of residence in data in 2006-2007)

Routinely collected administrative data sets have previously been used to understand quality of care at a population level¹⁹. However, no examples were found in the published literature of decision rules which related to the identification of individuals with diabetes in routinely collected administrative data. Three methods were therefore used to validate the decision rules:

- Literature review examining laboratory tests and diabetes products (in 2006 New Zealand Pharmaceutical Schedule) to establish the scope of use of identified tests and pharmaceuticals beyond their use in diabetes and the likely frequency of laboratory test monitoring in diabetes in the northern region
- Consultation took place with seven experts in the areas of diabetes/ endocrinology, epidemiology, primary care and clinical coding to gain different perspectives on the suitability of the decision rules
- Sensitivity analyses were undertaken to explore changes in rates of detection of diabetes cases with different laboratory testing frequencies and different frequency thresholds for pharmaceutical dispensing

Detail on each of these three validation processes is available in the technical companion document that accompanies this report.

Statistical analyses

Analyses presented in this report were undertaken using Microsoft Excel™, SPSS® (version 13.0) and SAS®.

Unless otherwise stated, reconstructed populations for CMDHB and the northern region constituted the denominators for the analyses in this report. Point estimates are reported for descriptive statistics and 95% confidence intervals are included where appropriate. In the case of calculating 95% confidence limits for proportions, an assumption was made that the Normal approximation to the binomial distribution applied in this data collection, as the number of cases in calculations was generally large.

Standardisation for age and sex used Statistics New Zealand national population estimates for 2006 and 2007. Estimates for these years by age and sex were averaged to give the reference population for standardisation.

Results

In total, 26,961 diabetes cases were identified using the decision rules within the reconstructed CMDHB population of 427, 404 people. Absolute numbers for identified diabetes cases are presented in terms of age, sex and prioritised ethnicity in Table 1.

Table 1 Age in years, sex and ethnicity of diabetes cases identified within the reconstructed CMDHB population for 2006-2007

	00-04	05-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84	85+	Total
Female											
Maaori	1	10	40	142	336	509	547	337	77	6	2005
Pacific	0	14	57	258	713	1060	1241	827	286	44	4500
Asian	0	6	16	130	259	435	550	432	157	28	2013
Other	2	26	75	176	456	717	1111	1229	1011	363	5166
Total	3	56	188	706	1764	2721	3449	2825	1531	441	13684
Male											
Maaori	0	8	28	88	271	421	477	258	62	3	1616
Pacific	1	10	31	128	442	914	1033	651	230	11	3451
Asian	0	3	13	52	293	569	543	409	111	15	2008
Other	2	39	64	149	470	1088	1712	1546	944	187	6201
Total	3	60	136	417	1476	2992	3765	2864	1347	216	13276
Total											
Maaori	1	18	68	230	607	930	1024	595	139	9	3621
Pacific	1	24	88	386	1155	1974	2275	1478	516	55	7952
Asian	0	9	29	182	552	1004	1093	841	268	43	4021
Other	4	65	139	325	926	1805	2823	2775	1955	550	11367
Total	6	116	324	1123	3240	5713	7215	5689	2878	657	26961

By way of comparison, 8,448 diabetes cases were identified within the reconstructed Northland DHB population of 145,250 people, 21,056 diabetes cases were identified in the reconstructed Waitemata DHB population of 439,628 people and 21,679 diabetes cases were found in the 381,458 individuals who made up the Auckland DHB reconstructed population.

Results of analyses of identified diabetes cases in CMDHB and the northern region are presented in this section. Initially, crude prevalence and age- and sex-standardised prevalence of diabetes in CMDHB and in each of the other three DHB's in the northern region are described. Age, sex, ethnicity and deprivation distributions are explored and compared. Utilisation of laboratory tests and pharmaceuticals is then described. Finally, a review of hospital service utilisation by diabetes cases in NMDS is undertaken.

Prevalence

Crude prevalence estimates

The crude prevalence of diabetes cases (i.e. people identified within the reconstructed population using the decision rules) for all of CMDHB was 6.3% (95% CI 6.2% to 6.4%), as seen in Table 2. This was the highest crude prevalence of any of the four DHB's in the northern region.

Table 2: Crude prevalence of diabetes in reconstructed northern DHB populations in 2006-2007

	Diabetes cases	Reconstructed population	Crude prevalence (%)	95% CI for prevalence (%)	Crude adult (15+ years) prevalence (%)	95% CI for adult (15+ years) prevalence (%)
CMDHB	26961	427400	6.3	6.2 - 6.4	8.6	8.5 - 8.7
NDHB	8448	145300	5.8	5.7 - 5.9	7.4	7.2 - 7.5
ADHB	21679	381500	5.7	5.6 - 5.8	7.1	7.0 - 7.2
WDHB	21056	439600	4.8	4.7 - 4.9	6.1	6.0 - 6.1

In comparison, average estimated DHB population numbers for the calendar years 2006-2007 (based on the March 2006 national census estimate for each DHB) were used as a denominator for further calculation of crude prevalence (Table 3). The prevalence estimates were similar to those calculated using the reconstructed populations, although in all cases were lower due to the larger DHB populations found in census estimates.

Table 3: Crude prevalence of diabetes in northern DHB populations using identified diabetes cases and averaged census denominator of 2006-2007 calendar years

	Diabetes cases	Census 2006 population	Crude prevalence (%)	95% CI for prevalence (%)	Crude adult (15+ years) prevalence (%)	95% CI for adult (15+ years) prevalence (%)
CMDHB	26961	459200	5.9	5.8 - 5.9	8.3	8.2 - 8.4
NDHB	8448	153100	5.5	5.4 - 5.6	7.2	7.0 - 7.3
ADHB	21679	432100	5.0	5.0 - 5.1	6.2	6.1 - 6.3
WDHB	21056	509200	4.1	4.1 - 4.2	5.3	5.2 - 5.3

Across the three other northern DHB's (using the reconstructed denominator) the crude prevalence of diabetes was 5.3%, a statistically significant 1.1% lower than the estimate found in CMDHB for 2006-2007 ($\chi^2 = 572.9$, 1 df, $P < 0.001$) in this crude analysis.

Standardised prevalence estimates

Table 4 describes the prevalence of diabetes within the reconstructed CMDHB population for 2006 and 2007, with results stratified by age (in years), sex and prioritised ethnicity. A high prevalence of diabetes is noted in those of Maori, Pacific and Asian ethnicities, especially in those aged 45 years or more.

Table 4: Prevalence of diabetes in CMDHB reconstructed 2006-2007 population, stratified by age (in years), sex and ethnicity

	00-04	05-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84	85+	Total
Female											
Maaori	0.0%	0.1%	0.6%	2.5%	6.9%	14.5%	27.5%	36.9%	31.4%	17.1%	5.5%
Pacific	0.0%	0.1%	0.7%	3.3%	10.2%	22.6%	40.5%	48.1%	38.8%	29.5%	9.0%
Asian	0.0%	0.1%	0.5%	2.6%	4.8%	10.6%	22.3%	31.2%	31.7%	29.2%	6.8%
Other	0.0%	0.2%	0.5%	1.3%	2.6%	4.4%	8.0%	13.6%	16.5%	13.7%	4.5%
Total	0.0%	0.2%	0.6%	2.2%	5.0%	9.5%	16.2%	21.6%	20.1%	15.0%	5.9%
Male											
Maaori	0.0%	0.1%	0.6%	2.9%	8.7%	18.4%	32.9%	40.2%	41.6%	23.1%	5.7%
Pacific	0.0%	0.1%	0.5%	2.6%	8.7%	23.7%	40.3%	45.6%	41.1%	20.4%	8.1%
Asian	0.0%	0.1%	0.4%	2.0%	9.4%	20.3%	30.6%	35.7%	27.9%	24.2%	8.9%
Other	0.0%	0.3%	0.5%	1.5%	3.2%	6.9%	12.3%	17.4%	19.2%	15.7%	6.0%
Total	0.0%	0.2%	0.5%	2.0%	5.7%	12.1%	19.1%	23.7%	22.4%	16.4%	6.7%

By the age of 55 years, 40% of all Pacific people in CMDHB have diabetes, by age 65 years nearly half of all Pacific people have diabetes. Note also that the category ‘Asian’ contains much heterogeneity. For example, diabetes prevalence in individuals of Indian ethnicity has been noted at more than three times that of Chinese people in CMDHB and both of these ethnic groups contribute to the overall ‘Asian’ category²⁰.

An average New Zealand population for the years 2006 and 2007 (using estimates developed from the March 2006 national census) was used to standardise the prevalence of diabetes in the four northern DHB’s by age and sex, where the reconstructed population was used as denominator. The age- and sex-standardised prevalence of diabetes in CMDHB was found to be 7.1% (95% CI 7.0% to 7.2%), the highest of any of the four DHB’s in the northern region (Table 5).

Table 5: Age- and sex-standardised prevalence of diabetes in four DHB’s of northern region, using 2006-2007 reconstructed population denominator

	Standardised prevalence (%)	95% CI for prevalence (%)	Adult (15+ years) prevalence (%)	95% CI for adult prevalence (%)
CMDHB	7.1	7.0 - 7.2	9.0	8.9 - 9.1
NDHB	5.1	4.9 - 5.2	6.4	6.2 - 6.5
ADHB	5.9	5.8 - 5.9	7.4	7.3 - 7.5
WDHB	4.6	4.6 - 4.7	5.8	5.7 - 5.9

The age- and sex-standardised prevalence for the three other northern DHB’s was 5.2% (95% CI 5.1% to 5.2%). The difference in prevalence of 1.9% between CMDHB and the other three northern DHB’s was statistically significant ($\chi^2 = 2086.3$, 1 df, $P < 0.001$).

By way of comparison, population estimates from the 2006 national census for CMDHB and the other three northern DHB’s were used as denominators in the standardisation process, replacing the reconstructed population denominators. An age- and sex-standardised prevalence of 7.0 (95% CI 7.0 to 7.1) was found in CMDHB when census 2006 CMDHB population estimates were used for the denominator groups in direct standardisation (Table 6). This was very close to the estimated prevalence of 7.1% found using the reconstructed denominator. This

similarity appears to be due to the better coverage of reconstructed population estimates in age groups that have the greatest numbers of diabetes cases.

Table 6: Age- and sex-standardised prevalence of diabetes in four DHB's of northern region, using census 2006 estimate denominator

	Standardised prevalence (%)	95% CI for prevalence (%)	Adult (15+ years) prevalence (%)	95% CI for adult prevalence (%)
CMDHB	7.0	7.0 - 7.1	8.9	8.8 - 9.0
NDHB	5.0	4.9 - 5.1	6.3	6.1 - 6.4
ADHB	5.9	5.9 - 6.0	7.5	7.4 - 7.5
WDHB	4.4	4.4 - 4.5	5.5	5.5 - 5.6

Age-standardised prevalence estimates for each ethnicity within CMDHB are found in Table 7. A marked disparity is noted between the prevalence estimates for Maaori, Pacific and Asian, and the estimates for those of Other ethnicity.

Table 7: Age-standardised prevalence of diabetes in CMDHB by ethnicity and sex, 2006-2007

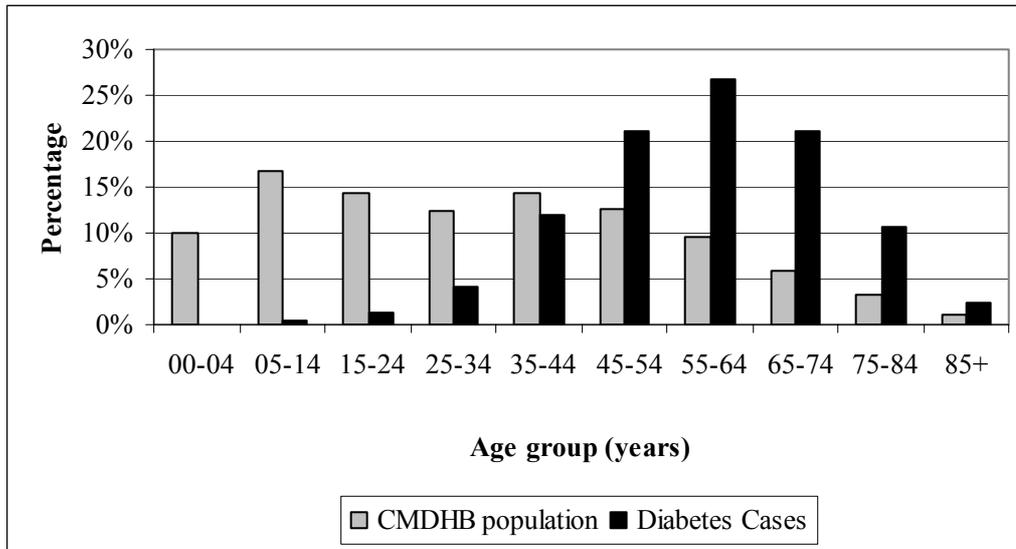
	Female		Male	
	Standardised prevalence (%)	95% CI for prevalence (%)	Standardised prevalence (%)	95% CI for prevalence (%)
Maaori	10.6	10.1 - 11.1	12.2	11.6 - 12.7
Pacific	15.0	14.6 - 15.4	13.9	13.5 - 14.3
Asian	9.1	8.7 - 9.4	11.3	10.9 - 11.8
Other	4.0	3.9 - 4.1	5.0	4.9 - 5.2
Total	6.8	6.7 - 6.9	7.4	7.3 - 7.5

Social and demographic characteristics

Age distribution

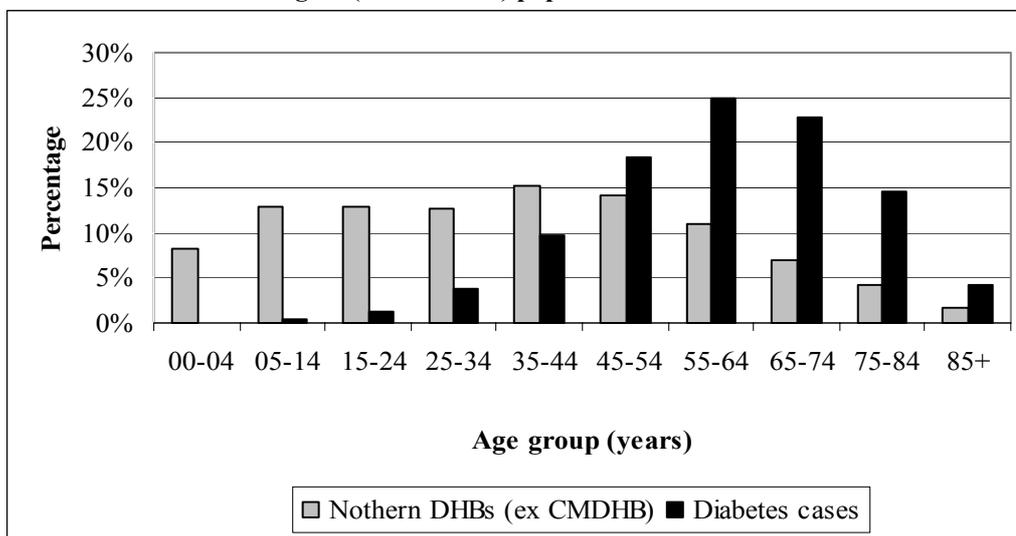
The age distribution for those in the CMDHB population identified as diabetes cases is compared against that for the whole reconstructed CMDHB population in Figure 4. Diabetes cases have an age distribution that is weighted towards the older end of the age spectrum. The peak of the distribution is found in the 55-64 year age group. In contrast, the age distribution for the whole reconstructed CMDHB population is dominated by younger age groups, with the four groups made up by those aged 55 years or older contributing to only a small proportion of the population.

Figure 4: Age distributions of diabetes cases in CMDHB and of the entire reconstructed CMDHB population for 2006-2007



The difference between the age distribution of diabetes cases and that of the broader reconstructed CMDHB population is consistent with the difference found between age distributions for the other three northern DHB's (not including CMDHB) and diabetes cases within those DHB's, as seen in Figure 5. Again, those identified as having diabetes are spread towards the older end of the age spectrum, with the peak of the distribution for diabetes cases again in the 55-74 years age group.

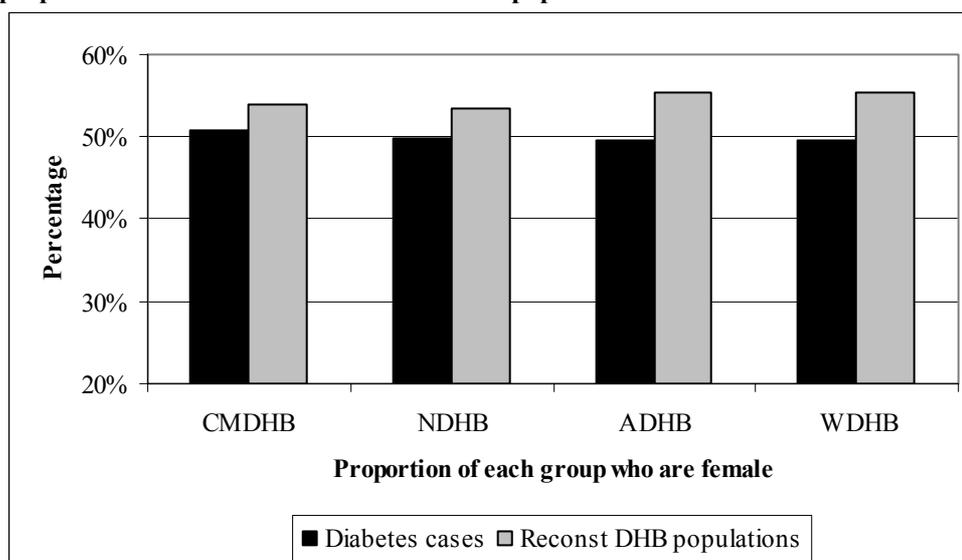
Figure 5: Age distributions of diabetes cases in the northern region (ex. CMDHB) and of the reconstructed northern region (ex. CMDHB) population for 2006-2007



Sex

As can be seen in Figure 6, the proportion of females amongst diabetes cases is only slightly less than the proportion of females in the reconstructed CMDHB population. This trend is consistent across all four of the northern DHB's, where the proportions of females amongst diabetes cases are fairly similar to the proportions of females in the reconstructed DHB populations.

Figure 6: Proportion of females in diabetes cases identified within each DHB, compared with proportion of females in reconstructed DHB populations for 2006-2007

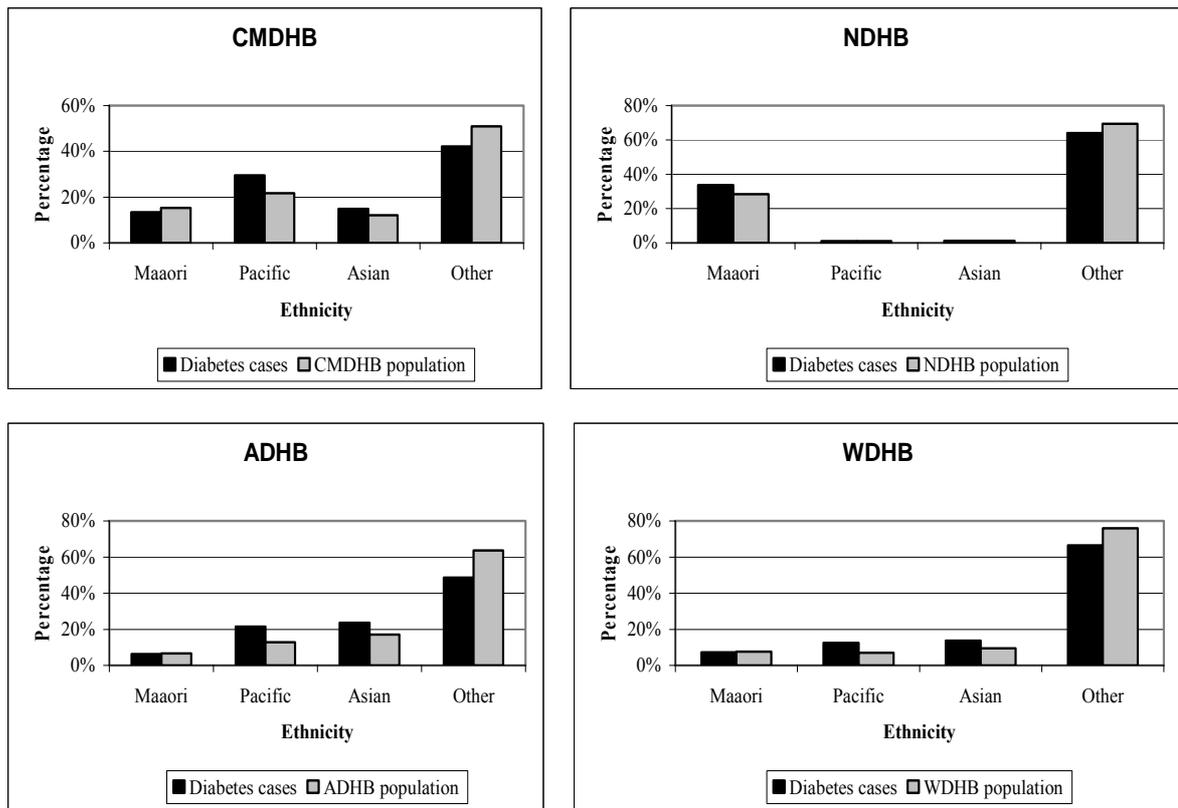


Distribution of ethnicity

As mentioned in the introductory section, prioritised ethnicity is used in this report. While prioritisation greatly simplifies the analysis and presentation of data for individuals who have recorded more than one ethnicity, it is not without limitation. It is contradictory to the concept of self-identification in ethnicity, some groups become over-represented at the expense of others and it places people in specific ethnic groups which although simplifying results may also introduce bias. These limitations should be acknowledged when interpreting the data presented below.

The composition of ethnicity for diabetes cases in the northern DHB's follows the general pattern of ethnicity distribution within the reconstructed populations of each of the four DHB's (Figure 7). Those of Pacific, Maaori and Asian ethnicities tended to be over-represented in the diabetes groups for all four DHB's, while the proportion of people of Other ethnicity in reconstructed populations for all four DHB's exceeds their proportional representation in diabetes groups in all cases.

Figure 7: Ethnic composition of the diabetes case group and reconstructed 2006-2007 population within each of the four northern DHB's



Deprivation

As discussed in the introductory section of this report, level of deprivation for individuals within the reconstructed data set is approximated by matching individual domicile codes with average NZDep2006 deciles by census area unit (CAU). Figure 8 compares the proportion of diabetes cases in each NZDep2006 decile against the approximated distribution of deprivation for the reconstructed CMDHB population. Likewise, Figure 9 presents the same comparison for the wider northern region (ex. CMDHB).

Figure 8: Mean NZDep2006 decile of CAU for CMDHB residents identified as diabetes cases compared with CMDHB residents in 2006-2007 reconstructed population

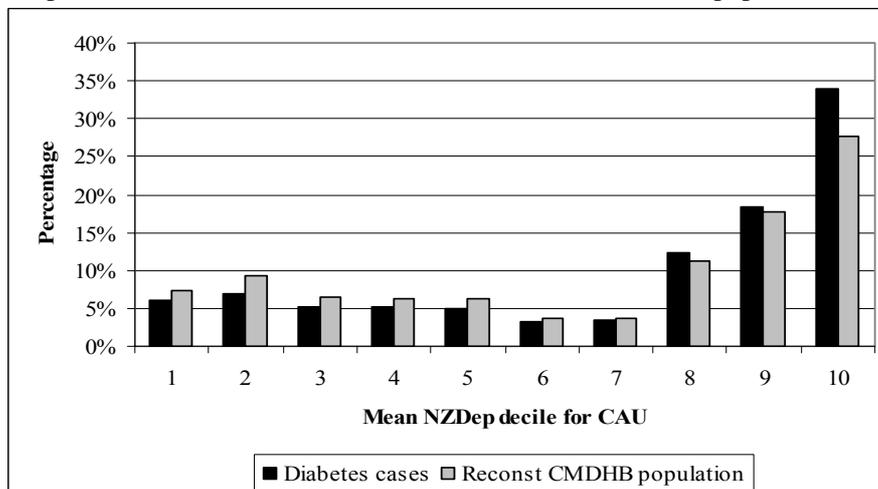
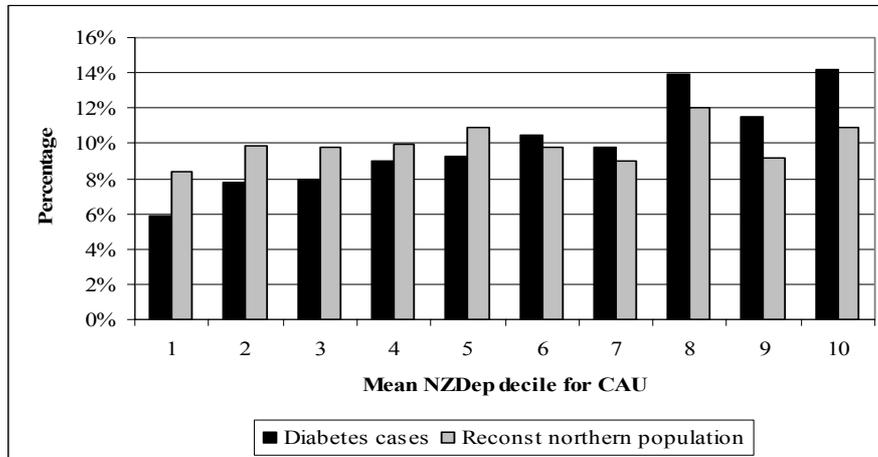


Figure 9: Mean NZDep2006 decile of CAU for northern region (ex. CMDHB) residents identified as diabetes cases compared with general northern regional reconstructed population in 2006-2007



In both Figures 8 and 9 the diabetes case populations are characterised by a shift in the distribution of deprivation towards the lower NZDep2006 deciles in comparison to the reconstructed populations within CMDHB and the northern region (ex. CMDHB) respectively.

Laboratory utilisation

Electrolytes, glucose and creatinine

Within the reconstructed CMDHB population, 79.0% of diabetes cases were found to have had at least one test for ‘BE3 – Sodium and potassium, serum’ and 92.4% had at least one test for ‘BR1 – Creatinine, serum’ in the community during the two-year study period. These results were very similar to those found in the (ex. CMDHB) northern region. 82.3% of identified CMDHB diabetes cases had the test ‘BG5 – Serum glucose’ in the study period, compared with 83.4% of diabetes cases in the remaining northern region. Figure 10 shows the frequency of electrolyte testing amongst CMDHB diabetes cases over the two-year period, while Figure 11 shows frequency of testing for serum creatinine in the diabetes group.

Figure 10: Frequency of electrolyte testing amongst diabetes cases in CMDHB reconstructed population, 2006-2007

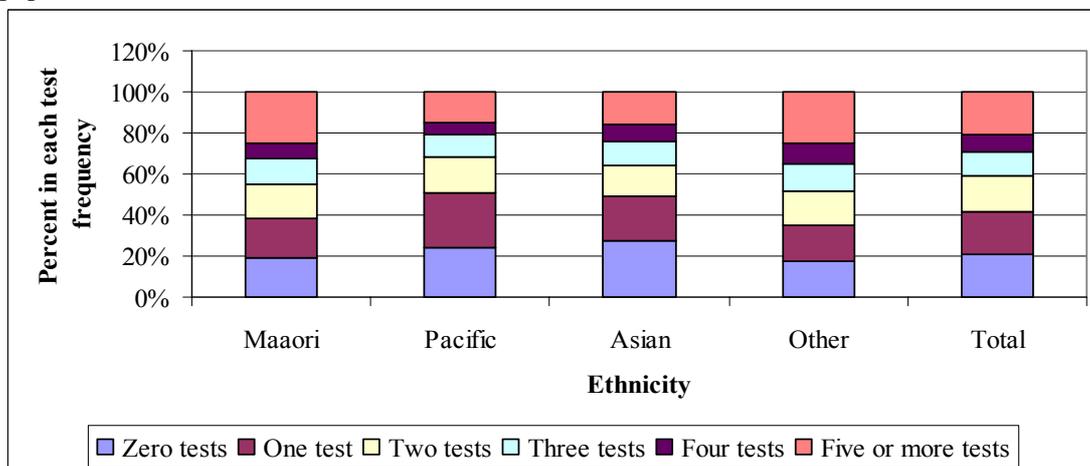
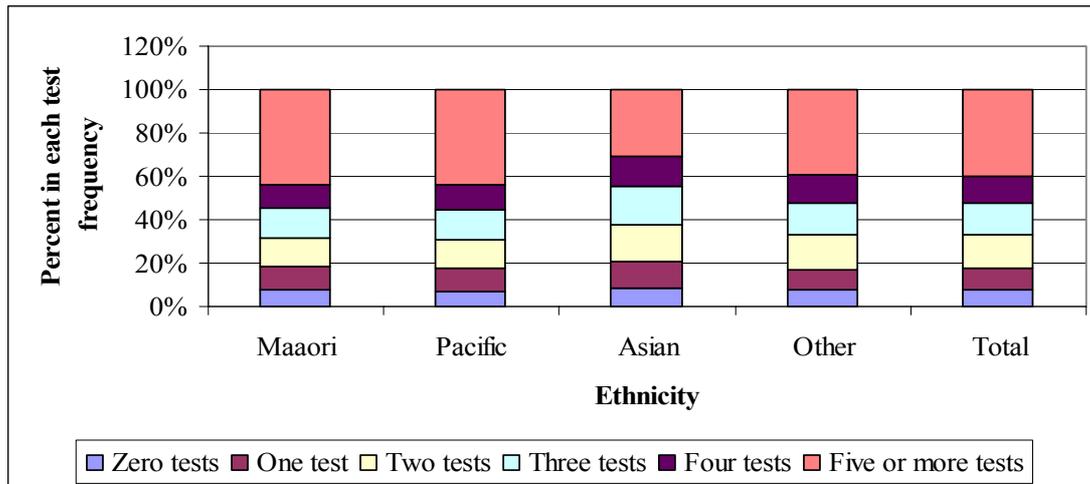


Figure 11: Frequency of serum creatinine testing amongst diabetes cases in CMDHB reconstructed population, 2006-2007

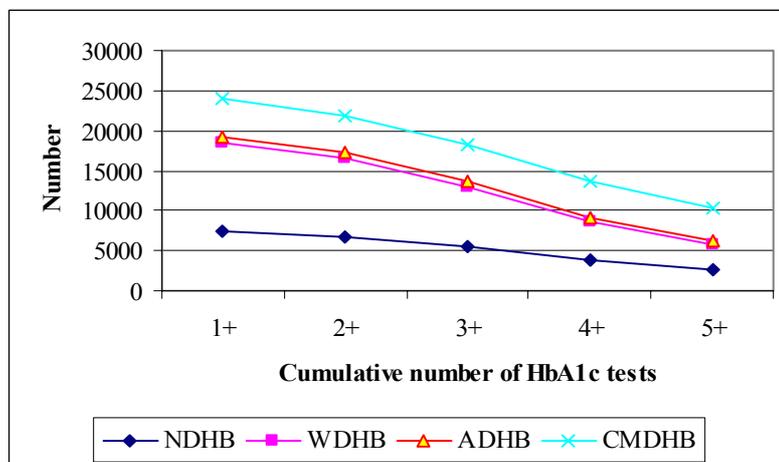


Glycosylated haemoglobin (HbA1c)

Frequency of glycosylated haemoglobin (HbA1c) testing was included in the decision rules for identification of individuals with diabetes in the reconstructed population (methods section). Sensitivity analysis was performed around the frequency of HbA1c testing within the decision rules. Around 50,000 people in the reconstructed CMDHB population had a laboratory claim for at least one HbA1c test during the two-year period, 25,000 people had two or more HbA1c claims during the study period and 18,000 people satisfied the inclusion criteria of three or more HbA1c tests during the two-year period. About 4,000 diabetes cases (out of the 18,000 with three or more tests) were exclusively identified by way of HbA1c testing (and not by pharmaceutical or NMDS decision rules).

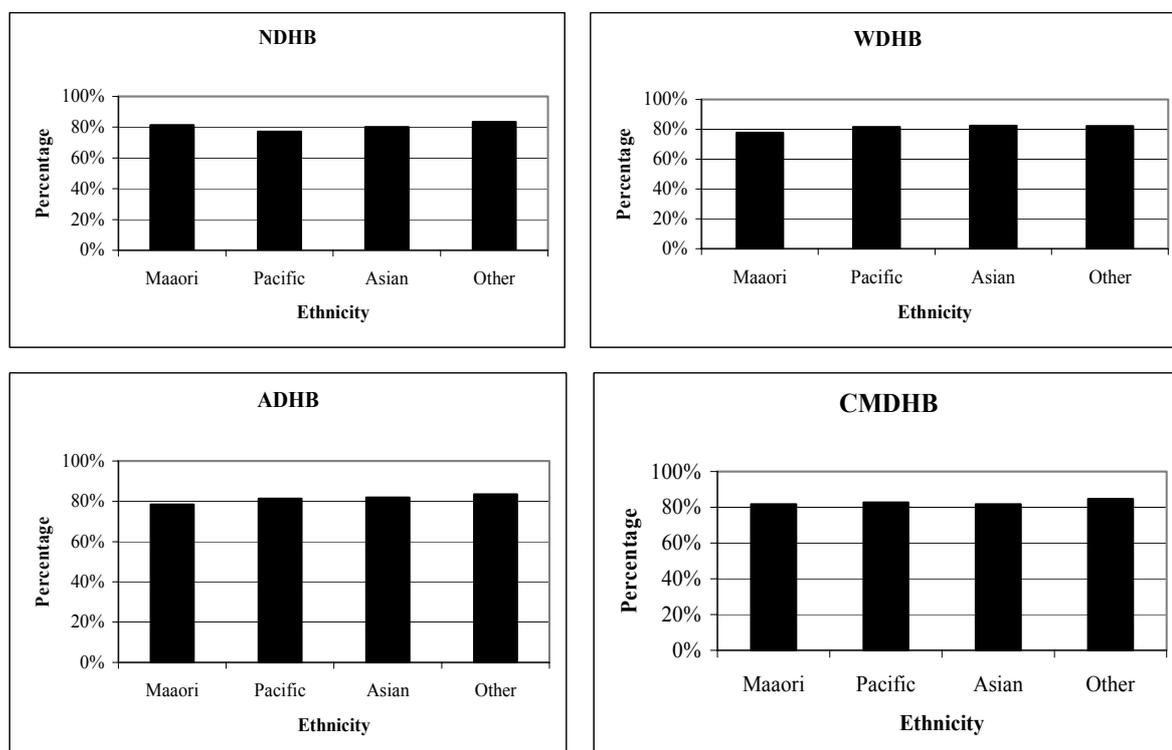
Across the four northern DHB's for the 2006-2007 period, over 6,000 diabetes cases identified using pharmaceutical and NMDS decision rules did not have subsidy claims for HbA1c testing. Figure 12 describes the cumulative frequency of HbA1c testing across the four northern DHB's for the remaining 70,000 or so diabetes cases in 2006-2007.

Figure 12: Cumulative frequency of HbA1c testing over two-year period in diabetes cases in four northern DHB's, 2006-2007



The Get Checked diabetes programme entitles all people with diabetes in New Zealand to a free annual GP or GP practice nurse review, including measurement of HbA1c. In the CMDHB population of diabetes cases identified using all of the decision rules, 83.3% of cases had two or more HbA1c tests completed in the community¹ during the two-year 2006-2007 period, compared with 82.1% for the other three northern DHB's across the same period. Figure 13 describes the proportion of diabetes cases within each DHB who had HbA1c performed at least twice in the community during the two year period, by ethnicity. While these results do not suggest that the HbA1c tests detected in laboratory claims data necessarily related to annual Get Checked reviews, they do indicate that HbA1c testing was reasonably frequent in the majority of diabetes cases.

Figure 13: Proportion of diabetes cases with two or more HbA1c tests over two-year period, 2006-2007, by ethnicity and DHB (northern region)



Within the reconstructed CMDHB population, a significantly greater proportion of diabetes cases of Other ethnicity were found to have had two or more HbA1c tests within the two-year period ($\chi^2 = 27.1$, 1 df, $P < 0.001$) in univariate analysis. The proportion of individuals of Other ethnicity who had two or more HbA1c tests was 84.7% (95% CI 84.0% to 85.3%), while 82.2% of those of Maaori, Pacific or Asian ethnicities had two or more HbA1c tests during the period (95% CI 81.6% to 82.8%).

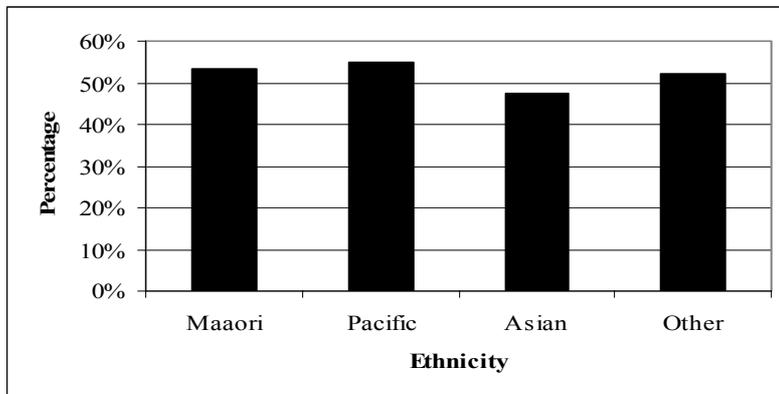
Current recommendations suggest that individuals with diabetes should have HbA1c monitored three-to-six monthly, depending on stability of glycaemic control²¹⁻²⁴. This frequency of testing would roughly approximate to four or more tests in the two-year period (although it is recognised that some diabetes cases may have had HbA1c tests performed in hospital laboratories and that four, evenly-spaced HbA1c

¹ Not including testing undertaken in hospital

monitoring tests would not have been performed in many cases). Overall in CMDHB, just over half (52.3%) of diabetes cases had four or more HbA1c tests during the two-year period. This was a significantly greater proportion than the 43.9% found in the other three northern DHB's in univariate analysis ($\chi^2 = 485.3$, 1 df, $P < 0.001$). Within CMDHB, only 47.5% of diabetes cases of Asian ethnicity had four or more HbA1c tests in two years, compared with over 50% in those of Maaori, Pacific and Other ethnicity (Figure 14).

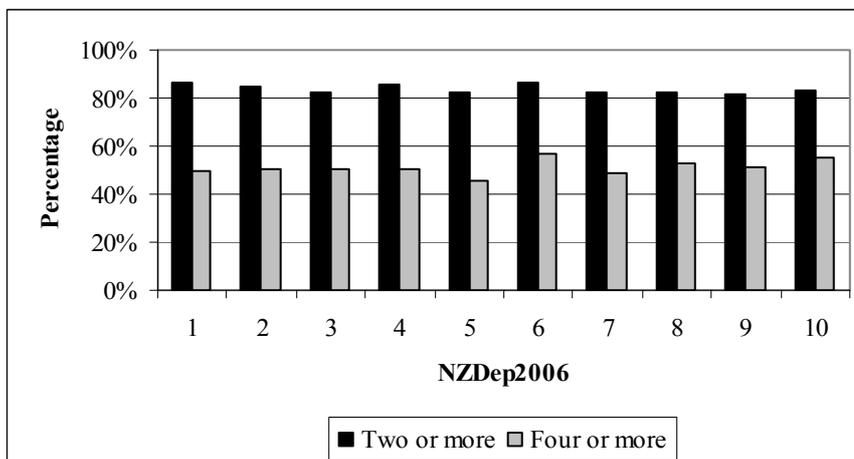
The reasons behind higher HbA1c test frequency in CMDHB compared with the rest of the northern region are not clear. The higher frequency could be due to closer monitoring of individuals with diabetes (though initiatives such as CCM). Alternatively, more people with diabetes in CMDHB may have glycaemia that is difficult to control, requiring more frequent monitoring.

Figure 14: Proportion of diabetes cases in CMDHB that had ≥ 4 HbA1c tests in two years, by ethnicity, 2006-2007



Crude analysis of frequency of HbA1c testing by deprivation shows that the proportion of diabetes cases in CMDHB who had either two or more HbA1c tests or four or more HbA1c tests in the two-year period was fairly consistent across the spectrum of deprivation, as measured by mean NZDep2006 decile of a resident's CAU (Figure 15). There was no evidence of any gender difference in the frequency of HbA1c testing amongst diabetes cases in the reconstructed CMDHB population or the northern region more generally.

Figure 15: Mean NZDep2006 deprivation decile in CAU by frequency of HbA1c testing in CMDHB diabetes cases, 2006-2007



The lack of correlation between mean NZDep2006 by CAU and HbA1c test frequency was surprising, given that there is usually a socio-economic gradient attached to health care access^{25 26}. This may indicate effective targeting of initiatives such as CCM.

Lipid studies

The NZGG² recommends that cardiovascular risk assessment (including fasting lipid studies) be performed annually on all people with diabetes from the time of diagnosis²³. This advice is consistent with international recommendations from groups such as the ADA^{3 21}.

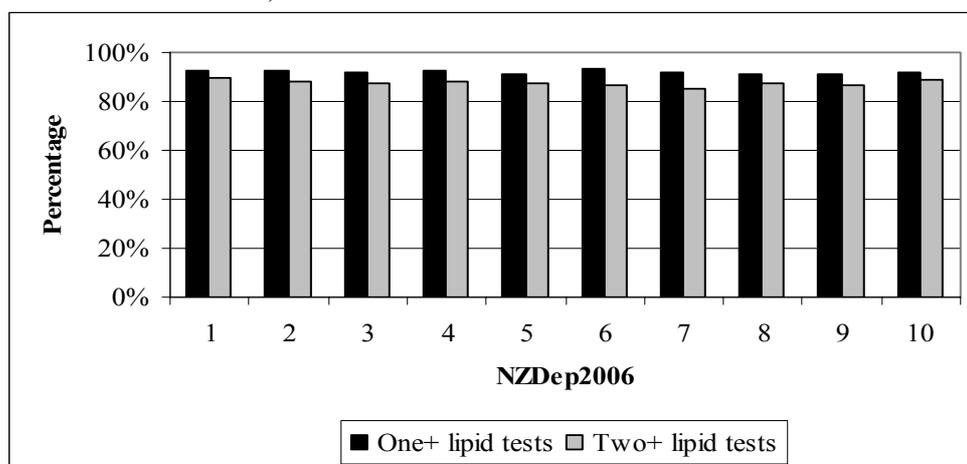
In diabetes cases identified in the CMDHB reconstructed population for 2006-2007, 91.7% (95% CI 91.4% to 92.1%) had at least one claim for the test ‘BL4 – Fasting lipid group’, and 80.6% (95% CI 80.1% to 81.2%) had claims for at least two fasting lipid tests during this two-year period. This is higher than 89.8% (95% CI 89.6% to 90.1%) for one lipid test or more and 75.3% (95% CI 74.9% to 75.7%) for two or more lipid tests found in the remaining three DHB’s in the northern region.

Slightly fewer Maaori were found to have had either one (or more) or two (or more) fasting lipid test claims in the two-year period (Table 8). The differences observed were not statistically significant.

Table 8: Proportion of diabetes cases in CMDHB reconstructed population in 2006-2007 who had claims for at least either one or two fasting lipid tests

	One or more lipid tests	Two or more lipid tests
Maaori	90.7%	79.1%
Pacific	92.1%	81.1%
Asian	92.3%	80.6%
Other	91.6%	80.6%

Figure 16: Mean NZDep2006 deprivation decile in CAU by frequency of fasting lipid testing in CMDHB diabetes cases, 2006-2007



² New Zealand Guidelines Group

³ American Diabetes Association

No significant gender differences in fasting lipid testing were identified either within the CMDHB diabetes cases or diabetes cases identified in reconstructed populations of the remaining three northern DHB's. Likewise, no significant differences in frequency of fasting lipid testing were noted between different groups by level of deprivation in CMDHB (Figure 16).

Microalbumin

Urinary microalbumin is a screening test used in people with diabetes to detect early nephropathy (at a point where it is reversible with good blood pressure control and management of hyperglycaemia)²⁷. Results for this test are often expressed in the form of an albumin-creatinine ration (ACR)²⁸. In people with diabetes, no microalbuminuria and normal serum creatinine, the NZGG recommends that urinary microalbumin be tested annually²³. This recommendation is consistent with international guidelines generated by organisations such as the ADA²¹.

Of the diabetes cases identified in the reconstructed CMDHB population, 77.7% (95% CI 77.2% to 78.2%) had one claim or more for test 'BP8 – Microalbumin, early morning urine', leaving almost 6,000 cases with no claim for microalbumin during the two-year study period. By comparison, only 68.8% (95% CI 68.4% to 69.2%) of diabetes cases in the remaining three northern DHB's had one or more claims for urinary microalbumin during the two years. This difference of almost 9% was statistically significant in univariate analysis ($\chi^2 = 512.8$, 1 df, $P < 0.001$). When the threshold was lifted to two or more microalbumin tests within the two-years, 61.8% (95% CI 61.3% to 62.4%) of CMDHB diabetes cases had at least two such tests while only 49.2% (95% CI 48.8% to 49.6%) of diabetes cases in the remaining three DHB's were identified, a statistically significant difference of almost 13% ($\chi^2 = 1098.3$, 1 df, $P < 0.001$).

The distribution of testing frequency for urinary microalbumin by ethnicity in CMDHB diabetes cases is presented in Figure 17, while the distribution by deprivation level is shown in Figure 18.

Figure 17: Proportion of diabetes cases in CMDHB with either 1+ or 2+ urinary microalbumin screening tests in two years (2006-2007), by ethnicity

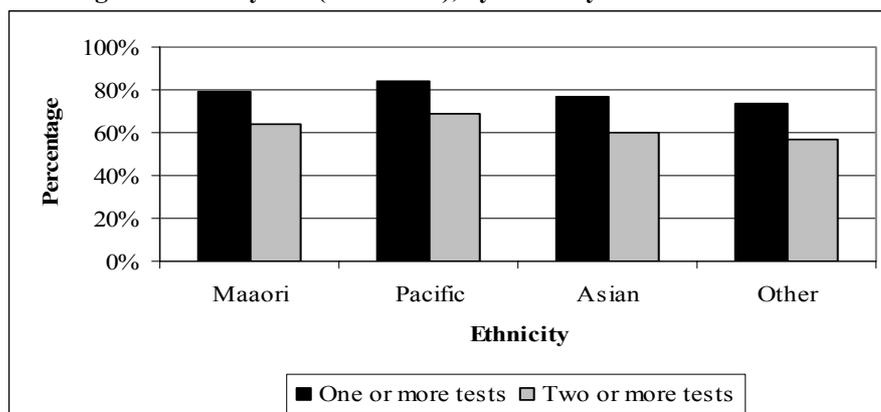
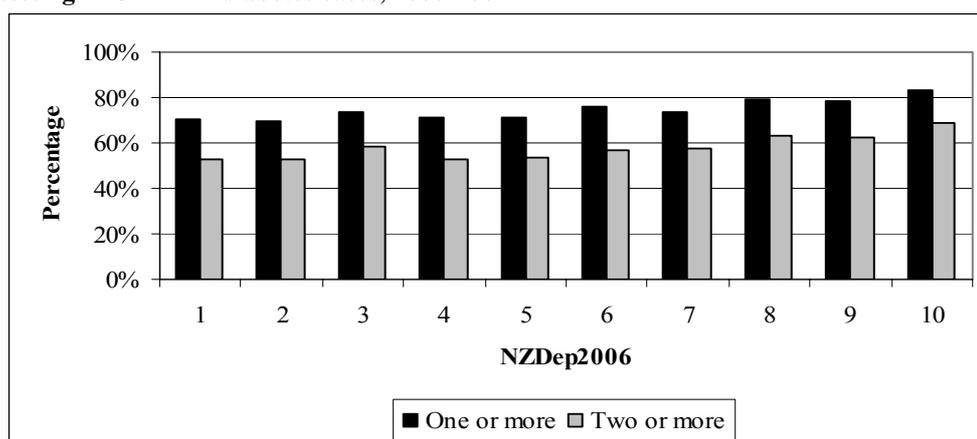


Figure 18: Mean NZDep2006 deprivation decile in CAU by frequency of urinary microalbumin testing in CMDHB diabetes cases, 2006-2007



A proportion of diabetes cases have no requirement for microalbumin as a screening tool (as they have known renal disease) and it was difficult to identify these people within the reconstructed populations, given the limitations of the available data. Some insight into this population can be gained by removing individuals with documented ICD-10-AM diagnosis and procedure codes for renal disease in NMDS from the study population. In CMDHB, 12.4% of diabetes cases had either an ICD-10-AM diagnosis code or a procedure code related to renal disease, compared with 11.2% in the remaining three northern DHB's.

For the whole northern region (including CMDHB), 9,103 diabetes cases were identified who also had documented ICD-10-AM diagnosis and procedure codes relevant to renal disease. This left a remainder of 23,620 diabetes cases who did not have evidence of renal disease documented in NMDS in the reconstructed CMDHB population and 45,435 diabetes cases without documented renal disease in the remaining northern DHB's.

Frequency of microalbumin screening was in fact lower in diabetes cases without documented evidence of renal disease in NMDS. Of CMDHB diabetes cases without documented renal disease, 76.2% (95% CI 75.6% to 76.7%) had claims for at least one microalbumin test in two years and 59.7% (95% CI 59.1% to 60.4%) had claims for at least two tests. In the other three northern DHB's, 66.9% (95% CI 66.5% to 67.4%) of diabetes cases without renal disease had claims for one or more microalbumin test, while 47.4% (95% CI 46.9% to 47.8%) had claims for at least two tests. The reason for the lower frequency of microalbumin screening in those without renal disease is not easily explained in the data. Perhaps this test is also being used for monitoring progression of renal disease in those already recognised as having nephropathy.

Cost

The total cost of laboratory tests in the reconstructed population for the whole northern region (excluding GST) in 2007 was just over \$86 million, of which diabetes cases accounted for around \$15 million (18%). Within CMDHB, the total cost of laboratory claims in the reconstructed population for 2007 was almost \$25 million, of which \$5.5 million was attributed to diabetes cases, i.e. 6.3% of the population used almost one quarter of the laboratory costs for this period.

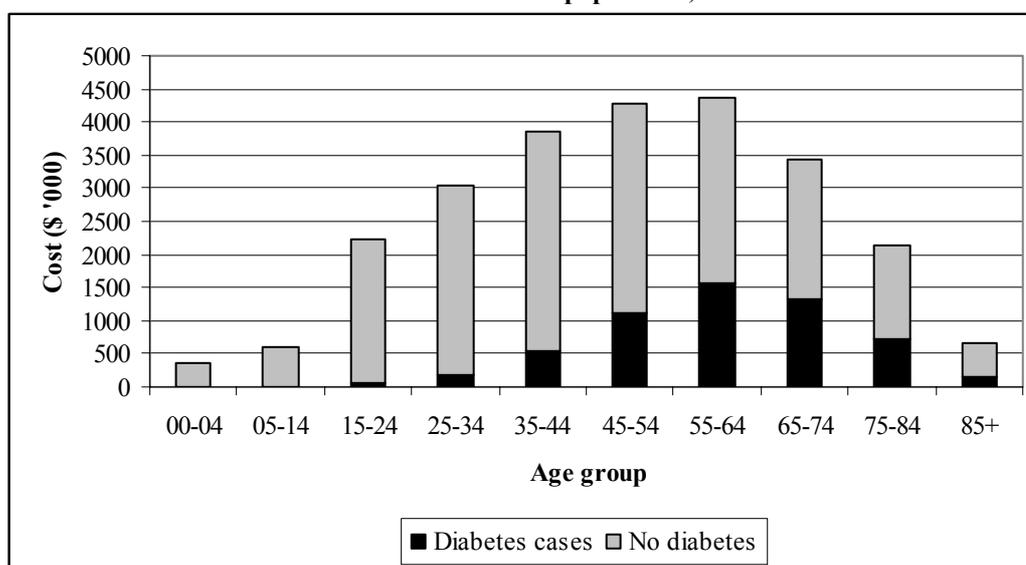
The unadjusted cost of community laboratory testing claims per person in the reconstructed population is presented in Table 9 for diabetes cases and those without diabetes, by DHB in 2007.

Table 9: Claims for community laboratory testing by DHB, per person for diabetes cases and those without diabetes, by DHB in 2007 (excl. GST)

District Health Board	Cost/person (\$) – diabetes cases	Cost/person (\$) – no diabetes
Northland DHB	193	48
Waitemata DHB	183	49
Auckland DHB	190	50
Counties Manukau DHB	214	44

While CMDHB spent the about the same amount as the other three DHB’s on community laboratory testing per (average) resident overall, it spent the most (on average) on diabetes cases. The peak age group for community laboratory claims (in absolute terms) was the 55-64 year age group, while the proportional contribution of diabetes cases to total laboratory claims increased steadily until the 65-74 year age group and then declined slightly amongst those aged 75 years or more (Figure 19).

Figure 19: Distribution of dollar value of laboratory claims by age group for diabetes cases and those without diabetes in reconstructed CMDHB population, 2007



Pharmaceutical utilisation

As was the case with decision rules for identification of diabetes cases, the decision rule for identification of pharmaceutical utilisation in the following analyses consisted of two or more dispensing claims for a drug category within calendar years 2006 and 2007.

The analysis looked at claims for medications considered relevant to the diabetes population. It used the therapeutic groupings for pharmaceutical claims found in the

New Zealand Pharmaceutical Schedule at around the mid-point of the analysis period, in August 2006¹². The specific therapeutic groupings analysed are found in Table 10.

Table 10: Specific therapeutic group categories and chemical names of medications for which analysis of pharmaceutical utilisation was undertaken

TG Level 2	TG Level 3	Chemical name
Diabetes	Insulin - short-, intermediate-, long-acting preparations and rapid acting insulin analogues	Metformin Glipizide Gliclazide Glibenclamide Tolbutamide Rosiglitazone Acarbose
Agents affecting renin-angiotensin system	ACE inhibitors Angiotensin II antagonists	
Antidepressants		
Lipid modifying agents	HMG Co A reductase inhibitors	
Beta adrenoceptor blockers		
Calcium channel blockers		
Thiazide and related diuretics		
	Antiplatelet agents	

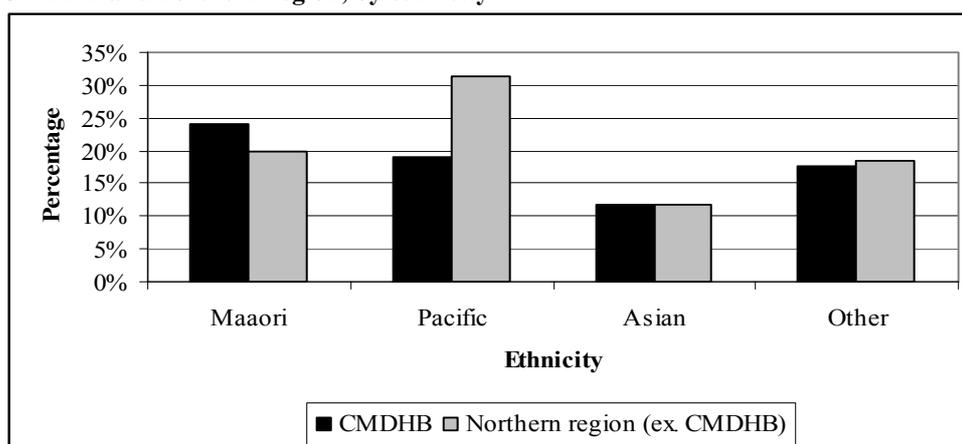
Diabetes medications

The therapeutic group (TG) level 2 category ‘Diabetes’ contained 15 TG level 3 classifications which in turn contained a variety of different chemical preparations¹². In this analysis, short-, intermediate-, and long-acting insulin preparations, plus rapid-acting insulin analogues were aggregated into the single category ‘insulin’. Oral diabetes agents were analysed at the level of chemical name.

Almost 5,000 diabetes cases had two or more claims for insulin in 2006 and 2007 in CMDHB, 18.0% of the diabetes population. In the remaining three northern DHB’s, 17.5% of diabetes cases had claims for regular insulin dispensing. These figures appear to be consistent with the frequency of insulin use amongst people with diabetes nationally. In the 2006/07 NZHS, 19.4% of adults with diabetes reported daily insulin injections (with or without concurrent oral diabetes agents)⁷. The distribution of insulin claims in diabetes cases by ethnicity is given in Figure 24. Notably, the proportion of diabetes cases of Asian ethnicity with regular claims for insulin was much lower than those of other ethnicities. Proportionally more Maaori diabetes cases in CMDHB had claims for insulin compared to the remainder of the region, while the opposite was found for diabetes cases of Pacific ethnicity in CMDHB.

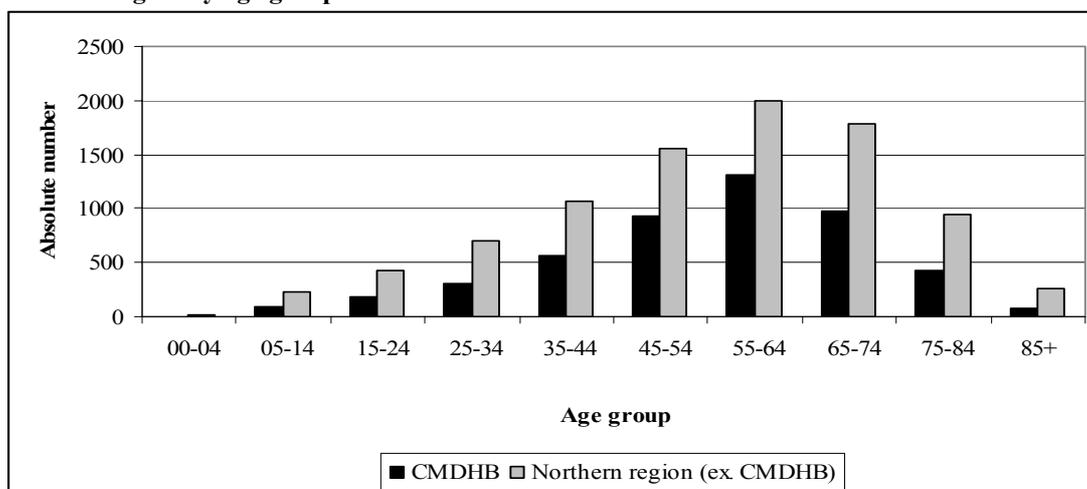
Note that some insulin prescriptions and monitoring equipment for diabetes cases in CMDHB were obtained from Diabetes New Zealand in Oamaru, rather than from local pharmacies. Because individuals are identified by residential address in this data set, northern region diabetes cases who purchased diabetes supplies in Oamaru have been accounted for according to their DHB of residence.

Figure 20: Proportion of diabetes cases with two or more claims for insulin in two years in CMDHB and northern region, by ethnicity



No significant gender differences in claims for insulin were noted either amongst diabetes cases in CMDHB or those in the other three DHB's. The age distribution for diabetes cases with two or more insulin prescription claims in 2006-2007 is presented in Figure 25. In keeping with the distribution of diabetes cases more generally, the peak of insulin claims amongst northern region diabetes cases is in the 55-64 year age group.

Figure 21: Absolute numbers of diabetes cases with regular insulin claims in CMDHB and northern region by age group

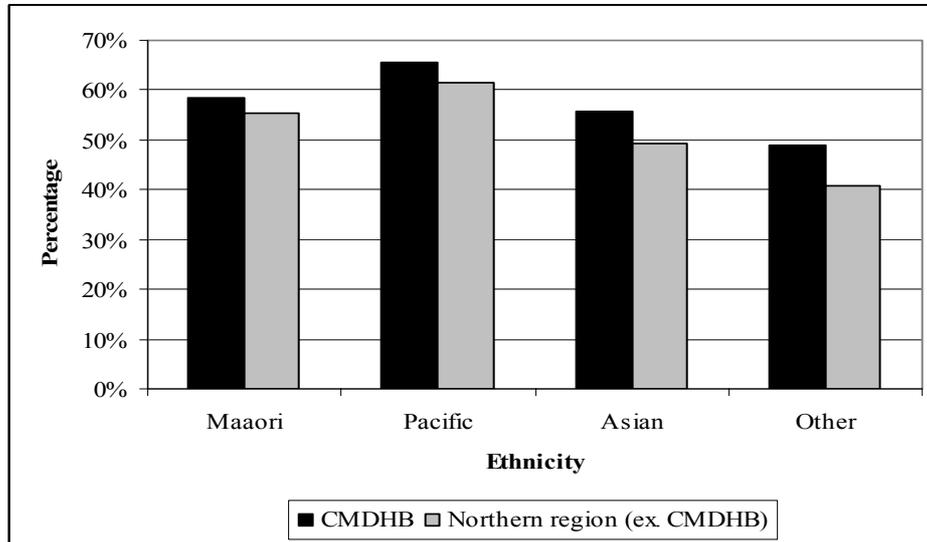


When proportion of diabetes cases with regular prescription claims for insulin was compared across the deprivation spectrum and between DHB's, no observable difference was found in claim patterns. Around 16% to 18% of diabetes cases in each deprivation decile had regular claims for insulin and this pattern was similar between CMDHB and the remaining three DHB's in the northern region.

Oral diabetes medications are an important part of the management of hyperglycaemia in individuals with type 2 diabetes²⁹. In the 2006/07 NZHS, 52.4% of adults with diabetes in the national sample reported taking only oral diabetes medication⁷. In CMDHB, 56.1% of diabetes cases had community pharmaceutical claims for two or more metformin scripts in two years and over 80% of these people were aged 45 years or more. In comparison, only 46.7% of diabetes cases in the other three northern

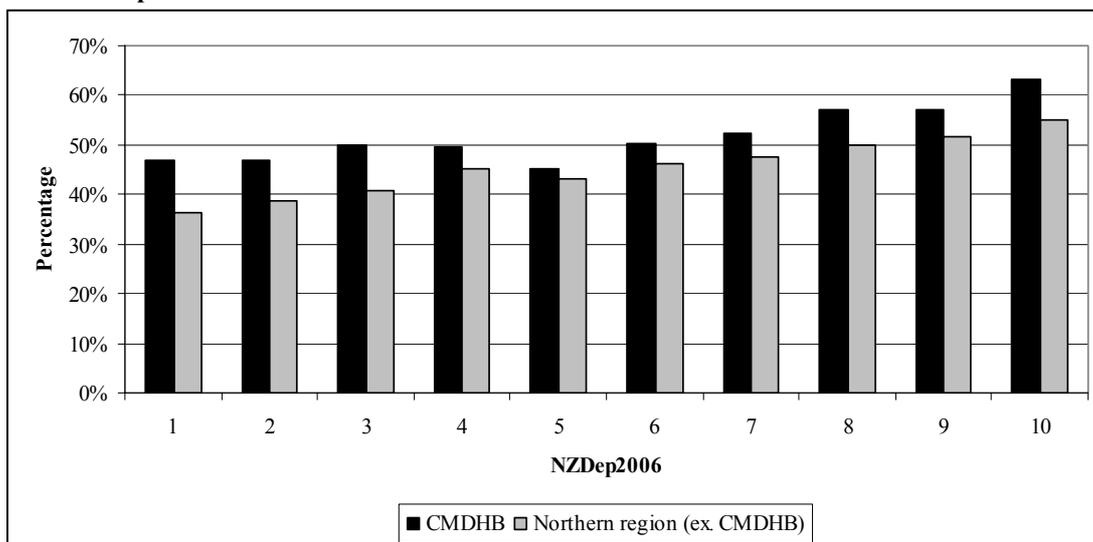
DHB's had two or more claims for metformin. The proportion of diabetes cases with claims for metformin was highest amongst those of Pacific ethnicity and lowest amongst those of Other ethnicity (Figure 26).

Figure 22: Proportion of diabetes cases with two or more claims for metformin in two years in CMDHB and northern region, by ethnicity



An association was noted between level of deprivation and proportion of diabetes cases with two or more claims for metformin, with proportion of metformin claimants increasing with greater average NZDep2006 decile for CAU (Figure 27). The regression coefficient for this trend in the northern region was statistically significant in simple (unadjusted) linear regression ($t = 24.5, 8 \text{ df}, P < 0.001$).

Figure 23: Proportion of diabetes cases with two or more claims for metformin in two years by mean NZDep2006 decile for area of residence



Pharmaceutical claims for sulfonylurea oral hypoglycaemic agents were common in both CMDHB and in the remainder of the northern region in 2006-2007. Table 13 documents the proportion of diabetes cases in CMDHB and in the other three northern DHB's who had two or more claims for sulfonylurea agents during these two years.

Table 11: Proportion of diabetes cases in CMDHB and three other DHB's in northern region with 2+ sulfonylurea claims in two years

	Proportion of CMDHB diabetes cases	Proportion of northern region diabetes cases
Glibenclamide	1.6%	1.5%
Gliclazide	19.6%	14.6%
Glipizide	10.6%	10.8%
Tolbutamide	0.1%	0.0%

Pioglitazone is a drug in the thiazolidinedione class which increases the sensitivity of fat, muscle and liver to insulin²⁹. It is used infrequently in New Zealand in combination with other diabetes medications or as monotherapy where other oral agents are not tolerated. It requires special authority approval for reimbursement in New Zealand^{12 13}. Around 1,500 diabetes cases in the northern region were regularly prescribed pioglitazone in 2006 and 2007, of which 450 people were CMDHB residents. Likewise, the drug acarbose is an alpha-glucosidase inhibitor which reduces the digestion of complex sugars in the intestine. It too is used rarely in New Zealand and requires special authority approval for reimbursement. Only 185 diabetes cases in CMDHB (less than one percent of diabetes cases) had two or more prescription claims for acarbose during 2006 and 2007, and only 85 diabetes cases in the other three northern DHB's had claims for acarbose during this period.

Blood pressure-lowering agents

The NZGG recommends annual cardiovascular risk assessment, including blood pressure monitoring for people with type 2 diabetes²³. Hypertension is common in individuals with diabetes³⁰. The prevalence of hypertension amongst adults with type 2 diabetes is typically between 40% and 60% internationally, with risk of hypertension increasing with age^{31 32}. Appropriate management of blood pressure can significantly reduce the risk of cardiovascular morbidity and mortality experienced by a person with diabetes^{32 33}. Management of hypertension in people with diabetes includes lifestyle interventions and blood pressure-lowering medication²³.

In CMDHB, 69.7% of diabetes cases had two or more prescription claims for blood pressure-lowering agents during the study period, compared with 66.1% of diabetes cases in the other three northern DHB's. Given the limitations of the data, it is not possible to evaluate the appropriateness of blood pressure medication prescribing amongst diabetes cases in the northern region. However, differences in utilisation of blood pressure-lowering medications between regions, by ethnicity and by deprivation can be described amongst diabetes cases and can provide insight into prescribing patterns.

Drugs that affect the renin-angiotensin system, including ACE⁴ inhibitors and angiotensin II antagonists, have a number of advantages over other blood pressure-lowering agents in diabetes, including favourable toxicity profiles, no adverse effects on lipid metabolism and protective effects on the progression of nephropathy^{34 35}. These agents are used as first-line therapy in people with diabetes and

⁴ Angiotensin converting enzyme

microalbuminuria or overt nephropathy²³. Within CMDHB, 61.1% of diabetes cases had pharmaceutical claims for agents that affect the renin-angiotensin system, while 55.4% of diabetes cases in the other three DHB's in the northern region had two or more claims for such agents in 2006 and 2007. The majority (77.9%) of claims by CMDHB diabetes cases in this category were for ACE inhibitors, with angiotensin II antagonists accounting for 10.7% of claims. Claims for these agents were inconsistent across ethnicity categories in all four northern DHB's, with diabetes cases of Asian ethnicity notable in particular for lower proportions of claims for these agents (Figure 20). Further analysis is required to explore whether the lower proportion of claims for those of Asian ethnicity was due an age effect, as found for blood pressure medication use in the 2006/07 NZHS⁷. The distribution of claims for renin-angiotensin agents amongst diabetes cases by deprivation (average NZDep2006 decile for CAU) showed a relatively even spread across all ten deciles, with higher utilisation levels for CMDHB diabetes cases within each stratum, except for decile seven (Figure 21). Claim patterns were similar between genders, with dispensing claims slightly more common amongst males in all four northern DHB's.

Figure 24: Proportion of diabetes cases with two or more claims for agents that affect renin-angiotensin system in two years (2006-2007)

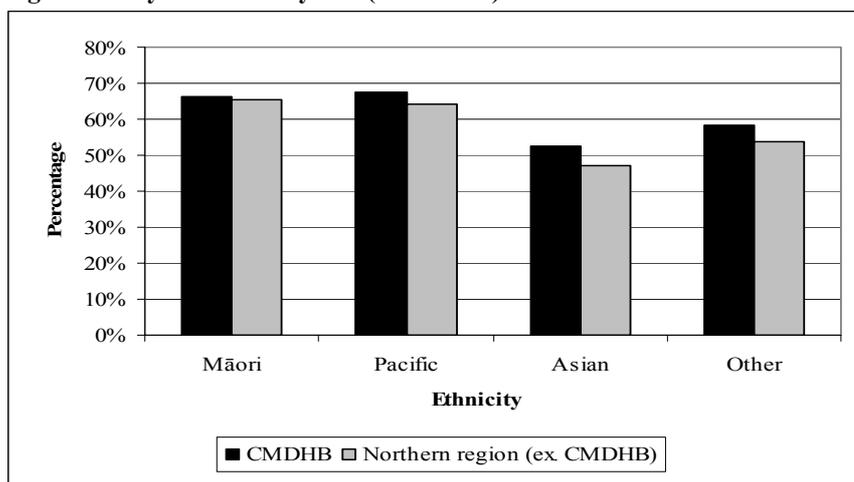


Figure 25: Percentage of diabetes cases with two or more claims for renin-angiotensin agents by deprivation level for CMDHB and three other northern DHB's

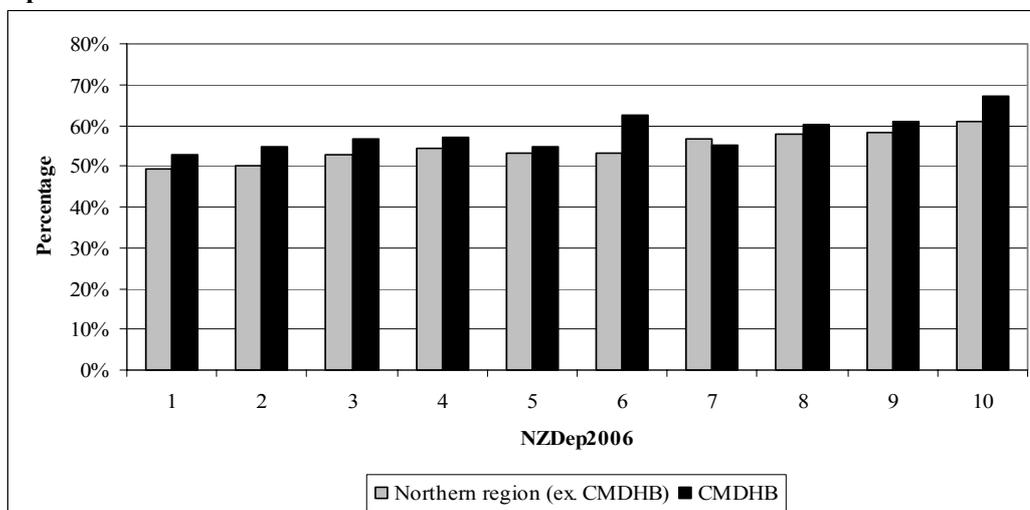


Table 12 shows the proportion of identified diabetes cases within CMDHB and the other remaining northern region DHB's who have two or more claims for blood pressure-lowering medication in 2006 and 2007. Drugs that affect the renin-angiotensin system are the most commonly dispensed group of any pharmacological blood pressure-lowering agent and more than half of diabetes cases in the northern region have at least two claims for this therapeutic grouping. By way of reference, 13.4% of adults (with diabetes and without) in the 2006/07 NZHS in CMDHB reported that they were currently taking medication for high blood pressure ⁷.

Table 12: Proportion of diabetes cases in CMDHB and three other DHB's in northern region with claims for blood pressure-lowering medication

	Proportion of CMDHB population (%)	Proportion of northern DHB (ex. CMDHB) population (%)
Agents affecting renin-angiotensin system	61.1%	55.4%
ACE inhibitors	47.6%	41.8%
Angiotensin II antagonists	6.5%	6.9%
Beta adrenoceptor blockers	26.3%	27.3%
Calcium channel blockers	23.3%	23.7%
Thiazide diuretics	7.9%	9.4%

Lipid modifying agents

Dyslipidaemia is common in people with diabetes and is an important contributor to cardiovascular disease in this group ³⁶. Interventions to manage dyslipidaemia include lifestyle modifications (e.g. weight loss and reduction in intake of cholesterol, saturated and 'trans' fats) and medications such as HMG CoA reductase inhibitors (statins) ^{37 38}. Within the New Zealand pharmaceutical Schedule (August 2006), the therapeutic group level 2 category 'lipid modifying agents' contained agents of several classes, including fibrates, statins, resins and cholesterol absorption inhibitors ¹². The entire therapeutic group 'lipid modifying agents' has been examined, together with statins, the most commonly prescribed of these agents (Table 13).

Table 13: Proportion of diabetes cases in CMDHB and northern region with two or more claims for lipid modifying agents in 2006-2007

	NDHB	WDHB	ADHB	CMDHB
Lipid modifying agents	56.1%	58.0%	57.0%	63.9%
HMG CoA reductase inhibitors (statins)	53.4%	55.8%	55.1%	62.3%

There is no easy way to recognise which diabetes cases in the reconstructed population 'should' have been taking lipid modifying agents. Suitability for these medications is dependent on individual clinical profiles. However, recommendations for the use of lipid modifying agents in clinical guidelines suggest that a high proportion of individuals with diabetes are likely to benefit from their use ^{3 21}. The finding that CMDHB had the highest proportion of diabetes cases with claims for these agents therefore seems positive on face value. Further research looking at the appropriateness of statin prescribing in diabetes cases would add further perspective to this finding.

As with ACE inhibitors and angiotensin II antagonists, the statins group (which contained the drugs atorvastatin and simvastatin) was analysed further to look at utilisation by ethnicity and deprivation (Figures 22 and 23). A greater proportion of diabetes cases in CMDHB had claims for two or more statin prescriptions compared with the other three northern DHB's, across all ethnic groups and at all levels of deprivation.

Figure 26: Proportion of diabetes cases with two or more claims for statins in two years (2006-2007) in CMDHB and northern region

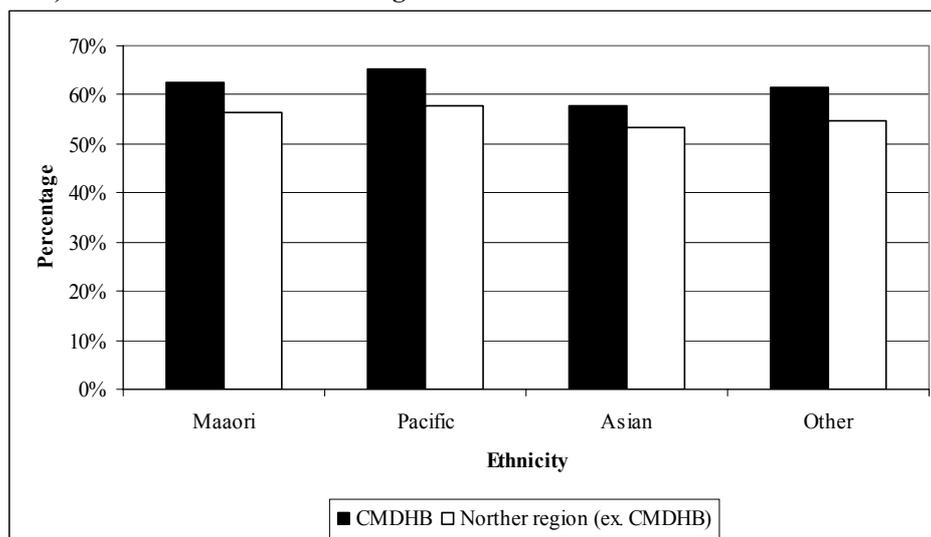
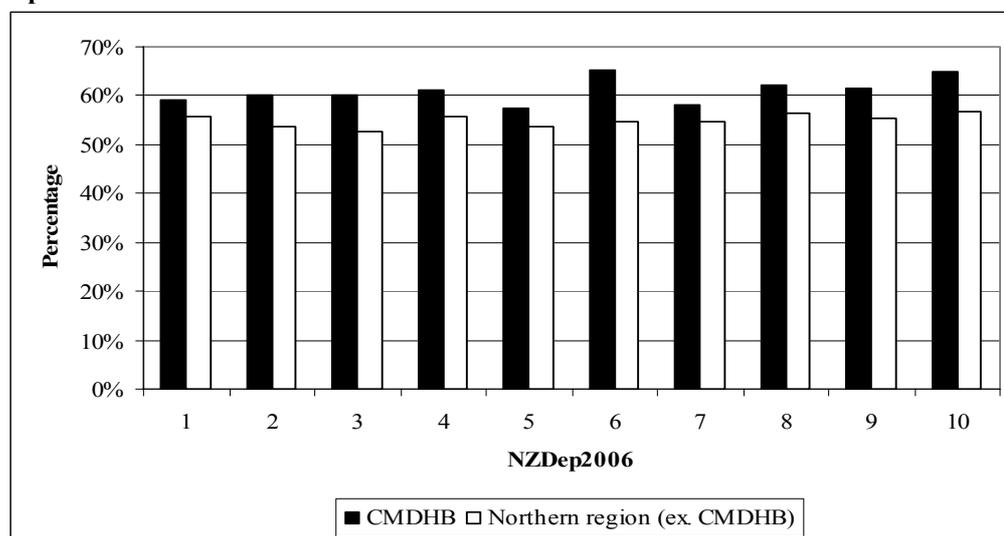


Figure 27: Percentage of diabetes cases with two or more claims for lipid modifying agents by deprivation level for CMDHB and three other northern DHB's



Almost 90% of pharmaceutical claims for statins amongst CMDHB diabetes cases were in adults aged over 45 years (as with the remainder of the northern region). Consistent with the slightly greater number of males identified amongst diabetes cases, 52.2% of diabetes cases with claims for statins were male.

Other medications

Depression is more common in individuals with diabetes than in the general population³⁹ and micro- and macrovascular complications of diabetes are frequently associated with the presence of depression²³. There are many methods for the treatment of depression; antidepressant medication being just one of those methods. It is unclear what an appropriate level of antidepressant prescribing in diabetes cases would be. Notwithstanding, 11.7% of diabetes cases in CMDHB had two or more pharmaceutical claims for antidepressant medication during the two-year period, compared with 14.7% of diabetes cases in the remaining northern DHB's.

The TG level 3 category 'antiplatelet agents' contains the drugs aspirin and dipyridamole (Persantin)¹². Within CMDHB, 46.2% of diabetes cases had two or more prescription claims for antiplatelet agents, while 40.7% of diabetes cases in the other three northern DHB's had claims for these agents.

Cost

The total value of community pharmaceutical reimbursement claims⁵ (excluding GST) in the reconstructed population for the whole northern region in 2007 was \$310 million, of which diabetes cases accounted for about one quarter of that total at \$78 million. Within CMDHB, the total cost of pharmaceutical reimbursement claims in the reconstructed population in 2007 was \$92 million, of which \$28 million was attributed to diabetes cases, i.e. 6.3% of the population accounted for more than 30% of community pharmaceutical reimbursement costs during 2007.

The unadjusted cost of community pharmaceutical claims per person is presented in Table 14 for both individuals without diabetes in the reconstructed DHB populations and diabetes cases for each DHB.

Table 14: Unadjusted cost of community pharmaceutical subsidy claims by DHB, per person, for reconstructed DHB populations and diabetes cases within those populations in 2007 (excl. GST)

District Health Board	Cost/person (\$) – diabetes cases	Cost/person (\$) – no diabetes
Northland DHB	1,093	187
Waitemata DHB	996	154
Auckland DHB	962	156
Counties Manukau DHB	1,057	146

It is not clear what pharmaceutical costs for people with diabetes 'should be'. Comparatively, the mean 2007 cost of community pharmaceutical claims for individual diabetes cases in CMDHB was similar to that found in the other three northern DHB's. While it is difficult to compare pharmaceutical costs between countries, a recent report indicated that the average net ingredient cost (NIC)⁶ for diabetes agents prescribed in primary care (insulin, monitoring agents and oral diabetes agents) in the 1.9 million people with registered diabetes in the United Kingdom in 2006 was around £300 (\$750). The average drug cost (as opposed to reimbursement value) for all community pharmaceuticals prescribed to diabetes cases

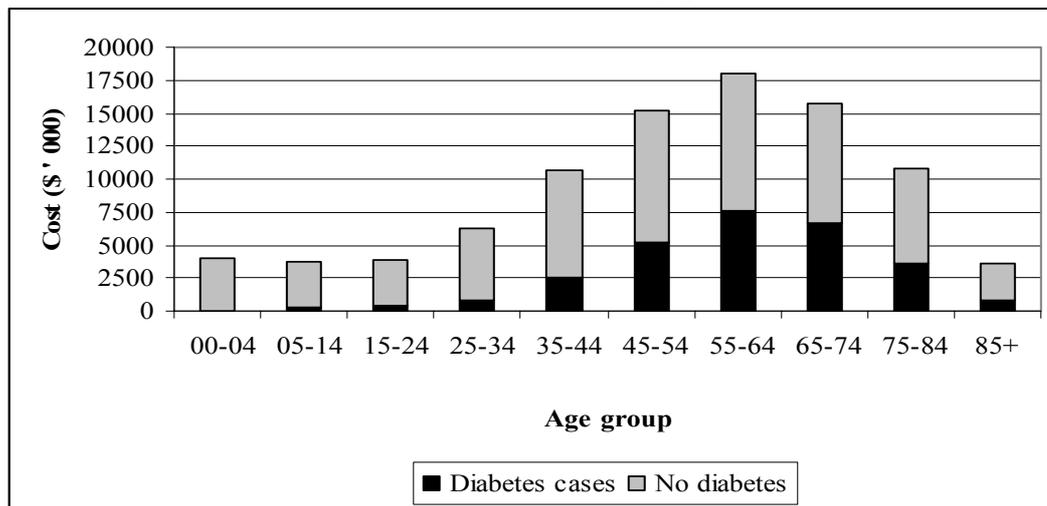
⁵ Reimbursement value is the basic drug cost, less patient co-pay, plus pharmacy fee

⁶ NIC is the basic drug cost, not including dispensing costs, discounts, fees or prescription charges

in CMDHB in 2007 was \$817. Of the four northern DHB's, the mean drug cost for diabetes cases in 2007 ranged from \$752 in ADHB to \$830 in NDHB.

Consistent with the findings for cost of laboratory claims, the peak age group for community pharmaceutical claims (in absolute terms) was the 55-64 year old group (Figure 28).

Figure 28: Distribution of dollar value of pharmaceutical claims by age group for diabetes cases and those without diabetes in the reconstructed CMDHB population, 2007



Adherence

It is not possible to accurately estimate adherence/compliance to diabetes medications given the limitations of the pharmaceutical claims data available. Around 60% of pharmaceutical claims in the northern region data set contained data for 'total days supply'. This variable was aggregated for northern region diabetes cases with two or more claims for a particular medication in two years and then used to obtain an estimate of the mean number of days of medication dispensed per person for the 2007 calendar year (Table 15). It was therefore possible to obtain a crude appreciation of adherence to individual medications based on the mean number of days medication supply in 2007 (assuming that medications which were dispensed were then used in accordance with prescribing advice). Because of the way insulin dispensing was described in the pharmaceutical claims data, information on mean days dispensed is not available for this category.

The figures given in Table 15 are rough estimates only and must be treated with caution. The estimates include only those diabetes cases that had data recorded for the variable 'total days supply'. They do not account for admissions to hospital (and hence medications used in hospital) and an assumption is made that dispensing of medications equates to those medications actually being taken. Furthermore, some medications may have been initiated during the 2007 calendar year (and others stopped for legitimate medical reasons). Initiation (and cessation) of medications part way through 2007 would have reduced the mean number of days dispensed for these medications, falsely implying that adherence/compliance was lower than it really was. A thirteen month period from December 2006 to December 2007 was used to include prescription claims which fell just outside the January 2007 to December 2007 period.

There are no established rules for how adherence/compliance to medication should be measured, although adherence to 80% of prescribed medication is often used as a threshold in clinical trials⁴⁰. The proportion of diabetes cases who were considered 'adherent', in that they were dispensed medication for >80% of days in 2007, is presented in Table 15 for each separate medication.

Table 15: Number of diabetes cases in northern region with data on 'total days supply' and regular claims for diabetes (and related) medications in 2007, together with mean days supplied per medication and proportion with >80% medication adherence

Medication	Number of diabetes cases	Mean days supply in 2007	Proportion of year for which medications dispensed (%)	Proportion of diabetes cases with >80% adherence
Atorvastatin	4412	289	79%	62%
Bendrofluazide	6080	266	73%	55%
Candesartan	4107	308	84%	71%
Captopril	468	277	76%	59%
Carvedilol	605	251	69%	52%
Cilazapril	19069	263	72%	51%
Cilazapril with hydrochlorothiazide	6766	286	78%	60%
Enalapril	1683	289	79%	64%
Glibenclamide	1164	258	71%	48%
Gliclazide	12403	270	74%	54%
Glipizide	8133	274	75%	56%
Lisinopril	360	286	78%	61%
Losartan	965	299	82%	67%
Metformin hydrochloride	38150	274	75%	54%
Metoprolol succinate	15294	301	83%	69%
Nifedipine	373	265	73%	55%
Pioglitazone	1575	199	55%	29%
Quinapril	12668	278	76%	59%
Quinapril with hydrochlorothiazide	2670	282	77%	60%
Simvastatin	40507	288	79%	61%
Verapamil hydrochloride	421	302	83%	70%

Hospital service utilisation

For the calendar year 2007, 11,800 medical and surgical hospital discharges were recorded in NMDS for CMDHB amongst diabetes cases (1,100 principal diagnosis discharges, 5,900 secondary and 4,800 with documentation of diabetes), while 57,700 hospital discharges were recorded for the remainder of the reconstructed population. Sixteen point nine percent of the total hospital discharges in CMDHB for 2007 were for people identified as diabetes cases using the decision rules. Across the remaining three DHB's in the northern region, diabetes cases accounted for 14.5% of hospital admissions in 2007.

Diabetes discharges were spread across a range of different hospital services, although the greatest number (42.3%) were in inpatient adult medical services. Within the northern region (ex. CMDHB), 49.3% of hospital discharges for diabetes cases were for inpatient adult medical services.

Across the whole northern region for public and private hospitals (including CMDHB), diabetes cases were found to stay in hospital more than 50% longer on average than hospital patients who did not have diabetes. The average length of

hospital stay (LOS) in the northern region for diabetes cases was 3.6 days, whereas for hospital patients without diabetes, the average hospital LOS was 2.4 days. These average LOS estimates for the northern region were consistent with those found in CMDHB for diabetes and non-diabetes cases (3.6 and 2.4 days).

Hospital admissions

Hospital discharge rates

Public and private hospital discharges in NMDS for the calendar year 2007 were aggregated and then examined by diabetes status and DHB. Hospital discharges of all types were more than twice as frequent in diabetes cases as in the total CMDHB reconstructed population. In CMDHB, the crude annual hospital discharge rate for diabetes cases was 436 discharges per 1,000 people, whereas for the total reconstructed CMDHB population the 2007 hospital discharge rate was 195 per 1,000 people. In the northern region (ex. CMDHB), the crude 2007 hospital discharge rate for diabetes cases was 460 per 1,000, whereas for the total reconstructed (ex. CMDHB) northern population it was 168 per 1,000 (Table 16).

When 2007 hospital discharge rates were standardised by age and sex, the discharge rate in the group of diabetes cases increased to more than 2.5 times that of the total reconstructed CMDHB population (Table 16). A similar situation was found in the northern region (ex. CMDHB), where the hospital discharge rate for diabetes cases was 2.4 times that of the total reconstructed northern population. Note also in Table 16 that age- and sex-standardised hospital discharge rates were higher (narrowly) for both the total reconstructed CMDHB population and the CMDHB diabetes population than for the corresponding northern region populations.

Table 16: Crude and age- and sex-standardised hospital discharge rates for CMDHB and northern region (ex. CMDHB) for 2007

	Crude rate per 1,000 people	Age-, sex-standardised rate per 1,000 people
CMDHB reconstructed population	163	195
Northern region (ex. CMDHB) reconstructed	168	188
CMMDHB diabetes cases	436	501
Northern region (ex. CMDHB) diabetes cases	460	446

Crude and age-standardised hospital discharge rates for the population of diabetes cases in CMDHB, by ethnicity are presented in Table 17. Maaori diabetes cases had particularly high hospital discharge rates (both crude and age-standardised) in comparison to the other three ethnic groupings.

Table 17: Crude and age-standardised hospital discharge rates by ethnicity for diabetes cases in CMDHB, 2007

	Crude rate per 1,000 people	Age-standardised rate per 1,000 people
Maaori	626	722
Pacific	462	517
Asian	299	565
Other	407	421

Proportion of diabetes cases admitted to hospital

Further perspective on hospital admissions can be gained by looking at the proportions of diabetes cases and of those without diabetes who had medical or surgical admissions in 2007. Almost one quarter (23.4%) of diabetes cases in the CMDHB reconstructed population had at least one medical or surgical hospital admission in 2007, compared with only 10.7% of people without diabetes. When these figures were standardised by age and sex, 28.8% of diabetes cases in CMDHB were found to have had at least one admission in 2007, compared with 11.2% of those without diabetes.

Table 18 describes the proportion of diabetes cases in CMDHB who had hospital admissions in 2007, by ethnicity. Considerably more Maaori diabetes cases had one or more admissions to hospital in 2007 than diabetes cases of other ethnicities.

Table 18: Proportion of diabetes cases in CMDHB who had medical/surgical hospital admissions in 2007, by ethnicity

	Crude proportion of cases admitted ≥ 1 times in 2007 (%)	Age-standardised proportion admitted ≥ 1 times in 2007 (%)
Maaori	31.3%	37.3%
Pacific	24.5%	25.2%
Asian	18.2%	20.7%
Other	21.9%	27.2%

Procedures

As with hospital discharge rates, major surgical procedures for the calendar year 2007 in NMDS were aggregated and then examined by diabetes status and DHB.

Procedural DRG's (diagnosis-related groups) were used to identify whether an individual had a significant surgical procedure or not. The unadjusted frequency of major surgical procedures in CMDHB diabetes cases in 2007 was about 2.5 times that of the total CMDHB reconstructed population (Table 19). The CMDHB crude major procedure rate for diabetes cases in 2007 was 111 procedures per 1,000 people, whereas the procedure rate was 44 per 1,000 for the total CMDHB reconstructed population. This difference diminished substantially once procedure rates were standardised for age and sex.

Table 19: Crude and age- and sex-standardised major surgical procedure rates for CMDHB and northern region (ex. CMDHB) for 2007

	Crude rate per 1,000 people	Age-, sex-standardised rate per 1,000 people
CMDHB reconstructed population	44	56
Northern region (ex. CMDHB) reconstructed	43	50
CMDHB diabetes cases	111	86
Northern region (ex. CMDHB) diabetes cases	112	83

When major surgical procedures within the population of diabetes cases of CMDHB were analysed, it was apparent that (as was the case with hospital discharges) Maaori diabetes cases had noticeably higher crude and age-standardised major surgical procedure rates than diabetes cases of other ethnicities (Table 20).

Table 20: Crude and age-standardised major surgical procedure rates by ethnicity for diabetes cases in CMDHB, 2007

	Crude rate per 1,000 people	Age-standardised rate per 1,000 people
Maaori	146	113
Pacific	99	84
Asian	74	59
Other	120	85

Ischaemic heart disease

There were 639 NMDS hospital discharges in CMDHB with principal diagnoses of IHD (ischaemic heart disease, ICD-10-AM codes I20 to I25) in diabetes cases in the calendar year 2007. This corresponded to a crude hospital discharge rate of 24 discharges per 1,000 diabetes cases. In comparison, there were 1,878 hospital discharges for IHD (principal diagnosis) in the total CMDHB population in 2007, corresponding to a crude hospital discharge rate of only 4 per 1,000 people. In the whole northern region (including CMDHB), the crude hospital discharge rate for diabetes cases was 31 per 1,000 and for the total population it was 6 per 1,000. Crude hospital discharge rates for IHD by ethnicity for CMDHB are presented in Table 21.

The age-standardised CMDHB hospital discharge rate for diabetes cases with principal diagnoses of IHD in 2007 was 12 per 1,000 people, while for the total CMDHB population it was 5 per 1,000. In the whole northern region (including CMDHB), the age-standardised rate in diabetes cases was 15 per 1,000 and for the entire northern population it was 6 per 1,000 people.

Table 21: Crude hospital discharge rates for ischaemic heart disease in CMDHB in 2007, by ethnicity

	Diabetes cases - rate per 1,000	Total population - rate per 1,000
Maaori	31	3
Pacific	22	3
Asian	19	4
Other	24	5

Cerebrovascular disease (stroke)

In CMDHB, there were 215 hospital discharges amongst diabetes cases with principal diagnosis codes for cerebrovascular disease (stroke), ICD-10-AM I60 to I69, in calendar year 2007, corresponding to a crude hospital discharge rate of 8 per 1,000 people. For the whole CMDHB population, the crude hospital discharge rate for cerebrovascular disease was one quarter that of diabetes cases, at 2 per 1,000 people. Across the entire northern region (including CMDHB) in 2007, the crude hospital discharge rate for cerebrovascular disease was 9 per 1,000 for diabetes cases and 2 per 1,000 for the total population. Crude hospital discharge rates by ethnicity for cerebrovascular disease are given in Table 22.

Table 22: Crude hospital discharge rates for cerebrovascular disease in CMDHB in 2007, by ethnicity

	Diabetes cases - rate per 1,000	Total population - rate per 1,000
Maaori	11	1
Pacific	8	2
Asian	6	1
Other	8	2

The age-standardised discharge rate for cerebrovascular disease in diabetes cases in CMDHB in 2007 was 4 per 1,000, compared with 2 per 1,000 for the total CMDHB population. These rates were consistent with those found in the total northern region (including CMDHB) in 2007, where the discharge rates were 4 and 2 per 1,000 for diabetes cases and the entire population respectively.

Diabetes in pregnancy

There were 16,800 births in CMDHB in 2006-2007. Diabetes in pregnancy complicates analysis of diabetes in the reconstructed population. A woman may have known pre-existing diabetes and become pregnant, pre-existing type II diabetes that is first diagnosed in pregnancy, or gestational diabetes (GDM) caused by changes in endocrine function during pregnancy⁴¹. Women with GDM are at greater risk of developing type II (and also type I) diabetes postpartum than the general population⁴²⁴³. Women with ICD-10-AM codes for diabetes diagnosed during pregnancy were excluded from the diabetes case group in this study, as resolution of normal glucose metabolism postpartum is likely in the majority of this group and their inclusion may therefore over-estimate prevalence. However, uncertainty around diagnostic categories at the time of clinical coding may result in misclassification of some women with diabetes in pregnancy. In particular, women with first diagnosis of type II diabetes in pregnancy may be missed from the diabetes case group using the existing decision rules. This section aims to quantify absolute numbers of women in CMDHB and the northern region with ICD-10-AM codes for diabetes in pregnancy in order to understand the potential magnitude of misclassification.

The ICD-10-AM codes O24.0 to O24.3 are used for pre-existing diabetes in pregnancy. There were 403 women in CMDHB who had hospital discharges in NMDS with principal or secondary codes for pre-existing diabetes between 1990 and 2007, who also had a health event recorded in the 2006-2007 study period. This group of women was included in the diabetes case group (1.5% of CMDHB diabetes case group). Of these women, 129 had discharge codes for pre-existing diabetes in 2006-2007. In the whole northern region, 1,075 women had discharges coded for pre-existing diabetes between 1990 and 2007, of which 344 were coded for this diagnosis in 2006-2007 (Table 23).

Table 23: Absolute numbers of women with diagnosis codes for pre-existing diabetes in pregnancy in northern region, by ethnicity in 2006-2007 reconstructed group

	Maaori	Pacific	Asian	Other	Total
NDHB	65	3	1	35	104
WDHB	34	73	43	136	286
ADHB	24	138	37	83	282
CMDHB	85	213	25	80	403
Total	208	427	106	334	1075

The ICD-10-AM codes O24.4 to O24.9 correspond to NMDS discharges for diabetes arising in pregnancy, which includes GDM and newly diagnosed type II diabetes. Women with these diagnosis codes were not included in the diabetes case group unless they also met the laboratory or pharmaceutical criteria for inclusion. Within the whole northern region, 1,267 women had discharge codes for diabetes arising in pregnancy in 2006-2007 (Table 24).

Table 24: Absolute numbers of women with diagnosis codes for new diabetes in pregnancy in northern region, by ethnicity in 2006-2007 reconstructed group

	Maaori	Pacific	Asian	Other	Total
NDHB	36	1	1	38	76
WDHB	30	46	102	143	321
ADHB	25	102	154	91	372
CMDHB	74	217	122	85	498
Total	165	366	379	357	1267

Of the 1,267 women in the northern region with diagnosis codes for new diabetes, 681 (53.7%) were included in the diabetes group anyway by way of the decision rules for laboratory and pharmaceutical claims (251 of these women in CMDHB).

Discussion

This retrospective, cross-sectional study used routinely collected administrative data from community laboratory and pharmaceutical subsidy claims, together with data on hospital discharges recorded in NMDS, to create a ‘reconstructed’ population for CMDHB and three other DHB’s in the northern region. Within this reconstructed population, individuals with diabetes were identified using a set of decision rules which were developed using a review of diabetes literature, consultation with experts and sensitivity analysis. This study found an age- and sex-standardised prevalence of diabetes in CMDHB of 7.1%, the highest prevalence of any DHB in the northern region.

Health inequities, often called health inequalities, are “differences in health that are unnecessary, unavoidable, unfair and unjust”⁴⁴. Ethnicity-based inequity in health, particularly between Maaori and non-Maaori, has been a consistent feature of the health landscape in New Zealand for many years⁴⁵⁻⁴⁷. Like previous studies of diabetes in CMDHB, this analysis identified inequity in the prevalence of diabetes between those of Maaori, Pacific and Asian ethnicities and those of Other ethnicity^{6,8}. Those of Maaori and Pacific ethnicities were found to have the highest prevalence of diabetes in CMDHB. Those of Asian ethnicity were also found to have considerably higher diabetes prevalence than those of Other ethnicity. The disparity in diabetes prevalence was greatest between Pacific females and females of Other ethnicity. Inequity in diabetes prevalence is consistent with differences in diabetes mortality rates. Between 2001 and 2005, the mortality rate for type 2 diabetes (as the underlying cause of death [ICD-10-AM code E11]) for Maaori aged 65 or more years was 520 per 100,000, for Pacific it was 440 per 100,000, while for Other it was 85 per 100,000 people⁴⁸. These disparities reinforce the need for culturally appropriate programmes such as Let’s Beat Diabetes, which aim to reduce inequity by giving priority to the most vulnerable groups.

Access to health care is defined as “...timely use of personal health services to achieve the best possible health outcomes”⁴⁹. Differential access to health care is noted to be an important driver of health inequity⁵⁰. Access is dependent on both utilisation of health services and achievement of health outcomes⁴⁹. Although outcome gaps are clearly evident for diabetes in CMDHB, this study found several positive signs that utilisation of community laboratory monitoring tests and pharmaceuticals may be similar between groups of different ethnicity. Utilisation of tests such as HbA1c, microalbumin and lipid studies was similar between Maaori, Pacific, Asian and Other diabetes cases, and was similar across the spectrum of deprivation (although some under-utilisation of monitoring tests by those of Asian ethnicity was noted in unadjusted analysis). Likewise, patterns of prescribing for medications used for secondary prevention in diabetes, such as statins and ACE inhibitors, were similar between the four groups (and across the spectrum of deprivation). Perhaps initiatives such as CCM, which aim to improve the access of people with chronic conditions to primary care, have had a role in improving utilisation of primary health care amongst disadvantaged groups in CMDHB.

Analysis of ethnicity using high-level categories such as ‘Pacific’ and ‘Asian’ is not without limitation and assumes that individual ethnicities aggregated within these groups have similar health characteristics. This is not necessarily the case, as was highlighted in a recent report on Asian health needs which found considerable

heterogeneity in health indicators between the different groups (such as Indian and Chinese ethnicities) which made up the broader Asian group²⁰.

Monitoring and medication for diabetes in CMDHB

There are a number of missing factors which make it difficult to judge the performance of the CMDHB community in monitoring and appropriately treating diabetes and preventing admissions to hospital. However, overall CMDHB seems to have led the other three northern DHB's in several areas during 2006-2007. A greater proportion of diabetes cases in CMDHB had regular claims for important monitoring tests such as HbA1c and urinary microalbumin. There are several possible explanations for the greater utilisation of these tests in CMDHB. Examples of possible explanations include greater awareness of diabetes (and of the guidelines for diabetes monitoring) amongst GP's in CMDHB, greater disease severity with corresponding requirements for more frequent monitoring in CMDHB and initiatives to improve access to primary care services, such as CCM. Almost 92% of 3,500 people who were enrolled in the diabetes module of CCM across the entire January 2006 to December 2007 period had at least two HbA1c tests performed in the two years, while just over 60% had four or more HbA1c tests (compared with 83% and 52% respectively for the entire CMDHB diabetes population⁵¹). If individuals in the CCM diabetes module were removed from analysis, 82% of remaining diabetes cases had two or more HbA1c tests in two years (the same proportion as the other three northern DHB's) and 51% had four or more tests (compared with 44% for the other DHB's). Although CCM probably did influence the frequency of claims for HbA1c amongst diabetes cases, CMDHB appeared to perform well in comparison to the other three DHB's even when CCM patients were excluded from analysis.

As is the case with laboratory claims, it is difficult to assess the appropriateness of prescribing patterns for diabetes in CMDHB using the available data in this study. However, it is heartening to see that CMDHB again leads the way in the prescription of medications, such as ACE inhibitors and statins, which are important for secondary prevention of diabetes complications. What then is the role of programmes such as CCM, in this instance? It is not possible to give a definitive answer. However, we do know that half way through the study period in January 2007, there were almost 7,000 people enrolled in the diabetes module of CCM, 78.5% of whom were prescribed statins⁵². If these individuals are removed from the group of CMDHB diabetes cases, almost 57% of the 20,000 or so remaining diabetes cases had regular pharmaceutical claims for statin medication. In the other three northern DHB's the proportion of total diabetes cases with regular pharmaceutical claims for statins ranged between 53% and 56%. It therefore seems probable that the CCM programme did influence the proportion of diabetes cases prescribed statins, however even without the influence of CCM, CMDHB performed well in this part of secondary prevention. Further work on medication adherence and prescribing patterns will help tease the performance of CMDHB in this area out further.

A key question is whether more intensive follow up of diabetes cases offered by community-focused programmes such as CCM reduced hospitalisation amongst diabetes cases in 2006-2007? It is not possible to answer this question using only the data in this study. CMDHB did have similar hospitalisation and major procedure rates to the other three DHB's in the northern region, yet the part played by factors such as severity of local disease and the role of initiatives like CCM is not clear.

Further longitudinal research that compares admission rates for those in CCM with other diabetes cases over time is required.

Comparison with Known Diabetes

Several attempts have been made to quantify the burden of diabetes in CMDHB. As mentioned in the introduction to this report, the Known Diabetes database has identified around 23,000 people with diabetes who have previously accessed hospital and specific primary care services in CMDHB ⁹. The age distribution, sex and ethnicity compositions of CMDHB diabetes cases from the reconstructed population were very similar to those of the Known Diabetes group (Figures 29 and 30).

Figure 29: Comparison of age structure of diabetes cases in reconstructed population with that of cases identified in Known Diabetes database

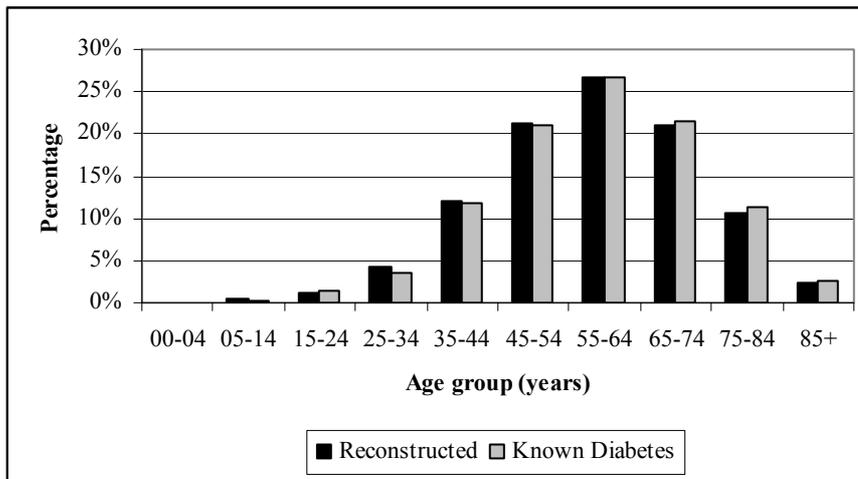
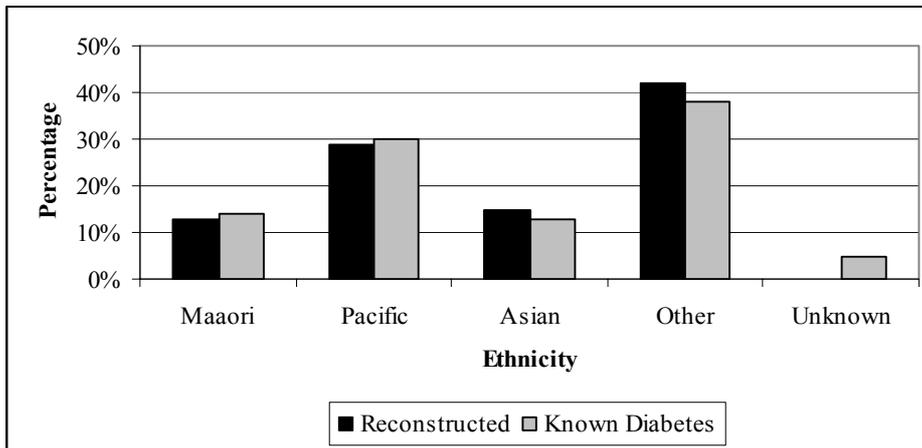


Figure 30: Comparison of ethnicity of diabetes cases in reconstructed population with that of cases in Known Diabetes group for CMDHB



The prevalence rates for diabetes within the reconstructed CMDHB population (by ethnicity) also appear generally consistent with those found in the Diabetes Heart and Health Study, the New Zealand Health Survey 2002/03, the LDB Benchmark Survey and with estimates of diabetes prevalence in CMDHB undertaken by the Ministry of Health ^{6 8 53 54}. The estimate of 26,400 adults aged ≥ 15 years with diabetes in CMDHB (a crude adult prevalence of 8.2%) found in 2006/07 NZHS is also close to 27,000 or so adults estimated to have diabetes in CMDHB during the same period in the reconstructed population used in this study ⁷.

Cost of diabetes care

This study found that diabetes cases in CMDHB (and the other DHB's in the northern region) had substantially higher costs for community laboratory and pharmaceutical claims than individuals without diabetes in the reconstructed population. The mean cost of laboratory claims for diabetes cases in CMDHB in 2007 was almost five times the cost of claims for people without diabetes. CMDHB had the greatest difference in mean laboratory claims between diabetes cases and those without diabetes of any of the northern DHB's. Even so, the difference was still around fourfold for all of the other three DHB's. In the case of community pharmaceutical claims, the cost for diabetes cases in CMDHB was more than seven times that of people without diabetes. Similar results were found for pharmaceutical claims in the other three DHB's. When crude mean costs for pharmaceutical and laboratory claims (ex. GST) were combined with the mean cost of hospitalisation for diabetes cases and those without diabetes in CMDHB in 2007 (using a hospitalisation cost estimate of 1 wies⁷ = \$3,740 for 2007/08), diabetes was noted to be responsible for an additional \$73 million to the DHB for the year (Table 25).

Table 25: Difference in cost of medical/surgical hospital discharges, community laboratory and pharmaceutical claims for those with and without diabetes in CMDHB in 2007

	Cost per person with diabetes (\$)	Cost per person w/o diabetes (\$)	Difference per person (\$)	Number with diabetes	Additional cost (\$ '000)
Laboratory claims	214	44	170	26961	4574
Pharmaceutical claims	1057	146	911	26961	24561
Inpatient discharges	2025	406	1619	26961	43650
Total	3296	596	2700	26961	72785

When the laboratory, pharmaceutical and hospital costs were standardised by age and sex, there was a slight reduction in the total additional cost for diabetes in CMDHB (Table 26). However, the additional cost remained considerable, at around \$66 million.

Table 26: Age- and sex-standardised cost of medical/surgical discharges, community and pharmaceutical claims for those with and without diabetes in CMDHB in 2007

	Cost per person with diabetes (\$)	Cost per person w/o diabetes (\$)	Difference per person (\$)	Number with diabetes	Additional cost (\$ '000)
Laboratory claims	160	51	108	26961	2914
Pharmaceutical claims	1229	181	1049	26961	28269
Inpatient discharges	1858	561	1297	26961	34977
Total	3247	793	2454	26961	66160

The estimated additional cost of diabetes in this analysis is likely to be an underestimate of the true cost of health care for diabetes in CMDHB. Several aspects of diabetes health care have not been included in the estimate, for example primary care visits and retinal screening.

⁷ Weighted Inlier Equivalent Separations, cost-weighting applied to hospital admissions

Strengths and weaknesses

The main strengths of this study lay in the currency of the data, the low cost (to CMDHB) of its collection, the extensive detail collected in the three contributing databases and the ability to link numerators with denominators from the same data set (Table 27).

Laboratory and pharmaceutical data came from claims processed by the HealthPAC General Transaction Processing System for reimbursement of community laboratories and retail pharmacies, meaning that the data became available only a few months after claims for late 2007 were processed. This meant that very timely estimates could be made of diabetes in the northern region. Additionally, CMDHB did not incur any direct financial cost in acquisition of the claims data. Costs were only incurred in time spent analysing and reporting on the data.

There was a substantial amount of data available for analysis in the final complete data set. The pharmaceutical data alone contained 42 separate variables. Furthermore, numerators and denominators in the analyses all came from the same reconstructed population. The advantage of consistency between numerators and denominators was that social and demographic variables in the data analyses were directly linked, thereby avoiding numerator-denominator bias in the analysis of ethnicity⁵⁵ (although ethnicity data in hospital records can still differ substantially from self-identified ethnicity⁵⁶).

The result was a set of timely, cheap and comprehensive data for the resident populations of CMDHB and the northern region. In this situation the data was used to explore diabetes in CMDHB; however it is also suitable for analysis of a wide range of different clinical conditions in various contexts.

In terms of limitations, the data used to create the reconstructed population for CMDHB and the rest of the northern region was of an administrative nature and was not designed for assessment of prevalence and other epidemiological analyses. This meant that decision rules were necessary to identify individuals with diabetes (and there was a degree of uncertainty around the criterion validity of such rules). For example, although current advice does not support the use of HbA1c as a screening test for diabetes^{3 21 57}, there is some discussion of its use as a screening tool in the literature^{58 59} and anecdotal evidence suggests it is being used for such purposes. Even though the final decision rule for HbA1c required claims for at least three such tests in two years, it is still likely that a (probably small) subset of patients may have been misclassified as having diabetes based on frequency of HbA1c testing when they had no diabetes diagnosis. Similarly, medications such as metformin may be used in people without diabetes^{60 61}, although sensitivity analysis and review of the literature indicated that for diabetes medications in the August 2006 Pharmaceutical Schedule such use would not have materially influenced the findings in this study. Furthermore, some individuals with pre-diabetes (impaired fasting glucose and impaired glucose tolerance) may have been misclassified as having diabetes using the decision rules. Any misclassification of these individuals into the diabetes group is not of great concern, as people with pre-diabetes are at increased risk of developing diabetes and share some of the risks experienced by those with diabetes, such as greater risk of cardiovascular disease than the general population⁶²⁻⁶⁶.

Table 27: Table of study strengths and weaknesses

Strengths	Weaknesses
<ul style="list-style-type: none"> • Current data (as recent as December 2007) was available, meaning that analyses could be conducted and results generated in a timely fashion • The large number of people in the final data set indicated fairly comprehensive coverage of the CMDHB and northern region populations in the reconstructed group • Availability of community laboratory and pharmaceutical data meant a community-level approach to analysis was possible for the first time • Creation of the data set from routinely collected administrative data meant that it was inexpensive and relatively easy to acquire for CMDHB • Analyses in the study are easily replicable in future using updated data • The large number of variables available for analysis meant that a reasonable understanding of laboratory monitoring, prescribing habits and hospital utilisation in CMDHB was possible • Availability of data from the other three northern DHB's meant that comparison of CMDHB with other populations was possible • Study findings are consistent with 2006 census population estimates and with findings of other studies of diabetes in CMDHB, i.e. estimates of reconstructed populations are broadly similar to census 2006 and estimates of diabetes prevalence triangulate approximately with other estimates from previous analyses • High rate of service utilisation implies that diabetes cases are highly likely to feature in data sets 	<ul style="list-style-type: none"> • Data was not collected for epidemiological purposes, creating the need for proxy means of detection of diabetes cases (decision rules) • Decision rules were not formally validated in a published study – rely on literature review of decision rule appropriateness, expert opinions and sensitivity analysis • ‘Churn’ created by people moving in and out of CMDHB meant some residential address data may have been obsolete, causing misclassification in both numerators and denominators • Not all scripts and lab requests had NHI numbers (meaning small number left out of reconstructed population) • Hospital lab tests and pharmaceuticals were not included in analysis • Those who did not access health services in 2006/2007 were excluded from denominator – resulting in possible prevalence over-estimation • Not all prescriptions or laboratory tests may have generated subsidy claims, e.g. prescriptions for medications not on Schedule • Some diabetes cases would have ‘fallen through the cracks’ – not detected using decision rules • Data was encrypted, so could not be linked to Known Diabetes database, CCM, or other ‘live NHI’ data • Likely to be different monitoring/prescribing patterns in CCM vs. other diabetes cases – has not been teased out in analysis • Unquantified overseas visitor/student prescription of diabetes medications and use of community laboratory tests

The collection of data for the reconstructed population was dependent on the recording of a hospital event or claim for a community pharmaceutical or a laboratory test during the 2006/2007 period, meaning some residents who did not experience

such health events during this period were left out of the analysis. This effect was evident in younger age groups in CMDHB (especially for males), when the reconstructed population was compared with census estimates. A further group of patients may have been excluded due to not having NHI numbers recorded on pharmaceutical or laboratory claims. It is difficult to estimate the size of this second group. It is known that last year (2007) around 94% of prescription claims in Pharmhouse and laboratory claims in Labs had NHI numbers recorded⁶⁷. It is therefore likely that this group of missing patients is quite small. The under-quantification of the denominator resulting from both of these factors would have resulted in over-estimation of the diabetes prevalence in CMDHB and the other three northern DHB's. However, the effect of this over-estimation was largely lost when prevalence was standardised by age and sex, as the bulk of diabetes cases occurred in those aged 35 years or more and this group had the best coverage in the total reconstructed population when compared with census data.

Recommendations for further analysis

1. Longitudinal comparison of CCM diabetes cases with non-CCM diabetes cases. The CCM programme gives patients with chronic conditions the opportunity for close support and follow up from their primary care provider⁶⁸. This programme began in 2001 and was fully operational by late 2003. There were 6,900 patients in the diabetes module in December 2006 and 7,470 in June 2007. Diabetes patients in CCM would have had closer disease monitoring in the community and this may have distorted the analyses of laboratory test monitoring and prescribing patterns. Further work needs to compare patterns of care in each group and hospital admission rates, through encryption of CCM NHI numbers and subsequent linkage to the reconstructed population for CMDHB
2. Domicile codes can be used to map diabetes cases in CMDHB geographically according to CAU, using a geographic information system (GIS). The findings of such analyses can then be used to inform service provision and to describe patterns of diabetes laboratory monitoring and prescribing patterns by locality
3. Further analysis of diabetes in those of Asian ethnicity is required in order to understand the prevalence of diabetes in groups that make up this ethnicity category and to describe patterns of laboratory testing, pharmaceutical prescribing and hospital utilisation in these groups
4. Further work on adherence/compliance to pharmaceuticals within CMDHB. This could be expanded to all medications on the pharmaceutical schedule which are prescribed long-term
5. Further research is needed to understand the expected frequency of laboratory test monitoring in relation to current guidelines and to establish the expected proportion of diabetes cases likely to benefit from particular medications such as ACE inhibitors and statins. This may enable the formulation of targets and indicators for the care of diabetes in the community

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