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Trends in the Prevalence and Incidence of Type 2 Diabetes and Its Complications and Care Process in Taiwan - A Population-Based Study of Taiwan National Health Insurance Research Database 2000-2007

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中文摘要

研究目的：探討台灣 2000 年至 2007 年間糖尿病及其併發症的盛行率、發生率的時間趨勢；及利用時間趨勢分析評估 1997 年至 2007 年間各項檢查的糖尿病病人的受檢率。

研究方法：利用健保資料庫之承保抽樣歸人檔定義糖尿病病人及糖尿病病人的急性、小血管及大血管併發症，以及檢查項目。並利用分層分析探討不同年齡、性別、納保金額和都市化程度下之盛行率及發生率；羅吉斯迴歸分析糖尿病及其併發症及受檢率之時間趨勢及其 95%信賴區間。受檢率則進一步利用線性迴歸分析比較加入「論質計酬改善方案」實施前後受檢率的時間趨勢是否有顯著不同。

結果：第二型糖尿病的粗盛行率由 2000 年的 6.22% 上升至 2007 年的 11.03%，其每兩年盛行率的調整勝算上升 14.6%[OR：1.146; 95% CI 1.142-1.149]。粗發生率則由 2000 年的 9.46 每千人年上升至 2005 的 10.96 每千人年，無顯著的時間趨勢。併發症其盛行每兩年間的調整勝算比除了腎衰竭減少了 2%以外，其餘均呈上升的趨勢：高血糖上升了 30%，酮酸中毒上升 15%，截肢上升 24%，視網膜病上升 20%，腎臟病上升 6.6%，神經病上升 6%，心肌梗塞上升 52%，中風上升 24%，慢性心臟病上升 20 % 及周邊動脈疾病上升 69%。實施「論質計酬改善方案」之後，第二型糖尿病病人的受檢率在蛋白尿肌酐酸比值、糖化血色素值、空腹血脂、血清麩胺酸丙酮酸轉胺基胺及微量白蛋白在 2003- 2007 間有顯著的上升趨勢。

結論： 2000 年到 2007 年，台灣的第二型糖尿病盛行率持續上升，其發生率則於 2000 年些微上升至 2005 年，而往後則上下波動直到 2007 年。糖尿病併發症的盛行率亦呈上升的趨勢，而發生率則呈反向趨勢。糖尿病「論質計酬改善方案」是為了提高糖尿病照護品質的

給付政策，本研究亦發現在實施「論質計酬改善方案」之後，糖尿病病人的受檢率有上升的趨勢。

關鍵字：第二型糖尿病、併發症、照護品質、盛行率、發生率

Abstract

Aim

The purpose of the this study is to determine the trends of prevalence and incidence of type 2 diabetes and its complications in Taiwan between 2000 and 2007, and to evaluate the trends of prevalence of laboratory tests of type 2 diabetes between 1997 and 2007.

Methods

Retrospective population-based study of 1,000,000 residents from Taiwan National Health Insurance Research Database (NHIRD) was used to identify patients with type 2 diabetes, those with diabetic complications and those with laboratory tests. Prevalence and incidence of type 2 diabetes were estimated according to various groups of age, gender, insurance premium and urbanization degree. Prevalence and incidence of complications in patients with type 2 diabetes were determined. Logistic regression model was used to estimate odds ratio and its 95% confidence interval (CI). Linear regression model was used to analyze whether the trends of prevalence of laboratory tests before (1997-2002) and after pay-for-performance (P4P) program (2003-2007) were different.

Results

The crude prevalence of type 2 diabetes increased from 6.22% to 11.03% between 2000 and 2007. In the population of age >=30 years, the multivariate-adjusted per 2 years increase in odds was 14.6% [OR: 1.146; 95% CI 1.142-1.149]. The crude incidence increased from 9.46 per 1000 in 2000 to 10.96 per 1000 in 2005 and then fluctuated until

2007. Prevalence rate of renal failure in type 2 diabetic patients was declining, with a 2% decrease in odds in 2007. Prevalence odds of hypoglycemia, ketoacidosis, diabetes retinopathy, renal disease, neuropathy, amputation, MI, stroke, CHD and peripheral artery disease in type 2 diabetic patients increased, with 30%, 15%, 24%, 20%, 6.6%, 6% , 52%, 24%, 20% and 69% increase in odds for every 2-year period in 2007, respectively. After implementation of P4P, the prevalence of laboratory tests of type 2 diabetes in 2003 - 2007 increased significantly in ACR, HbA1C, fasting lipid profile, SGPT and microalbumin.

Conclusions

The prevalence of type 2 diabetes increased in Taiwan between 2000 and 2007. The incidence increased slightly in 2000-2005 and then fluctuated until 2007. The prevalence rates of diabetes-related complications continued to increase, but the incidence rates of most complications were decreasing.

The P4P program for diabetes care in Taiwan was designed to increase the quality of care. The prevalence rates of laboratory tests for the period of after implementation of the P4P program were rising faster than those for the period of before implementation of the P4P program.

Key words: type 2 diabetes, complications, quality of care, prevalence, incidence

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Chapter 1

Introduction

1.1 Background

World Health Organization (WHO) estimates that more than 220 million people worldwide have diabetes. This number is likely to more than double by 2030 without intervention (WHO, 2010). The prevalence of diabetes all over the world was increasing from 1995 to 2025 (King, et al., 1998), and the prevalence and incidence rates of diabetes increased in different age, gender and race groups (Riste, et al., 2001). The global prevalence of diabetes was 2.8% in 2000, projecting an increase to 4.8% in 2030. Total number of people with diabetes is projected to rise from 171 million in 2000 to 366 million in 2030 (Wild, et al., 2004). In a similar study, it indicated the world prevalence of diabetes among adults (aged 20–79 years) is 6.4% in 2010 and will increase to 7.7% by 2030 (Shaw, et al., 2010).

Diabetes causes a heavy health-care burden worldwide and presents major challenges to patients and health-care systems (Ambady Ramachandran, 2010). Estimate of the global cost of diabetes accounts for 2-3% of the total health care budget in every country (Jonsson, 1998); An American study reported the total estimated cost of diabetes in 2007 was $174 billion, and the budget attributable to treatment in complications of diabetes accounts for 11% ("Economic costs of diabetes in the U.S. in 2007," 2008).

Type 2 diabetes and its complications are leading causes of morbidity and premature mortality, imposing a heavy burden at the individual and societal level (Jonsson, 2002; Lipscombe, et al., 2007;

Wild, et al., 2004). The excess global mortality attributable to diabetes in the year 2000 was estimated to be 2.9 million deaths, equivalent to 5.2% of all deaths (Roglic, et al., 2005). The trend in mortality from diabetes is increasing in Taiwan (Tseng, et al., 2000). Based upon the data of leading causes of death in Taiwan during 1987-2009 from the Department of Health, Executive Yuan, R.O.C, it showed diabetes as a cause of death ranked as the 5th during 1987-2001, the 4th during 2002-2007, the 5th since 2008 (DOH, 2010).

As lifestyle behaviors westernized, prevalence of type 2 diabetes has rapidly increased in Asian populations (WHO, 2004). Diabetes develops at a younger age in Asian populations than in western countries, and the morbidity and mortality associated with diabetes and its complications are also common in young Asian people (Ambady Ramachandran, 2010; Koopman, et al., 2005). In developing countries, the majority of people with diabetes are in the age range of 45–64 years. In the developed countries, the majority of people with diabetes aged 65 years and over (King, et al., 1998).

In the Chinese population, type 2 diabetes has also become an important public health challenge, especially living in Taiwan, mainland China, Hong Kong, and Singapore, which accounts for at least one-fifth of the global population (Chang, et al., 2000; Gu, et al., 2003; Janus, et al., 2000; Wong, et al., 2006).

With the westernization of diet behaviors, the prevalence and incidence of type 2 diabetes increased dramatically in Taiwan. In Taiwan, the studies estimated the prevalence of diabetes were limited. According to a systematic review study, it showed the prevalent rates of diabetes in Taiwan established between 1985 and 1996 were between 4.9 and 9.2% (Chang, et al., 2000). The prevalence of

diabetes increased with age and varied by gender, race, and ethnicity. The findings of Nutrition and Health Survey in Taiwan (NAHSIT) showed that the prevalence rates of type 2 diabetes estimated in the population aged 19-44, 45-64, >=65years were 0.6%, 11.4%, 22% in female and 1.1 %, 7 %, 7.2 % in male during 1993-1996, respectively (Chang, et al., 2002). And the findings of the second wave of NAHSIT showed the prevalence rates of type 2 diabetes in the corresponding age groups were less than 5%, more than 10%, 24.5% in female and less than 5%, more than 15%, 28.2% in male between 2005 and 2008, respectively.

Regarding the incidence of type 2 diabetes in Taiwan, the overall 5-year incidences for men and women were 187.1 and 218.4 per 100,000 persons from 1992–1996, respectively (Tseng, et al., 2006). However, these estimates were based on relatively small population studies with limited nationwide representativeness or these estimates reflected the condition at least 10 years from now. Although a recent study evaluated annual prevalence and incidence of type 2 diabetes during 1999-2004, more recent data needed to be updated.

Type 2 diabetes causes serious problems such as acute complications (including hypoglycemia and ketoacidosis), microvascular disease (including renal disease, retinopathy and neuropathy), and macrovascular disease (including amputation, myocardial infarction, stroke, and peripheral artery disease) (Braun, et al., 2009; Potluri, et al., 2009; Shera, et al., 2004). These complications and diabetes itself have already created significant burden to the health care system. To improve the quality of diabetes care, the pay-for-performance (P4P) program had been implemented by the DOH, Taiwan in November 2002. This resulted in increased

intensive monitoring and aggressive management of diabetes, which may have impact on diabetic complications. Studies investigating the prevalence and incidence rates of complications of type 2 diabetes were scarce. Most studies in Taiwan regarding complications of diabetes only focused on one or two complications of diabetes but not all of them. In addition, time trend analysis was not carried out to describe the prevalence and incidence of complications in patients with type 2 diabetes. This study conducts time trend analyses regarding the prevalence and incidence of all complications in type 2 diabetes during 2000-2007 in Taiwan based on Taiwan National Health Insurance Research Database (NHIRD).

1.2 Study purposes

Using a random sample of nationwide dataset, the major goal of the present study is to describe the annual probability that general population have type 2 diabetes, annual probability that individuals without type 2 diabetes will develop type 2 diabetes, and annual prevalence of process and outcome measures for diabetes care in the Taiwan during 2000 to 2007. The specific objectives of this study are as follows:

1. To estimate annual prevalence and incidence rates of type 2 diabetes, and to describe their secular trends in different gender, age, insurance and urbanization degree during 2000-2007.
2. To estimate annual prevalence and incidence rates of complications in type 2 diabetes during 2000-2007.
3. To measure annual prevalence rates in laboratory tests, to describe their secular trends according to groups of different gender, age, insurance and urbanization degree during 1997-2007, and to examine the effect of Pay-for-performance (P4P) program on these secular trends.

Chapter 2

Literature Review

1.1 Definition of Diabetes

WHO describes diabetes as “a chronic disease that occurs when the body cannot effectively use the insulin it produces, or when the pancreas does not produce enough insulin.” Hyperglycaemia or raised blood sugar is a common effect of uncontrolled diabetes. Over time it leads to serious damage to many of the body's systems, especially the nerves and blood vessels (WHO, 2010).

There are three types of diabetes, and they are as follows:

1. Type 1 diabetes (insulin-dependent, IDDM; or juvenile diabetes):

   Type 1 diabetes is a polygenic disease, and it is usually diagnosed in children and young adults. In type 1 diabetes, the body does not produce insulin. The subsequent lack of insulin leads to increased blood and urine glucose. The classical symptoms consist of polyuria (frequent urination), polydipsia (increased thirst), polyphagia (increased hunger), and weight loss result. Only 5-10% of people with diabetes have this form of the disease.

2. Type 2 diabetes (non-insulin-dependent diabetes mellitus, NIDDM; or adult-onset diabetes):

   In type 2 diabetes, either the body does not produce enough insulin or the cells ignore the insulin. It comprises 90% of people with diabetes around the world, and it is more common in the world, as well as the aged population. Symptoms may be similar to those of type 1 diabetes, but are often less marked.

3. Gestational diabetes:

   Gestational diabetes is a condition in which women without previously diagnosed diabetes exhibit high blood glucose levels during pregnancy. The cause is unknown, but it is thought that some hormones from the placenta increase insulin resistance in the mother, causing elevated blood glucose levels. Gestational diabetes is most often diagnosed through prenatal screening, rather than symptoms.

This study focuses on the type 2 diabetes. Thus, 4 criteria of diagnosing type 2 diabetes proposed by four associations were introduced (Table 1). First, American Diabetes Association (ADA) recommended 4 tests for diagnosing diabetes (ADA, 2010): (1) diabetes symptoms: polyuria, polydipsia, polyphagia, increased fatigue, weight loss, blurred vision and casual plasma glucose ≥200 mg/dl (or 11.1 mmol/l), casual is defined as any time of day without regard to time since last meal or (2) fasting plasma glucose (FPG) >126 mg/dl (or 7.0 mmol/l) or (3) plasma glucose ≥200 mg/dl (or 11.1 mmol/l) during an oral glucose tolerance test (OGTT). If any of these test results occur, testing should be repeated on a different day to confirm the diagnosis. Second, WHO recommended for 2 tests diagnosing diabetes (WHO, 2006): (1) FPG ≥7.0mmol/l (or 126mg/dl) or (2) 2-h plasma glucose ≥ 11.1mmol/l (or 200 mg/dl), one of the above should exit. Third, National diabetes education program (NDEP) recommended 2 tests for diagnosing diabetes (NDEP, 2010): (1) A1C ≥ 6.5% or (2) FPG > 126 mg/dl or (3) 2-hr plasma glucose > 200 mg/dl post 75g oral glucose challenge or (4) random plasma glucose > 200 mg/dl and the symptoms of type 2 diabetes include polyuria, polydypsia and unexplained weight loss. For criteria of (1) to (3),

repeat test to confirm unless symptoms are present. It is preferable that the same test be repeated for confirmation. If two different tests are used and both indicate diabetes, consider the diagnosis confirmed. If the two different tests are discordant, repeat the test above the diagnostic cut-point. Last, International Diabetes Federation (IDF) recommended two tests for diagnosing diabetes: (1) FPG>7.0 mmol/l (or >126 mg/dl) or (2) 2–h plasma glucose >11.1 mmol/l (or >200 mg/dl), one of the above should exist.

Table 1 Criteria for Diagnosis of Type 2 Diabetes by American Diabetes Association, World Health Organization, National Diabetes Education Program and International Diabetes Federation

	American Diabetes Association	World Health Organization	National Diabetes Education Program	International Diabetes Federation
Glycated hemoglobin (HbA1C)			≥6.5%	
Fasting plasma glucose (FPG)	≧126mg/dl (7.0 mmol/l)	≧126mg/dl (7.0 mmol/l)	> 126mg/dl (7.0 mmol/l)	> 126mg/dl (7.0 mmol/l)
Oral glucose tolerance test (OGTT)	≥ 200 mg/dl (11.1 mmol/l)		> 200 mg/dl (11.1mmol/l)	
Casual plasma glucose	≥ 200 mg/dl (11.1 mmol/l)		> 200 mg/dl (11.1 mmol/l)	
2-h plasma glucose		≥ 200 mg/dl (11.1 mmol/l)		> 200 mg/dl (11.1 mmol/l)

2.2 Prevalence and incidence of diabetes in Taiwan

After thorough reviewing literature, a total of 14 articles estimating prevalence or incidence of type 2 diabetes in Taiwan had been reported (Table 2). Among them, a total of 10 studies, including a meta-analysis, reported prevalence rates whereas a total of 4 studies estimated incidence rates.

These prevalence estimates had been conducted in populations of Pu-Li during 1987-1988 (Chou, et al., 1992; Chou, et al., 1997), Hualien County during 1994-1995 (Chen, et al., 1997), Ann-Lo during 1988-1990 (Lin, et al., 1993), Kinmen during 1991-1994 (Chou, et al., 1994), Tainan in 1996 (Lu, et al., 1998) and Shonsun during 1996-1997 (Chen, et al., 2001). These studies had been conducted in various age groups, such as participants aged 20 years and over (Lu, et al., 1998), 30 years and over (Chou, et al., 1992; Chou, et al., 1997; Chou, et al., 1994), 40 old and over (Chen, et al., 1997; Lin, et al., 1993) and 50-79 years (K. T. Chen, et al., 2001). All of them were community-based studies with either random sampling or recruiting all eligible residents. The diabetes measurement used fasting glucose tolerance test (Chen, et al., 2001; Wang, et al., 1997), 2-hr postprandial blood sugar (Lin, et al., 1993), 75-g oral glucose tolerance test (Chou, et al., 1994; Lu, et al., 1998; Tseng, et al., 2000), WHO criteria (Chen, et al., 1997; Chou, et al., 1992; Chou, et al., 1997), ADA criteria (Chen, et al., 1999) and ICD-9-CM in outpatient and inpatient claim data (Chang, et al., 2010).

The prevalence of diabetes was different according to age, gender and races. These studies conducted before 1990 reported crude prevalence rates ranged from 2.6% to 6.9% (Chou, et al., 1992; Lin, et al., 1993) and those after 1990 ranging from 5.6% to 11.0% (Chang, et al.,

2010; Chou, et al., 1997; Chou, et al., 1994; Lu, et al., 1998; Tseng, et al., 2006; Wang, et al., 1997). In studies comparing prevalence rates of various race groups, one reported age-adjusted prevalence during 1994-1995 for Han Chinese was 9.8% in men and 12.3% in women; for aboriginal groups was 11.5% in men and 8.5% in women (Chen, et al., 1997); the other reported the age-standardized prevalence during 1996-1997 for Hakaas was 17.9% in men and 15.5% in women; for Fukienese was 14.5% in men and 12.8% in women; for aborigines was 10.0% in men and 13.3% in women (Chen, et al., 2001).

For incidence estimates, they had been determined in Chu- Dung and Pu-Tzu townships during 1993-1996 (Wang, et al., 1997), in Pu-Tai (Tseng, et al., 2000), in the entire Taiwan during 1992-1996 (Tseng, et al., 2006) and during 1999-2004 (Chang, 2010). All of these studies were community-based (Chang, et al.,2010; Tseng, et al., 2000; Tseng, et al., 2006; Wang, et al., 1997). The source of participants were 35-74 years (Wang, et al., 1997), ≧35 years (Tseng, et al., 2006). The diabetes status had been determined by FPG and self-report diabetic medication (Wang, et al., 1997), OGTT (Tseng, et al., 2000), self-report or ICD-9-CM in outpatient and inpatient claim data (Chang, et al., 2010).

Two of these studies reported cumulative incidence and two reported incidence density. Two studies reporting cumulative incidence had been conducted in the same time period but they had different estimates. One reported a cumulative incidence of 9.8 per 1000 persons per year in men and 9.0 per 1000 persons per year in women during 1993-1996 (Wang, et al., 1997). The other reported a cumulative incidence of 1.871 per 1000 persons per year in men and 2.184 per 1000 persons per year in women (Tseng, et al., 2006). The other two studies reporting incidence density were different in their sample size. The one with small sample size

reported an overall incidence density rate of 27.4 per 1000 person-years (Tseng, et al., 2000), whereas the one with large sample size reported the age-standardized incidence density rate of approximately 7.6 per 1000 person-years in men and 7.7 to 6.9 per 1000 person-years in women during 1999-2004 (Chang, et al., 2010).

Table 2 Previous studies estimated prevalence and/or incidence of type 2 diabetes in Taiwan, 1993-2010

Authors	Objectives	Study design	DM measurement	Source of participants Sample size	Findings
Prevalence of type 2 diabetes					
Chou, P.et al., 1992	To determine the prevalence and possible risk factors associated with diabetes in Pu-Li from 1987-1988	Cross-sectional study	WHO criteria	Residents aged 30 yrs and over in Pu-Li selected by stratified cluster sampling: 1152 registered residents	The age-adjusted prevalence: 6.9% for previous diabetes 4.4% for new diabetes
Chou, P.et al., 1997	To determine the prevalence and possible risk factors associated with diabetes in Pu-Li from 1987-1988 and 1991-1992	Cross-sectional study	WHO criteria	Residents greater than or equal to 30 yr of age in Pu-Li selected by stratified cluster sampling 1987-1988: 1152 registered residents 1991-1992:2719 registered residents	Crude prevalence rates: 6.7% during 1987-1988 5.6% during 1991-1992 Age-adjusted prevalence: 6.9% during 1987-1988 4.0% during 1991-1992
Cheng et al., 1997	To determine the prevalence of diabetes in three different ethnic groups in Hualien County in the eastern Taiwan during 1994-1995	Cross-sectional study	WHO criteria	Six rural village inhabitants aged 40 years and over of Han Chinese, aboriginal Ami and aboriginal Atayal selected by random sampling: 1013 adults (460 men and 553 women)	Age-adjusted prevalence Han Chinese : 11.0% (9.8% in men and 12.3% in women) Amis: 9.1% (12.1% in men and 7.4% in women) Atayal: 10.8% (11.5% in men and 9.4% in women)
Chen et al., 1999	To estimate the prevalence of type 2 diabetes and IFG in Penghu, Taiwan	Cross-sectional study	ADA criteria	Residents 40-70 years of age in Penghu Islands, Taiwan- 2500 residents	Age-adjusted prevalence by world adult population : 16.8% (95% CI 15.0–18.6)
Chang, et al., 2000	To investigate the prevalence of diabetes and complications in Taiwan from1985 to 1996	Meta-analysis		Paper review	
Lin, et al., 1993	To investigate the prevalence of diabetes in the Ann-Lo district (northern Taiwan) from July 1988 to June 1990	Cross-sectional study	2-hr postprandial blood sugar	Residents ≧40 years of age in Ann-Lo district, a suburban area of Northern Taiwan: 9087 subjects	Overall prevalence: 2.6%; Residents aged 40 years and older: 8.0%
Chou, et al., 1994	To investigate the prevalence of type 2 diabetes in Kin-Hu, Kinmen in 1991-1994	Cross-sectional study	75-g oral glucose tolerance test	Residents ≧30 years of age in Kin-Hu, Kinmen: 7415 eligible residents	Crude prevalence rate : 6.5% Age-adjusted prevalence: 4.9%

IFG: impaired fasting glucose;

Table 2 Previous studies estimated prevalence and/or incidence of type 2 diabetes in Taiwan, 1993-2010 (Continued)

Authors	Objectives	Study design	DM measurement	Source of participants Sample size	Findings
Lu, et al., 1998	To investigate the prevalence of diabetes in southern Taiwan in 1996	Cross-sectional study	75-g oral glucose tolerance test	Residents aged ≧20 years in Tainan city selected by stratified systematic cluster sampling: 1638 subjects (780 men and 858 women)	Crude prevalence :9.0% (10.3% men and 7.9% women) Age-adjusted prevalence: 9.2% 10.4% men and 8.1% women).
Chen, et al., 2001	To compare the prevalence of diabetes in three racial groups in Taiwan from1996 to 1997	Cross-sectional study	Fasting plasma glucose	Residents aged 50-79 years in three townships of Shonsun, Kuanhsi and Fushin selected by random sampling: 1293 persons (468 Hakaas, 440 Fukienese, and 385 Aborigines)	Age-adjusted prevalence Hakaas: 17.9% in men and 15.5% in women Fukienese: 14.5% in men and 12.8% in women Aborigines: 10.0% in men and 13.3% in women
Chang, et al., 2010	To evaluate annual prevalence and incidence of type 2 diabetes and to examine possible trends among adults in Taiwan from1999 to 2004	Retrospective nationwide longitudinal study	ICD-9-CM diagnostic codes	Insurers aged ≧20 years from Taiwan NHIRD: 15,270,726-16,709,375 insurers from 1999 to 2004	The age-standardized prevalence Men: 4.7%-6.5% Women: 5.3%-6.6%
Incidence of type 2 diabetes					
Wang, et al., 1997	To determine type 2 diabetes incidence in Taiwan; The first survey: 1990-1993, The second survey: 1993-1996	Cohort Study	First survey : FPG; Second survey: diabetic medication	Residents aged 35-74 years free from diabetes of two townships selected by random sampling (Chu-Dung and Pu-Tzu): 2190 subjects (995 men and 1195 women)	Crude incidence rates: Men: 9.8 per 1000 per year Women: 9.0 per 1000 per year
Tseng, et al., 2000	To investigate the incidence of type 2 DM in Taiwan	Cohort Study	Oral glucose tolerance test	Non-diabetic residents in Pu-Tai for a period of up to four years: 446 residents	Incidence density rate: 27.4 per 1000 person years
Tseng, et al., 2006	To assess the yearly incidence of type 2 diabetes in Taiwan from1992 to 1996	Cohort study	Telephone interviews of 93,484 diagnosed diabetic patients	Patients aged ≧35 years selected from Taiwan NHIRD, Population from household registration system	Incidences Men: 87.1 per 100,000 persons Women: 218.4 per 100,000 persons
Chang, et al., 2010	To evaluate annual prevalence and incidence of type 2 diabetes and to examine possible trends among adults in Taiwan from1999 to 2004	Retrospective nationwide longitudinal study	ICD-9-CM diagnostic codes	Insurers aged ≧20 years from Taiwan NHIRD: 15,270,726-16,709,375 insurers	Age-standardized incidence rates Men: 7.6 per 1000 person-years and then remain stable Women: 7.7 to 6.9 per 1000 person-years

NHIRD: National Health Insurance Research Database; FPG: fasting plasma glucose;

2.3 Prevalence and incidence of complications in patients with type 2 diabetes

Type 2 diabetes is an important cause of complications (Lusignan, et al., 2005), the consequences of which include blindness, kidney damage, and foot ulcers that can result in amputation (IDF, 2010). Diabetic retinopathy is an important cause of blindness (Haik, et al., 1989), and it occurs as a result of long-term accumulated damage to the small blood vessels in the retina. After 15 years of diabetes, approximately 2% of people become blind, and about 10% develop severe visual impairment. Diabetes is among the leading causes of kidney failure and 10-20% of people with diabetes die of kidney failure. Diabetic neuropathy is damage to the nerves as a result of diabetes, and affects up to 50% of people with diabetes. Many different problems can occur as a result of diabetic neuropathy. Its common symptoms are tingling, pain, numbness, or weakness in the feet and hands. The overall risk of dying among people with diabetes is at least double the risk of their peers without diabetes (WHO, 2010). Diabetes increases the risk of heart disease and stroke, and 50% of people with diabetes die of cardiovascular disease, primarily heart disease and stroke.

The studies investigating the prevalence and incidence of complications in type 2 diabetes can be divided into acute complications, microvascular diseases and macrovascular diseases (Fasanmade, et al., 2008; Kar, et al., 2008; Rosolova, et al., 2008). In Taiwan, the studies invested the prevalence and incidence of complications in type 2 diabetes (Table3). There were five and five articles, reporting prevalence and/or incidence of amicrovascular diseases, and macrovascular diseases, respectively.

Ketoacidosis is an acute complication of diabetes. A retrospective cohort study analyzed the occurrence of diabetic ketoacidosis in Chinese adults from 1992 to 1997 and it showed 54.6% of type 2 diabetes had events of ketoacidosis (Yan, et al., 2000).

Previous studies reporting the prevalence and incidence of the microvascular disease included diabetic retinopathy (Chang, et al., 2000; Tung, et al., 2007), renal disease (Chang, et al., 2000; Lin, et al., 2007; Shen, et al., 2009), neuropathy (Chang, et al., 2000; Hsu, et al., 2009). Among these studies, there were 5 studies estimating prevalence. However, these prevalence studies were based upon small size of samples and most of them were conducted in outlying islander. In Lin's study, they estimated that the prevalence of renal impairment in patients with diabetes in Kinmen County in 1999-2001 was 15.1% (Lin, et al., 2007); the prevalence of diabetic retinopathy in Kinmen County was 18.5% in 1999-2002 (Tung, et al., 2007); the prevalence of neuropathy in Mastu islanders with type 2 diabetes was 9.0% (Hsu, et al., 2009). The nephropathy prevalence was 21.8 % in severe albuminuria, 9.8% in insulin use and 35.3% in use of albumin excretion rate blockades in 2004 (Shen, et al., 2009).

Previous studies reported prevalence or incidence of the macrovascular diseases included amputation (Chen, et al., 2006), myocardial infarction (Hsiao, et al., 2009), stroke (Hsiao, et al., 2009; Tseng, et al., 2000; Tseng, et al., 2005), coronary heart disease (Chang, et al., 2000) and peripheral artery disease (Chang, et al., 2000). Two of them reported prevalence of ischemic heart disease, stroke, leg vessel disease and large vessel disease and their prevalence rates were 15.8%, 0.4-11.8%, 1.7% and 20%, respectively (Chang, et al., 2000; Tseng, et al., 2005). In Chen's study, they found the incidence density of non-traumatic

lower-extremity amputation for diabetic men and women were 4.103 and 3.170 per 1,000 patient-years from 1997 to 2002, respectively (Chen, et al., 2006). The estimated incidence that had been reported were 6-year cumulative incidence of 2.10% and 1.68% in hemorrhagic stroke for diabetic men and women (Chen, et al., 2009), of 12.71% and 8.89% in MI and 0.80 and 0.41 in stroke for patients with rosiglitazone monotherapy and pioglitazone monotherapy, respectively (Hsiao, et al., 2009).

Table 3 Previous studies estimated prevalence and/or incidence of complications in patients with type 2 diabetes in Taiwan, 1992-2005

Authors	Objectives	Study design	Complications measurement	Source of participants	Findings
Microvascular diseases					
Chang et al., 2000	To investigate the prevalence of DM and its complications in Taiwan from 1985 to 1996	Meta-analysis		Paper review	Diabetic retinopathy: 35% Nephropathy: 12.9% Neuropathy: 23.5%
C-H Lin, et al., 2007	To estimate the prevalence of renal impairment in type 2 diabetes patients in 1999–2001	Cross-sectional study	GFR less than 60 ml/min per 1.73 m2	Residents with diabetes in Kinmen County: 763 diabetics	The prevalence of renal impairment Overall: 15.1% Men: 8.1% Women: 20.8%
Tao-Hsin Tung et al., 2007	To explore whether insulin resistance and beta-cell dysfunction are both related to diabetic retinopathy in type 2 diabetics between 1999 and 2002	Cross-sectional study	Indirect ophthalmoscopic examination and single-field fungus photographs	Residents with diabetes in Kinmen County: 715 diabetics	Diabetic retinopathy at first eye screening: 18.5%.
Wei-Chih Hsu et al., 2009	To investigate the prevalence of autonomic neuropathies concurrently in pre-diabetic and diabetic subjects from October 2002 to December 2003	Cross-sectional study	Both with an abnormal sural NCS and an abnormal peroneal NCS	All adult residents aged older than 30 years in Matsu islands with type 2 diabetes: 133 type 2 diabetics	The prevalence rates Definite neuropathy: 9.0% Probable neuropathy: 20.3%
F-C Shen et al., 2009	To determine the prevalence of diabetic nephropathy in type 2 diabetes in 2004	Cross-sectional study	Urinary albumin excretion rate,	Patients with type 2 diabetes from Chang Gong Memorial Hospital-Kaohsiung Medical Center:1069 patients	The nephropathy prevalence In severe albuminuria: 21.8 % In insulin use: 9.8% In use of albumin excretion rate blockades: 35.3%

NHIRD: National Health Insurance Research Database;

Table 3 Previous studies estimated prevalence and/or incidence of complications in patients with type 2 diabetes in Taiwan, 1992-2005 (Continued)

Macrovascular diseases					
Authors	**Objectives**	**Study design**	**Complications measurement**	**Source of participants**	**Findings**
Chang et al., 2000	To investigate the prevalence of DM and it complications in Taiwan from 1985 to 1996	Meta-analysis		Paper review	Leg vessel disease: 1.7% Large vessel disease: 20% Ischemic heart disease: 15.8% Stoke: 2.5%
C-H Tseng et al., 2005	To determine the prevalence for stroke in patients with Type 2 diabetes from 1995-1998	Cross-sectional study	Diagnosis by a physician or conform to the definition made by the WHO	Insurers with type 2 diabetes aged 45 years and over from NHIRD: 12,531 type 2 diabetics	Prevalence of stroke in type 2 diabetic Women-< 45 years old: 0.4% 45–54 years old: 2.4% 55–64 years old: 5.1% ≥ 65 years old: 9.1% Men-< 45 years old: 1.4% 45–54 years old: 3.1% 55–64 years old: 7.0% ≥ 65 years old: 11.8%
H-F Chen et al., 2006	To investigated the age- and sex-specific incidence density of lower-extremity amputation (LEA) of the diabetic population in Taiwan from 1997-2002	Prospective study	LEA (ICD-9: 84.1 ,84.10–84.18)	Insurers aged 30 years and over with diabetes from Taiwan NHIRD: 500,868 diabetic patients	Estimated incidence density of non-traumatic LEA Men: 4.103 per 1,000 patient-years Women: 3.170 per 1,000 patient-years
H-F. Chen et al., 2009	To explore the impact of gender on incidence of hemorrhagic and ischemic stroke among the diabetic population in Taiwan from 1997 to 2002.	Prospective study	Nontraumatic hemorrhagic stroke: ICD-9: 430–432) ischemic stroke: ICD-9: 433–438	Insurers with type 2 diabetes aged 35 years and over from NHIRD: 500,868 diabetic patients	The 6-year cumulative incidence Hemorrhagic stroke-Men: 3.55%; Women: 2.83% Ischemic stroke-Men: 30.46%; Women: 30.06%
F-Y Hsiao et al., 2009	To investigate the association between oral antihyperglycaemics with MI and stroke from 2000 to 2005	Retrospective cohort study	MI: ICD-9:410 and 411); Stroke : ICD-9: 433 and 434	Insurers with type 2 diabetes aged 35 years and over from NHIRD: 473 483 with type 2 diabetes	MI incidence rates In rosiglitazone monotherapy: 12.71% In pioglitazone monotherapy: 8.89% Stroke incidence rates In rosiglitazone monotherapy: 0.80%; In pioglitazone monotherapy: 0.41%;

NHIRD: National Health Insurance Research Database;

2.4 The importance of time trend studies

Time trend is one of seven uses of epidemiology (Thomas, 2008). It is an important method in epidemiology, which studies past and future trend in human and illness from the rise and fall of disease and changes in their characters. From time trend study we can make useful projections into the future.

Several previous studies have examined time trend of diabetes worldwide, and aggregating evidence across studies had shown that incidence (Burke, et al., 1999; Chang, 2010; Dahlquist, et al., 2000; Harjutsalo, et al., 2008; Ishak, et al., 2003; Jansson, et al., 2007; Lipscombe, et al., 2007; Tseng, et al., 2006) and prevalence (Chang, 2010; Cooper, et al., 2000; Jansson, et al., 2007; Lipscombe, et al., 2007; Lusignan, et al., 2005; Mokdad, et al., 2000) of diabetes were increasing annually.

We had summarized some scholars who used time trends to describe the trends in prevalence and incidence of either type 1, type 2 or gestation diabetes after 1999 (Table 4). Among them, there were a total of 4 studies reporting type 1 diabetes, including those conducted in Oxford from 1985 to 1996 (Gardner, et al., 1997), in Sweden from 1978 to 1997 (Dahlquist, et al., 2000), in Yorkshire from 1978 to 2000 (Cohen, et al., 2003) and in Finnish from 1980 to 2005 (Harjutsalo, et al., 2008). Using nationwide registration data, an annual increase of 4% was reported from 1985 to 1996 in Oxford (Gardner, et al., 1997), a mean annual increase 1.7% from 1985 to 1996 was observed in Sweden (Dahlquist, et al., 2000), and an average annual increase of 2.9% and 5.9% was reported from 1978 to 2000 in kids aged 0-14 and 15-29 year olds in West Yorkshire (Cohen, et al., 2003). A cohort study in Finnish, including children who were younger than 15 years had an average age-standardized incidence from 31.4 to 64.2 per 100 000 persons per year from 1980 to 2005 (Harjutsalo,

et al., 2008).

A total of 7 studies took advantage of time trends to describe trends of type 2 diabetes in San Antonio Heart Study between 1979 and 1996 (Burke, et al., 1999), in USA between 1990 and 1998 (Mokdad, et al., 2000), in England and Whales between 1994 and 2001 (Lusignan, et al., 2005), in Canada between 1997 and 2003 (Lipscombe, et al., 2007), in Sweden between 1997 and 2003 (Ringborg, et al., 2008) and in Taiwan between 1999 and 2004 (Chang, et al., 2010). Among these studies, there were 3 studies estimating prevalence, 2 studies estimating incidence and 2 studies estimating prevalence and incidence.

In those studies reporting prevalence, an increase was observed from 4.9% in 1990 to 6.5% in 1998 in USA (Mokdad, et al., 2000), from 0.17% in 1994 to 0.25% in 2001 in England and Wales (Lusignan, et al., 2005), from 5.2% in 1995 to 8.8% in 2005 in Canada (Lipscombe, et al., 2007), from 2.2% in 1996 to 3.5% in 2003 in Sweden (Ringborg, et al., 2008), from 4.7% to 6.5% for men and from 5.3% to 6.6% for women in Taiwan between 1999 and 2004 (J. W. Chang, et al., 2010), age-standardized prevalence increased from 28.3 to 45 per 1,000 for women and 25.9 to 46.3 per 1,000 for men during 1972-1988 in Sweden (Jansson, et al., 2007).

The findings of the San Antonio Heart Study reported 7- to 8-year incidence were 5.7% in participants enrolled in 1979 and 15.7% in participants enrolled in 1988 in Mexican Americans and 2.6% in participants enrolled in 1980 and 9.4% in participants enrolled in 1988 in non-Hispanic whites in 1979-1996 (Burke, et al., 1999). Similarly, an increase was observed form 1.2 per 1000 in 1992 to 2.4 per year in 1996 for men and from 1.6 per 1000 in 1992 to 2.6 per 1000 in 1996 for men in Taiwan (Tseng, et al., 2006); and from 6.6 in 1997 to 8.2 per 1000 in 2003 in Canada (Lipscombe, et al., 2007). On the contrary, the

age-adjusted incidence of type 2 diabetes was 7.6 per 1000 person-year in 1999 and remain stable for men, but decreased from 7.7 to 6.9 for women in Taiwan between 1999 and 2004 (Chang, et al., 2010).

A total of 2 studies described trends of gestational diabetes. Those studies at the period of 1988–1999 showed annual rate increased by 4.7% for non-aboriginal population (Ishak, et al., 2003) and age- and ethnicity-adjusted incidence increased by 45% from 3.0% to 4.4% during 1995-2005 (Anna, et al., 2008).

One study described trends of diabetic complications in Ontario. It reported over an 8-year period, the incidence rate of AMI were 6.6-5.5 per 1000 population reduce 15.1% and stroke were 4.2-3.2 per 1000 population reduce 24.2% between 1992 and 2000 (Booth, et al., 2006).

Table 4 Previous studies of time trend in diabetes

Authors	Objectives	Study design	Period	Source of participants	Sample size	Findings
Type 1 diabetes						
Gardner, S. G, et al., 1999	To monitor incidence of type 1 diabetes in children in Oxford health region since 1985	Prospective nationwide registration study	1985-1996	Residents in area formerly administered by Oxford Regional Health Authority	512 500 kids aged under 15 years (264,000 boys; 248,000 girls)	Overall incidence: 18.6 cases/100 000/year An annual increase: 4%
Dahlquist, et al., 2000	To analyze the 20 years of prospective registration in childhood onset diabetes	Nationwide registration study	1978-1997	The national breastfeeding data from Marknadsbyran AB, Stockholm, Sweden	32,511,364 cases	Incidence: 1978: 21.1/100000 1997: 31.9 /100000 Mean annual incidence: 26.4/100000 per year Mean annual increase: 1.7%.
Feltbower et al., 2003	To investigate whether the rising incidence of type 1 diabetes in children	Privately insured patients registration study	1978-2002	Yorkshire Register of Diabetes in Children and Young People in West Yorkshire	3,250,000 kids aged 0-14 years who were from 1978-2002 in Yorkshire; 2,084,000 kids aged 15-29 years who were from 1991-2002 in West Yorkshire	Average annual increase in incidence Kids of 0–14 year olds: 2.9%; Kids of 15–29 year olds: 5.9%
Harjutsalo, et al., 2008	To assess the time trend of incidence in type 1 diabetes in Finnish children	Cohort study	1980–2005	National Public Health Institute diabetes register, Central Drug Register, and Hospital Discharge Register in 1980-2005	The children were younger than 15 years in Finnish	The average age-standardized incidence: 42.9 per 100 000 per year 1980: 31.4 per 100 000 2005: 64.2 per 100 000
Type 2 diabetes						
Burke, et al., 1999	To examine the secular trends in the incidence of type 2 diabetes	Cohort study	From 1979 to 1988 and from 1987 to 1996.	Participants in the San Antonio Heart Study	3682 participants 2343 Mexican Americans 1339 non-Hispanic whites	The 7- to 8-year incidence: Enrolled in 1979: 5.7% in Mexican Americans Enrolled in 1980: 2.6% in non-Hispanic whites Enrolled in 1988: 15.7% in Mexican Americans 9.4% in non-Hispanic whites

Table 4 Previous studies of time trend in diabetes (Continued)

Authors	Objectives	Study design	Period	Source of participants	Sample size	Findings
Mokdad, et al., 2000	To examine trends in diabetes prevalence in the U.S.	Cross-sectional study	1990-1998	Participants aged 18 years or older in the Behavioral Risk Factor Surveillance System	US population excluding 8 states: Alaska (1990), Arkansas (1990 and 1992), the District of Columbia (1995), Kansas (1990 and 1991), Nevada (1990 and 1991), New Jersey (1990), Rhode Island (1994), and Wyoming (1990, 1991, 1992, and 1993)	The prevalence of diabetes: 4.9% in 1990 to 6.5% in 1998.
Lusignan, et al., 2005	To document trends in the prevalence of type 2 diabetes	Cross-sectional study	1994-2001	Doctors' Independent Network database in England and Wales	Patients from 74 general practices in England and Wales which routinely contribute to the Doctors' Independent Network database	Prevalence: 17/1000 in 1994 to 25/1000 in 2001 Incidence from 1994 to 2001 Men: 18 to 27 per 1000 Women: 16 to 23 per 1000
Tseng, et al., 2006	To assess the yearly incidence of diabetes in Taiwan	National cohort study	1992–1996	Taiwan National Health Insurance Research Database	Insurers from Taiwan National Health Insurance Database	The trends from 1992–1996 Men: 120.2 per 100,000 population in 1992 and 237.6 per 100,000 population in 1996 Women: 157.7 per 100,000 population in 1992 and 252.7 per 100,000 population in 1996
Lipscombe , et al., 2007	To assess diabetes trends in Ontario, Canada.	Longitudinal study	Prevalence: 1995 –2005; Incidence : 1997 - 2003,	Anonymised, administrative health-care database records and physician claims	12 million persons aged 20 years or older.	Age-adjusted and sex-adjusted diabetes prevalence: increased by 69% 5·2% in 1995 to 8·8% in 2005 Incidence: yearly increase by 31% 6·6 to 8·2 per 1000 from 1997 to 2003.
Ringborg, A. , et al., 2008	To evaluate the prevalence and incidence of type 2 diabetes in Uppsala county, Sweden	Cohort study	1996-2003	Patients aged ≥ 30 years from twenty-six public primary care centers	Total population was 289,153-300,495 in 1996-2003	Crude prevalence of type 2 diabetes: From 2.2 in 1996 to 3.5% in 2003. The age- and sex-adjusted period increase: 53% in 1996-2003.

Table 4 Previous studies of time trend in diabetes (Continued)

Authors	Objectives	Study design	Period	Source of participants	Sample size	Findings
C. H. Chang, et al., 2010	To evaluate annual prevalence and incidence of Type 2 diabetes	Nationwide registration	1999–2004	Taiwan National Health Insurance Research Database 1999–2004	Insured in Taiwan National Health Insurance	Age-standardized prevalence, 1999-2004: Men: 4.7 to 6.5%; Women: 5.3 to 6.6% Age-standardized incidence rates per 100,000 person-years, 1999-2004: Men: 7.6 and remain stable Women: 7.7 to 6.9
Type 1 diabetes and Type 2 diabetes						
Jansson, et al., 2007	To report the prevalence and incidence of diabetes from 1972 to 2001 in Laxa, a rural community in central Sweden.	Nationwide registration study	1972-2001	A diabetes register at the primary healthcare center in Laxå	Resident in Laxå	The age-standardized incidence for type 1 and type 2 diabetes were 0.15 and 3.03 cases per 1,000 persons, respectively. No increase in incidence over time was detected for either forms of diabetes. Age-standardized prevalence increased from 28.3 to 45 per 1,000 for women and 25.9 to 46.3 per 1,000 for men in 1972-1988, a mean of 43.5 per 1,000 for women, 44.9 per 1,000 for men of the study period
Gestational diabetes						
Ishak, et al., 2003	To investigates the prevalence, trends, and risk factors of gestational diabetes mellitus (GDM) in the Aboriginal population in Australia.	Cross-sectional study	1988 - 1999	Pregnancy Outcome Unit of the Department of Human Services in South Australia	All populations: 230,011 Australian Aboriginal: 54,843 Non-Australian Aboriginal: 5,225,168	Annual rate increase in GDM for the 12-year period: Non-Aboriginal: 4.7% Aboriginal: the trend was less pronounced and non-significant
Anna, V et al., 2008	To examine changes in the prevalence of GDM among all births between 1995 and 2005 in Australia's largest state	Population register	1995-2005	The New South Wales Department of Health Midwives Data Collection	A computerized database of all births (n =956,738) in New South Wales, Australia	Age- and ethnicity-adjusted incidence of GDM increased by 45% from 3.0 to 4.4% between 1995 and 2005

Table 4 Previous studies of time trend in diabetes (Continued)

Authors	Objectives	Study design	Period	Source of participants	Sample sizes	Finding
The complications of type 2 diabetes						
Booth, et al., 2006	To compare recent trends in cardiovascular disease among men and women with diabetes with those in the nondiabetic population.	Retrospective cohort study	1992-2000	Residents of Ontario aged_20 years who were alive and eligible for coverage under the Ontario Health Insurance Plan	9,164,603 in 1992 and 9,861,323 in 1999.	The 8-year incidence in patients diabetes AMI: 658.8-554.4 per 100,000, reducing 15.1%; Stroke: 419.5-319.0 per 100,000, reducing 24.2%

2.5 Pay-for-Performance program for diabetes care in Taiwan

If diseases can be discovered in the early stages through testing and then be treated, the progression of disease can be significantly prevented. Also, certain chronic diseases or illnesses which required long-term treatment were controlled if patients take drugs under the doctor's directions. Based on the concept of "buying health," the Bureau of National Health Insurance (BNHI) had selected a few common diseases to be handled under P4P programs.

Since November 2001, Taiwan's universal health insurance system operated by the BNHI had implemented P4P programs for 5 diseases: breast cancer therapy, diabetes, asthma, chronic hepatitis B and hepatitis C, and hypertension (BNHI, 2010). This polices primarily focused on encouraging healthcare providers to raise the monitoring and follow-up care of patients (Lee, et al., 2010).

The P4P program of NHI for diabetes care provides financial incentives for healthcare providers to increase exhaustive follow-up visits including self-care education, annual eye examinations and laboratory tests such as glycated hemoglobin A1C (HbA1C), FPG, fasting lipid profile, serum creatinine, glutamic-pyruvic transaminase (SGPT), microalbumin and urinalysis (Appendix 1).

Chapter 3

Methodology

3.1 Conceptual framework of the study

This section presents the conceptual framework of the study (Figure 1). The independent variables can be organized into 3 factors, including sociodemographic factors, insurance factors and P4P program. The sociodemographic factors consist of age and gender and insurance factors consist of insurance premium and urbanization degree of the township where an insurer insured his/her NHI program.

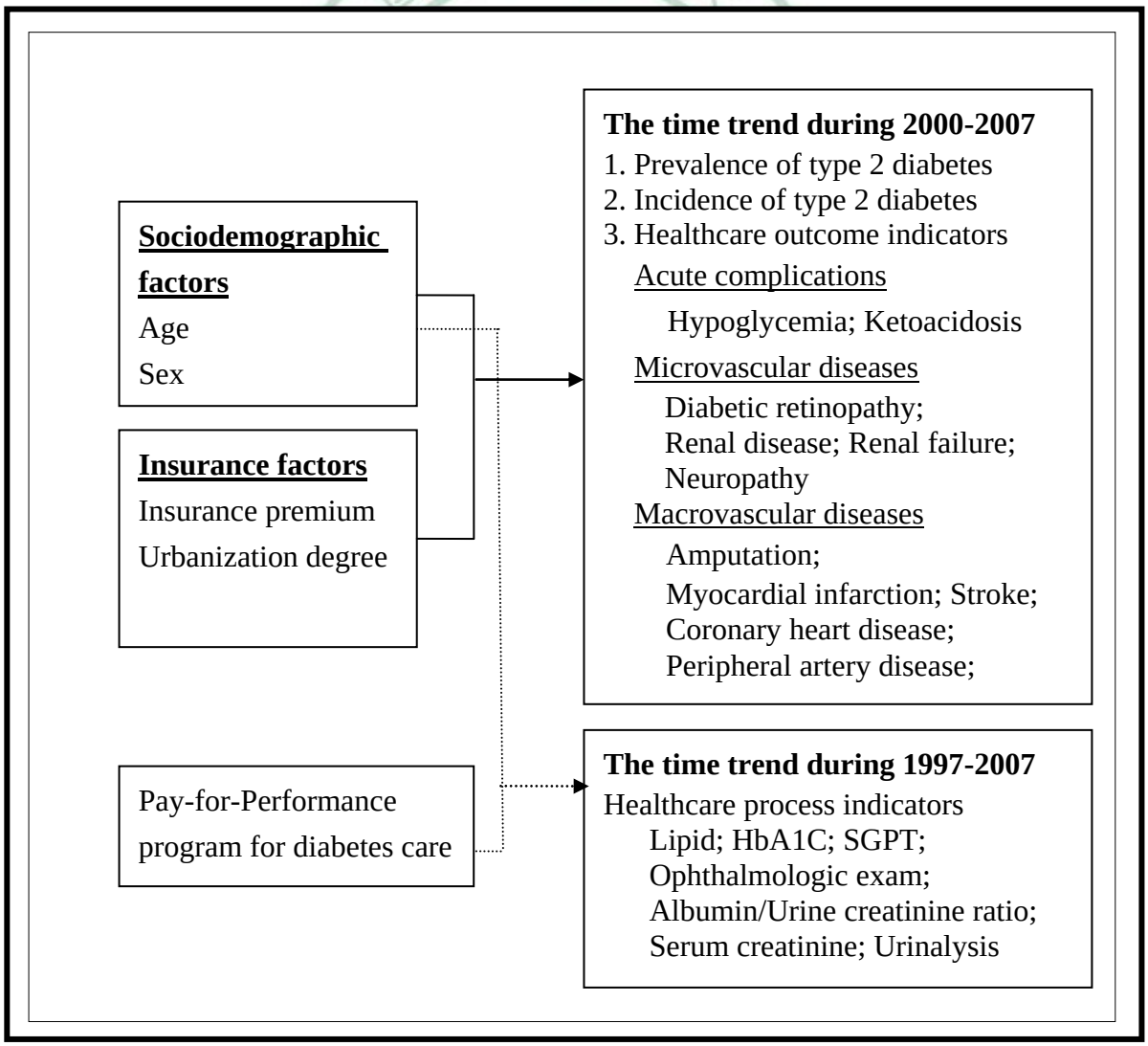

Figure 1 Conceptual framework of the current study

When the time trends of prevalence and incidence of type 2 diabetes and its complications during 2000-2007 are analyzed, sociodemographic and insurance factors are taken into account. In addition to sociodemographic and insurance factors, P4P program is considered when the time trends of healthcare process indicators are studied. The complications of type 2 diabetes are categorized into 3 classes: acute complication (hypoglycemia and ketoacidosis), microvascular diseases (diabetic retinopathy, renal disease, renal failure, and neuropathy), and macrovascular diseases (amputation, myocardial infarction, stroke, coronary heart disease, and peripheral artery disease). The healthcare process indicators consist of lipid profiles, HbA1C, SGPT, Ophthalmologic exam, albumin/urine creatinine ratio, serum creatinine, and urinalysis.

3.2 Data sources

A nationwide health insurance program was launched by the Taiwanese government in March 1995 (Wen, et al., 2008). In 2007, 22.60 million of Taiwan's 22.96 million persons were enrolled in this program (NHIRD, 2010). By the end of 2008, more than 99% of people in Taiwan were covered in the NHI program (Liu, et al., 2009), and the BNHI contracts with 97% of hospitals and 92% of clinics all over the nation (Department of Health, 2007).

Registration and claim datasets of the years 1995-2007 were obtained from Taiwan National Health Insurance Research Database (NHIRD). Files of registry for beneficiaries, ambulatory care by visits, and inpatient care by admission were analyzed. The BNHI performs expert review on random samples of every 50–100 ambulatory and inpatient claims in each hospital and clinic quarterly, and false reports of diagnosis generate a severe penalty (Chen, et al., 2008)

We used a random sample of 1,000,000 persons from 2005 in this study. All datasets can be interlinked through each individual personal identification number (PIN). Access to the NHI datasets was approved by the NHRI review committee. We used datasets of ambulatory care claims (1997–2007) and registry for beneficiaries (1997–2007) of the one million insurers, and all inpatient claims (1997–2007) for this study.

The data elements of ambulatory care by visits included encounter form-based dataset with date, time of visit, patient demographics (identifier, gender, date of birth), medical facility visited, department visited, prescribing physician, dispensing pharmacist, 3 categories of disease codes, as defined by The International Classification of Diseases,

Ninth Revision, Clinical Modification (ICD-9-CM) codes, and primary procedure such as drug or diagnostic procedure, etc.

3.3 Study subjects

According to research purposes there were two study populations: one was for prevalence and incidence of type 2 diabetes, and the other was for prevalence and incidence of complications and items of laboratory tests for process measures of diabetes care quality. They were described as follows: The population for prevalence and incidence of type 2 diabetes consisted of one million individuals who were randomly selected in 2005 from 23 million insured people of Taiwan's NHI program. The exclusion criteria were those who did not insure and who were younger than 30 years old. We defined the study population for each specific year. The population for prevalence and incidence of complications and items of laboratory tests for process measures of diabetes care quality consisted of those who have type 2 diabetes from the random sample of one million insured individuals. We searched the Taiwan NHIRD for the source population during 1997-2007 to identify who had at least 3 ambulatory claims or at least 1 inpatients claims with a diagnosis of ICD-9-CM codes 250, 2500, 25000, 25002, 2501, 25010, 2502, 25020, 2503, 25030, 2504, 25040, 2505, 25050, 2506, 25060, 2507, 25070, 2508, 25080, 2509 or 25090, or A-code A181 during the specific year period. The patients with diabetes who aged younger than 30 years, had gestation (ICD-9 code of 6480) or had type 1 diabetes (ICD code of 250.x1, 250.x3) were excluded in our study.

3.4 Measurements

Sociodemographic factors and insurance factors

Sociodemographic factors included age, gender and insurance premium. Age was categorized into 4 levels: 30-45, 46-60, 61-75 and >75 years. Gender was categorized into 2 levels: female and male. Insurance premium was categorized into 3 levels: dependent population, insurance premium less than its median value and insurance premium greater than or equal to its median value. The median values of insurance premium were 19,200 dollars in 1997-1999, 2001and 2003-2006; 19,400 dollars in 2000; 16,500 dollars in 2002 and 21,000 dollars in 2007.

We adopted urbanization indicator, which was developed by Liu et al. (Liu, et al., 2006). It categorized 365 Taiwan townships into 7 degrees of urbanization corresponding to high density urban area, medium density urban area, newly developed area, general area, aging society area, rural area and non-developed area (seclusion area). The variables used in developing the townships stratification for urbanization level consisting of population density (people/km^2), population ratio of people with college or above educational levels, population ratio of elder people over 65 years old, population ratio of people of agriculture workers and the number of physicians per 100,000 people, etc.

Definition of prevalence and incidence of type 2 diabetes

The NHIRD was used to estimate rates of prevalence and incidence of clinically diagnosed type 2 diabetes patients between 2000 and 2007. Annual prevalence rates were estimated for groups of age, gender, insurance premium and urbanization degree by dividing the number of

prevalent cases of type 2 diabetes identified at the NHIRD by the total number of residents enrolled in NHIRD in a given year. Annual incidence rates of clinically diagnosed type 2 diabetes were estimated for the same groups by dividing the number of newly diagnosed type 2 diabetes by the total number of insured individuals who did not have type 2 diabetes at the beginning of the year in NHIRD. Annual incidence was expressed as per 1000 residents of the source population in a given year.

Prevalence and incidence of complications

Prevalence and incidence rates of amputation (ICD-9 codes 841 and Surgical Procedures Codes 3925, 3929, 3959), myocardial infarction (MI) (A code A270 and CD-9 codes 410-412), stroke (A codes A290-A294, A299 and ICD-9 codes 4329, 431, 433-437), acute and chronic renal failure (A code A350 and ICD-9 codes 584-586, 588), coronary heart disease (CHD) (A code A27 and ICD-9 codes 140-414), renal disease (A code A350 and ICD-9 codes2504, 580-583, 585); diabetic retinopathy (A code A239 and ICD-9 codes 2505, 361, 366), neuropathy (A codes A22903, A22936 and ICD-9 codes 3572, 2506), peripheral artery disease (ICD-9 codes 2507); hypoglycemia (ICD-9 codes 2511, 2512) , ketoacidosis (ICD-9 codes 2501) were calculated using prevalent cases of type 2 diabetes with records of these complication for each specific year as numerator and all patients with type 2 diabetes for each specific year as denominator. Annual incidence rate of each complications was calculated using the number of new events identified in the NHIRD as numerator and the number of patients with type 2 diabetes and without history of the event on 1 January of the studied year as denominator. Rates were expressed as cases per 1000 patients.

Items of laboratory tests for process measures of diabetes care quality

We adopted the items of the laboratory tests for process measures of diabetes care quality proposed by P4P program (BNHI, 2010) and ADA (ADA, 2010). Items of laboratory tests included albumin–creatinine ratio (ACR), HbA1C, fasting lipid profile, serum creatinine, SGPT, microalbumin and urinalysis. Fasting lipid profile consisted of total cholesterol (TC), triglyceride (TG), high-density lipoprotein (HDL), and low-density lipoprotein (LDL). Physical assessment only included ophthalmologic exam. The codes of items and frequency of test in a year for physical assessment and laboratory test proposed by P4P program and ADA are described in Table 5.

Table 5 The codes of items and frequency of test in a year for physical assessment and laboratory tests proposed by P4P program and ADA

Item	Frequency of test in a year		Test code
	P4P	ADA	
Physical assessment			
Eye examinations	one	one	23501, 23502, 23702
Laboratory tests			
Albumin–creatinine ratio			12111, 09016
HbA1C	two	two	09006
Fasting plasma glucose	one		09005
Fasting lipid profile			
Total cholesterol	one	one	09001
Triglyceride	one	one	09004
HDL cholesterol	one	one	09043
LDL cholesterol	one	one	09044
Serum creatinine	one	bi-annually	09015
SGPT	one		09026
Urinalysis	one		06013
Microalbumin	one	one	12111

P4P: pay-for-performance; ADA: American Diabetes Association; HbA1C: glycated hemoglobin A1C; HDL: high-density lipoprotein; LDL: low-density lipoprotein; SGPT: serum glutamic-pyruvic transaminase;

3.5 Statistical analysis

Prevalence and incidence rates of type 2 diabetes and its complications and were adjusted through direct standardization method, which used the age-and gender-specific rates of each year and age and gender distributions of study population for year 2000.

Multiple logistic regression models were used analyze trends in prevalence and incidence over time while controlling for changes in the underlying age, sex, insurance premium and urbanization degree distributions. The dependent variable was diabetes prevalence/incidence (case=1; non-case=0) and categorical predictor variables were entered for year (2000 as the reference), age group (31-45 years as the reference), sex (male as the reference), insurance premium (dependent population as the reference and urbanization degree (non-developed area as the reference). If there exists a time trend, rates of change in prevalence were analyzed by replacing the set of categorical variables for calendar year with a continuous variable defined as time (in years). In order to examine the interaction effects between age group and time, the term of age group variable multiplied by variable was added as covariates to investigate whether rates of change over time in prevalence or incidence differed across age groups. A statistically significant interaction effect between time and a given age group indicates that the rate of change in prevalence/incidence differs as compared with the reference age group (60-69 years).

Liner regression model was used to analyze whether the trend of prevalence of laboratory tests before implementation of P4P program (1997-2002) and after implementation P4P program (2003-2007) was different. The dependent variable was prevalence rate of laboratory tests,

and the independent variables were year, period [before implementation of P4P program (1997-2002) =0; after implementation of P4P program (2003-2007) =1] and interaction term of year by period.

Chapter 4

Results

A total of 65,730 patients in the NHIRD were identified as prevalent cases between 2000 and 2007. The mean age of prevalent case during 2000-2007 was 62 with a SD of 12.5. The source population for which prevalence was estimated was 466,946 in 2000 and amounted to 595,854 in 2007

A 55% increase (from 6.2% to 11.0%) in the crude annual prevalence of type 2 diabetes took place during 2000-2007 (Table 6). After direct standardization of population of year 2000, the annual prevalence rates slightly decreased and discrepancy between crude and standardization annual prevalence rates increased as time elapsed. The annual prevalence rates were further stratified by age, gender, insurance premium and degree of urbanization, higher annual prevalence rates were observed in groups of older age, dependent population and aging society area. The annual prevalent rates increased from 6.48% to 10.75% for women and from 5.95% to 11.31% for men, and were higher in females before 2003 but they become lower since then.

The number of annual incident cases of type 2 diabetes increased from 4,126 to 5,833 during 2000-2007 (Table 6). The mean age of incidence cases during 2000-2007 were 58.5 with a SD of 13. Crude annual incidence increased slightly from 9.46 per 1000 in 2000 to 10.96 per 1000 in 2004, but fluctuated a little since then. After direct standardization of population of year 2000, the annual incidence rates increased gradually during 2000-2004 and then fluctuated up and down after 2004. The annual incidence rates were further stratified by age,

gender, insurance premium and degree of urbanization, higher incidence rates were observed in groups of older age, male, dependent population and aging society area.

Significant interactions in annual prevalence rate were observed between time and age groups for both gender (both <0.05) Figures 2 and 3. The annual rates of increase in the prevalence were largest in age group>75 years then next were age groups of 61-75 years, 46-60 years, and 31-45 years, accordingly. Annual prevalence increased by 90.91% (16.72%-31.92%) for females and 94.56% (13.78%-26.81%) for males in population aged 75 years and over, increased by 49.36% (18.07%-26.99%) for females and 68.85% (14.19%-23.96%) for males in the population aged 60-75 years, and 27.67% (7.48%-9.55%) for females and 59.19% (7.67%-12.21%) for males in the population aged 45-60 years, and 30.66% (1.37%-1.79%) for females and 69.94% (1.73%-2.94%) for males in the population aged 30-60 years during 2000-2007.

After multivariate adjustment, the odds of increase in prevalence per 2 year was 14.6% [OR (95%CI) =1.146 (1.142-1.49)] (Table 7). As expected, prevalence of type 2 diabetes was significantly associated with age [5.02 (4.97-5.08), 12.26 (12.11-12.41), 13.80 (13.61-14.00) for age groups of 46-60, 61-75 and >75 years, respectively]. It was generally lower in females [0.96 (0.96-0.97)], in individuals with insurance premium <median [0.86 (0.85-0.87)], and ≧median, [0.78 (0.77-0.79)], but higher in individuals living at medium density urban area [1.07 (1.05-1.09)], general area [1.02 (1.00-1.04)] and aging society area [1.08 (1.05-1.11)]. There was no linear trend in annual incidence rate, instead it fluctuated up and down. Thus, when we regard time as an ordinal variable, it was not significant. The incidence rates in women were lower [0.86

(0.84-0.88)], and higher incidence rates were observed in groups of aged 61-75 [6.16 (5.97-6.36)], middle income [1.23 (1.19-1.27)] and aging society area [1.07 (0.98-1.53)] (Table 8).

Table 9 showed the annual prevalence cases, rates and time trends of complications in patients with type 2 diabetes in Taiwan during 2000-2007. The complications of diabetes had been organized into 3 categories: acute complications, microvascular diseases and macrovascular diseases.

For acute complications, the crude annual prevalence increased 226% (0.46%-1.05%) in hypoglycemia, 72% (1.86%-3.19%) in ketoacidosis. For microvascular diseases, the crude annual prevalence increased 82% (7.84%-14.28%) in diabetes retinopathy, 26% (20.32%-25.54%) in renal disease and 28% (17.52%-22.41%) in neuropathy, but the crude annual prevalence decreased 2% (11.05%-10.80%) in renal failure. For macrovascular diseases, the crude annual prevalence increased 126% (0.50%-1.13%) in amputation, 52% (3.76%-5.71%) in myocardial infarction, 24% (14.78%-18.34%) in stoke, 20% (23.31%-27.94%) in CHD and 69% (5.57%-9.42%) in peripheral artery disease. After direct standardization by population of year 2000, the annual prevalence rates of hypoglycemia, ketoacidosis, renal disease, amputation, myocardial infarction, stoke, CHD and peripheral artery disease were slightly increased and discrepancy between crude and standardization annual rates increased as time passed. Significant increase in odds of adjusted prevalence rates over all time were observed in all complications except renal failure with a significant decline. For acute complications such as hypoglycemia and ketoacidosis, the odds ratios and 95% CI for every 2-year increase were 1.30 (1.26-1.34) and 1.15 (1.13-1.17). For microvascular diseases, the odds ratios and 95% CI for every 2-year

increase were 1.20 (1.19-1.12) for diabetes retinopathy, 1.07 (1.06-1.07) for renal disease and 1.06 (1.05-1.07) for neuropathy of the study period. For macrovascular disease, the odds ratios and 95% CI for every 2-year increase were 1.24 (1.20-1.28) for amputation, 1.10 (1.09-1.12) for myocardial infarction, 1.033 (1.025-1.041) for stroke, 1.04 (1.03-1.05) for CHD and 1.67 (1.57-1.71) for peripheral artery disease (Table 9).

Table 10 showed the annual incidence cases, rates and time trends of complications in patients with type 2 diabetes in Taiwan during 2000-2007. For acute complications, the crude annual incidence increased 91% (1.62-3.10 per 1000) in hypoglycemia and decreased 58% (7.59-3.20 per 1000) in ketoacidosis during 2000-2007. For microvascular diseases, the crude annual incidence during 2000-2007 decreased 6% (22.43-21.11 per 1000) in diabetes retinopathy, 45% (52.64-28.81 per 1000) in renal disease, 66% (67.75-23.17 per 1000) in neuropathy and increased 51% (8.18-12.38 per 1000 per year) in renal failure. For macrovascular diseases, the crude annual incidence during 2000-2007 decreased 2% (1.97-1.58 per 1000) in amputation, 9% (8.94-8.10 per 1000) in myocardial infarction, 25% (29.64-22.37 per 1000) in stoke, 35% (54.63-35.63 per 1000) in CHD and 58% (23.15-9.73 per 1000) in peripheral artery disease. After direct standardization of population at risk of year 2000, the annual incidence rates of hypoglycemia and renal failure become slight smaller than crude annual rates, but they still increased from 1.62 to 2.66 per 1000 and 8.18 to 11.45 per 1000 during 2000-2007, respectively. The annual incidence rates of complications remained decreasing from 7.59 to 8.20 per 1000 in ketoacidosis, from 52.64 to 28.81 per 1000 in renal disease, from 67.75 to 23.62 per 1000 in neuropathy, from 29.64 to 20.17 per 1000 in stoke, from 54.63 to 35.29 per 1000 in CHD and from 23.15 to 9.70 per 1000 in

peripheral artery disease from 2000 to 2007. For acute complications odds ratios and 95% CI for every 2-year increase were 1.13 (1.06-1.20) for hypoglycemia and 0.82 (0.78-0.85) for ketoacidosis. For microvascular diseases odds ratios and 95% CI for every 2-year increase were 1.01 (0.99-1.03) for diabetes retinopathy, 0.84 (0.82-0.85) for renal disease, 1.08 (1.04-1.11) for renal failure and 0.75 (0.73-0.76) for neuropathy of the study period. For macrovascular disease, odds ratios and 95% CI for every 2-year increase were 1.00 (0.93-1.07) for amputation, 0.989 (0.95-1.01) for myocardial infarction, 0.90 (0.89-0.92) for stroke, 0.88 (0.86-0.89) for CHD and 0.80 (0.78-0.82) for peripheral artery disease. (Table 10)

Table 11 showed the crude annual prevalence rates of having laboratory tests in patients with type 2 diabetes and stratified by gender, age, insurance premium, urbanization degree. The annual prevalence rates of all laboratory tests increased during 1997-2007. We observed that these annual prevalence rates increased in greater amount in 1997-2001 than in 2002-2007. The overall annual prevalence of ACR, HbA1C, fasting lipid profile, serum creatinine, SGPT, microalbumin, urinalysis and ophthalmologic exam from 1997 to 2001 were 2.02%-4.77%, 27.12%-33.42%, 40.66%-46.05%, 34.77%-37.94%, 28.24%-32.15%, 1.28%-3.65%, 23.43%-25.16%, 2.44%-4.39%, respectively, and from 2002 to 2007 were 7.58%-14.50%, 38.06%-49.80%, 43.56-46.77%, 38.61-43.59%, 33.69%-39.20%, 6.31%-13.92%, 28.23%-31.22%, 6.92%-10.63%, respectively. Regarding care quality proposed by ADA, the annual prevalence was 0.35%-0.80% from 1997 to 2001 and 2.20%-3.79% from 2002 to 2007. The result of the stratified annual prevalence rates of laboratory tests in patients with type 2 diabetes showed that annual prevalence rates were in general, higher in groups of

patients aged 46-60 and 61-75 years old, patients with insurance premium greater than or equal to median value, patients residing in areas of high density urban area and medium density urban area, and in patients joining P4P program.

Table 12 showed the results of logistic regression analysis to examine the time trends in annual prevalence rates of laboratory tests and ophthalmologic exam. Although it showed the ORs of all tests increased during 1997-2007, they substantial increased significantly after 2002, especially in ACR and ophthalmologic exam. The ORs and their 95% CIs of ACR and ophthalmologic exam were 4.60 (4.09-5.17) and 5.67 (4.90-6.56) in 2001, respectively, and 31.40 (28.17-35.00) and 49.05 (42.78-56.24) in 2007, respectively. Since the increases in ORs after 2002 were larger than those before 2002, we were interested in examining whether the annual increase in prevalence rates before 2002 were significantly different from those after 2002.

In order to examine whether the annual prevalence rates of laboratory tests were different during 1997-2002 and 2003-2007, we modeled the prevalence rates of laboratory tests with independent variables of time, period, and interaction of time and period (Table 13). A significant interaction term indicated the annual increased prevalence rates of laboratory tests were in different periods. The interactions were significantly different in ACR, HbA1C, fasting lipid profile, SGPT and microalbumin. For ACR, the annual increase in prevalence rates was 0.65% and 1.31% in 1997–2002 and in 2003–2007, respectively. For HbA1C, the annual increase in prevalence rates was 1.45% and 2.26% in 1997–2002 and in 2003–2007, respectively. For microalbumin, the annual increase in prevalence rates was 0.55% and 1.42% in 1997–2002 and in 2003–2007, respectively. For fasting lipid profile, the annual

prevalence rate decreased by 1.35% in 1997-2002 but increased by 0.47% in 2003-2007. For SGPT, the annual prevalence rate decreased by 0.87% in 1997-2002 but increased by 0.93% in 2003-2007.

Table 6-Prevalence and incidence rates of type 2 diabetes in Taiwan, 2000- 2007

	2000	2001	2002	2003	2004	2005	2006	2007
Prevalence rates of type 2 diabetes								
Prevalent cases	29043	33461	38350	43253	48199	54287	59809	65730
Age (year)	60±12	61±12	61±12	62±12	62±13	63±13	63±13	64±13
Total population	466946	479509	500711	521258	532897	561164	577371	595854
Prevalence rate (%)	6.22	6.98	7.66	8.30	9.04	9.67	10.36	11.03
Standardized prevalence rate (%)	6.22	6.80	7.31	7.80	8.31	8.75	9.21	9.65
Age								
31-45	1.55	1.70	1.84	1.95	2.07	2.16	2.28	2.36
46-60	7.57	8.21	8.72	9.17	9.67	10.02	10.40	10.87
61-75	16.12	17.58	18.91	20.25	21.66	22.94	24.29	25.53
>75	15.27	17.31	19.53	21.54	23.75	25.85	27.57	29.25
Sex								
Female	6.48	7.16	7.78	8.34	9.01	9.54	10.14	10.75
Male	5.95	6.80	7.54	8.25	9.08	9.81	10.58	11.31
Insurance premium								
Dependent population	9.65	10.80	11.42	13.04	14.41	15.59	16.88	18.11
< Median	5.56	7.46	6.71	8.73	9.62	10.31	11.13	11.52
≧ Median	5.80	4.24	7.26	4.90	5.28	5.64	6.02	6.38
Urbanization degree								
High density urban area	5.73	6.34	6.99	7.29	8.03	8.63	9.27	9.94
Medium density urban area	6.25	7.12	7.72	8.42	9.10	9.66	10.37	10.89
Newly developed area	5.81	6.50	7.20	8.04	8.68	9.33	9.91	10.49
General area	6.90	7.69	8.56	9.41	10.24	10.98	11.74	12.52
Aging society area	9.01	9.56	10.64	11.90	12.89	13.86	15.06	16.37
Rural area	7.51	8.54	9.32	10.25	11.38	12.25	13.26	14.20
Non-developed area	7.28	8.05	8.81	9.81	10.79	11.66	12.32	13.25
Incidence rates of type 2 diabetes								
Incident cases	4126	4370	4742	4818	5317	5318	5414	5833
Age (year)	58±12	58±12	58±13	58±13	59±13	59±14	59±13	59±13
Population at risk	436275	448517	460971	476611	485251	500025	522976	535923
Incidence rate (/1000)	9.46	9.74	10.09	10.11	10.96	10.64	10.35	10.88
Standardized incidence rate (/1000)	9.46	9.61	9.99	9.74	10.40	9.98	9.78	10.16
Sex								
Female	9.24	9.16	9.51	9.48	10.23	9.74	9.43	10.20
Male	9.68	10.34	11.08	10.74	11.69	11.54	11.30	11.59
Age								
31-45	3.32	3.27	3.73	3.64	3.57	3.59	3.70	3.64
46-60	12.68	12.25	13.61	12.87	14.01	12.64	12.38	13.58
61-75	22.15	22.59	21.97	22.46	23.91	23.45	23.14	23.34
>75	20.12	18.33	22.15	20.53	24.56	26.08	21.98	22.81
Insurance premium								
Dependent population	13.09	14.12	14.05	14.68	15.60	16.10	15.02	15.38
<Median	8.65	10.11	9.22	10.87	12.02	11.13	10.95	11.34
≧Median	9.09	7.05	9.96	6.63	7.28	7.38	7.49	8.06
Urbanization degree								
High density urban area	8.48	9.11	9.13	8.63	9.80	9.98	9.34	9.98
Medium density urban area	9.52	10.06	10.62	9.96	10.79	10.26	10.68	10.61
Newly developed area	9.11	8.84	10.15	10.02	10.65	10.45	9.98	10.36
General area	10.42	10.72	11.69	11.69	12.40	11.82	10.83	12.12
Aging society area	14.68	11.78	12.38	14.94	15.41	13.98	15.29	17.87
Rural area	11.21	12.74	11.46	12.70	14.08	13.72	14.06	14.11
Non-developed area	12.31	9.79	11.23	13.62	14.33	13.04	12.35	13.28

Figure 2-Time trends in prevalence of type 2 diabetes stratified by age in females

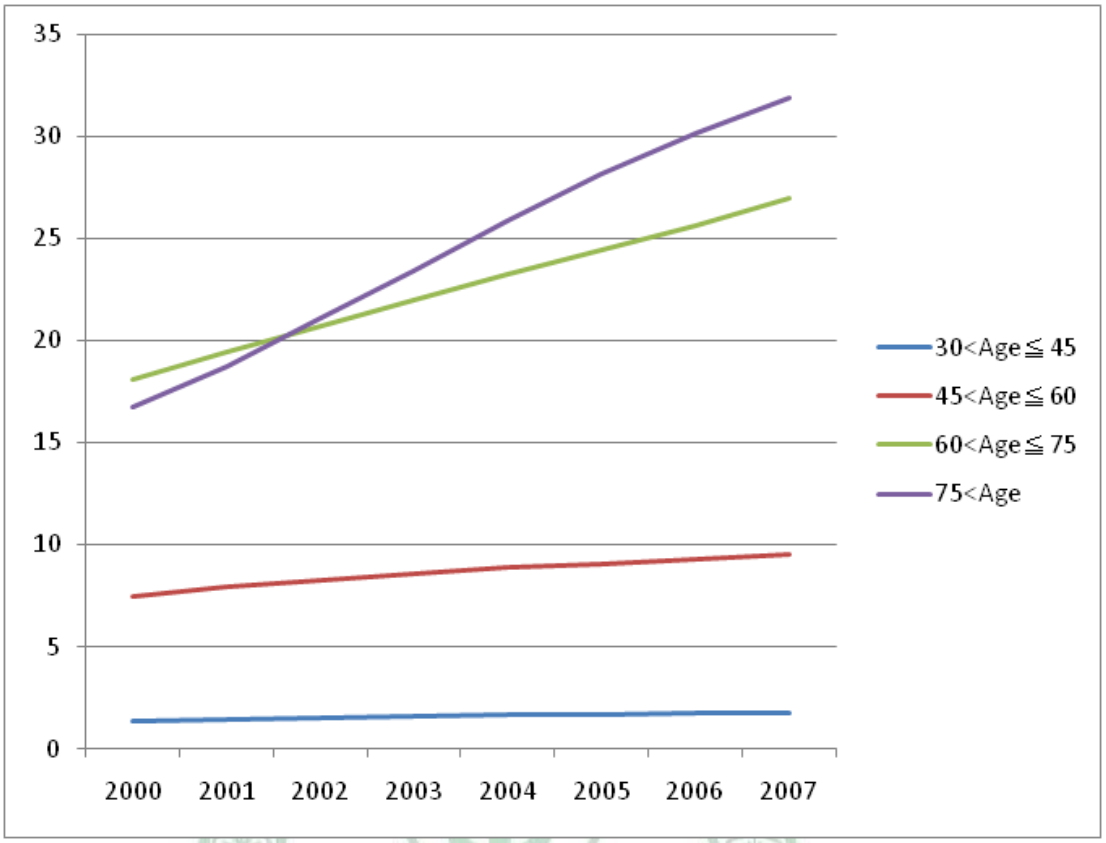

Figure 3-Time trends in prevalence of type 2 diabetes stratified by age in males

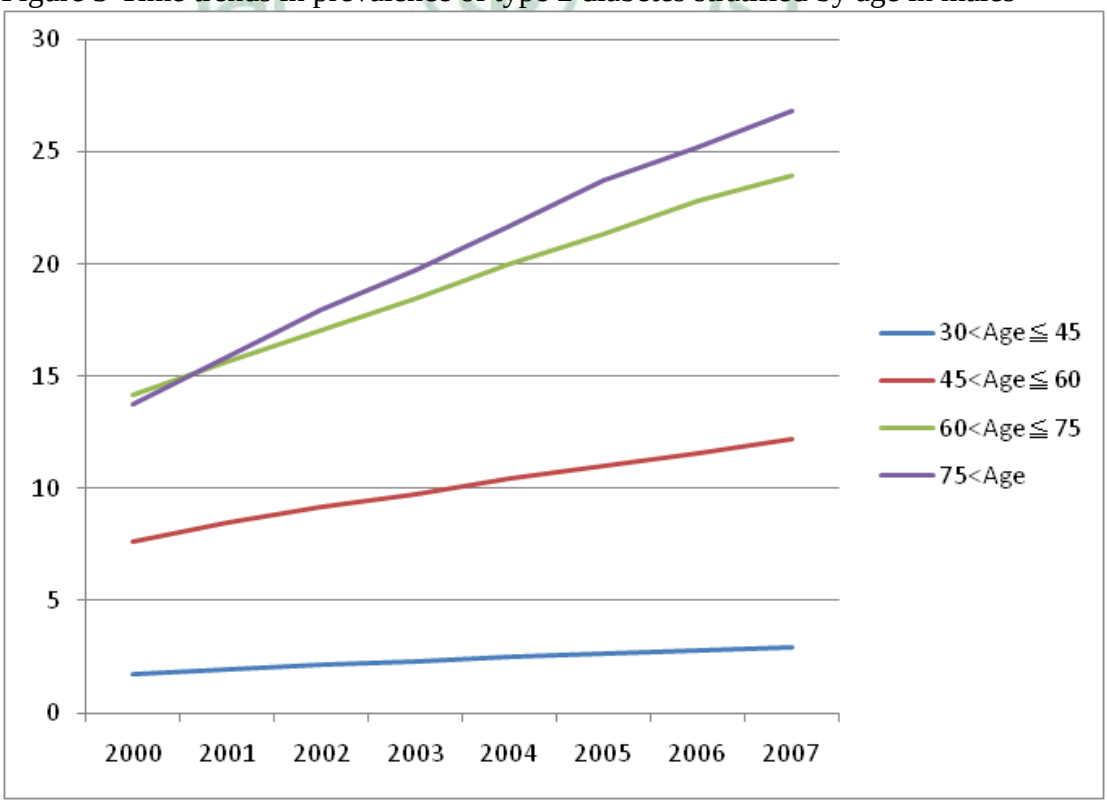

Table 7-Adjusted odds ratios of annual prevalence of type 2 diabetes rates for sex, age, time, insurance premium and urbanization degree

Variable	Crude odds ratio (95% CI)	Multivariate-adjusted odds ratio (95% CI)
Logistic regression model-Type 2 diabetes prevalence		
Time (per 2 years)[a]		1.146 (1.142-1.149)***
2000	1	1
2001	1.13 (1.11-1.15)***	1.05 (1.04-1.07)***
2002	1.25 (1.23-1.27)***	1.21 (1.19-1.23)***
2003	1.37 (1.35-1.39)***	1.24 (1.22-1.26)***
2004	1.50 (1.48-1.53)***	1.34 (1.32-1.36)***
2005	1.62 (1.60-1.65)***	1.43 (1.40-1.45)***
2006	1.75 (1.73-1.78)***	1.52 (1.50-1.55)***
2007	1.88 (1.85-1.90)***	1.61 (1.59-1.64)***
Sex		
Male	1	1
Female	0.994 (0.987-1.001)	0.96 (0.96-0.97)***
Age		
Age 31-45	1	1
Age 46-60	5.12 (5.06-5.18)***	5.02 (4.97-5.08)***
Age 61-75	13.10 (12.95-13.26)***	12.26 (12.11-12.41)***
Age > 75	15.48 (15.26-15.69)***	13.80 (13.61-14.00)***
Insurance premium		
0	1	1
<Median	0.62 (0.62-0.63)***	0.86 (0.85-0.87)***
≧Median	0.38 (0.37-0.38)***	0.78 (0.77-0.79)***
Urbanization degree		
High density urban area	0.73 (0.72-0.75)***	0.99 (0.97-1.01)
Medium density urban area	0.83 (0.81-0.84)***	1.07 (1.05-1.09)***
Newly developed area	0.78 (0.76-0.79)***	1.00 (0.98-1.02)
General area	0.94 (0.93-0.96)***	1.02 (1.00-1.04)
Aging society area	1.25 (1.21-1.28)***	1.08 (1.05-1.11)***
Rural area	1.06 (1.04-1.09)***	0.99 (0.97-1.02)
Non-developed area	1	1

*: p<0.05; **: p<0.01; ***: p<0.001

a: Being modeled as ordinal variable in a separate multivariate model with insurance premium, and with sex, age, insurance premium, and urbanization degree;

CI: confidence interval;

Table 8-Adjusted odds ratios of annual incidence rates of type 2 diabetes for sex, age, time, insurance premium and urbanization degree

Variable	Crude odds ratio (95% CI)	Multivariate-adjusted odds ratio (95% CI)
Logistic regression model-Type 2 diabetes incidence		
Time (per 2 years)[a]		1.008 (0.999-1.017)
2000	1	1
2001	1.03 (0.99-1.08)	0.98 (0.94-1.02)
2002	1.09 (1.04-1.13)**	1.06 (1.02-1.11)*
2003	1.07 (1.02-1.11)*	0.96 (0.94-1.03)
2004	1.16 (1.12-1.21)***	1.07 (1.02-1.11)*
2005	1.13 (1.09-1.18)***	1.03 (0.99-1.07)
2006	1.10 (1.06-1.15)***	1.00 (0.96-1.04)
2007	1.16 (1.11-1.20)***	1.04 (0.996-1.081)
Sex		
Male	1	1
Female	0.87 (0.85-0.89)***	0.86 (0.84-0.88)***
Age		
Age 31-45	1	1
Age 46-60	3.72 (3.61-3.83)***	3.71 (3.60-3.82)***
Age 61-75	6.54 (6.35-6.74)***	6.16 (5.97-6.36)***
Age > 75	6.44 (6.19-6.69)***	5.96 (5.73-6.21)***
Insurance premium		
Dependent population	1	1
<Median	1.84 (1.79-1.89)***	1.23 (1.19-1.27)***
≧Median	1.33 (1.30-1.36)***	1.10 (1.07-1.13)***
Urbanization degree		
High density urban area	0.74(0.70-0.78)***	0.93 (0.88-0.98)**
Medium density urban area	0.82(0.78-0.87)***	0.99 (0.93-1.04)
Newly developed area	0.79 (0.75-0.84)***	0.95 (0.90-1.00)
General area	0.91(0.86-0.97)**	0.97 (0.92-1.03)
Aging society area	1.17(1.08-1.27)**	1.07 (0.98-1.53)
Rural area	1.04(0.97-1.12)	0.99 (0.93-1.06)
Non-developed area	1	1

*: p<0.05; **: p<0.01; ***: p<0.001

a: Being modeled as ordinal variable in a separate multivariate model with insurance premium, and with sex, age, insurance premium, and urbanization degree;

CI: confidence interval;

Table 9-Annual prevalence cases, rates and time trends of complications in patients with type 2 diabetes in Taiwan, 2000-2007

	Year								Per 2 years
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**OR (95% CI)**
Acute complications									
Hypoglycemia									1.30 (1.26-1.34)***
N	134	202	275	366	481	630	785	988	
Crude rate	(0.46)	(0.60)	(0.72)	(0.85)	(1.00)	(1.16)	(1.31)	(1.50)	
Standardized rate	(0.46)	(0.59)	(0.67)	(0.77)	(0.89)	(1.00)	(1.12)	(1.24)	
Ketoacidosis									1.15 (1.13-1.17)***
N	540	725	951	1165	1345	1633	1881	2096	
Crude rate	(1.86)	(2.17)	(2.48)	(2.69)	(2.79)	(3.01)	(3.15)	(3.19)	
Standardized rate	(1.86)	(2.18)	(2.50)	(2.73)	(2.82)	(3.03)	(3.14)	(3.18)	
Microvascular diseases									
Diabetic Retinopathy									1.20 (1.19-1.21)***
N	2278	2883	3746	4640	5666	7002	8161	9387	
Crude rate	(7.84)	(8.62)	(9.77)	(10.73)	(11.76)	(12.90)	(13.65)	(14.28)	
Standardized rate	(7.84)	(8.57)	(9.66)	(10.56)	(11.51)	(12.60)	(13.30)	(13.92)	
Renal disease									1.066 (1.059-1.074)***
N	5901	7322	8779	10304	11812	13644	15202	16788	
Crude rate	(20.32)	(21.88)	(22.89)	(23.82)	(24.51)	(25.13)	(25.42)	(25.54)	
Standardized rate	(20.32)	(21.82)	(22.75)	(23.52)	(24.02)	(24.50)	(24.59)	(24.56)	
Renal failure									0.98 (0.97-0.99)**
N	3208	3538	3922	4422	4928	5643	6315	7098	
Crude rate	(11.05)	(10.57)	(10.23)	(10.22)	(10.22)	(10.39)	(10.56)	(10.80)	
Standardized rate	(11.05)	(10.52)	(10.10)	(9.98)	(9.83)	(9.82)	(9.79)	(9.87)	
Crude rate	(11.05)	(10.57)	(10.23)	(10.22)	(10.22)	(10.39)	(10.56)	(10.80)	
Neuropathy									1.06 (1.05-1.07)***
N	5089	6582	7963	9338	10587	12175	13470	14728	
Crude rate	(17.52)	(19.67)	(20.76)	(21.59)	(21.97)	(22.43)	(22.52)	(22.41)	
Standardized rate	(17.52)	(19.60)	(20.65)	(21.38)	(21.64)	(21.96)	(21.92)	(21.68)	
Crude rate	5089	6582	7963	9338	10587	12175	13470	14728	

*: p<0.05; **: p<0.01; ***: p<0.001; OR: odds ratio; CI: confidence interval;

Table 9-Annual prevalence cases, rates and time trends of complications in patients with type 2 diabetes in Taiwan, 2000-2007 (Continued)

	Year								Per 2 years
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**OR (95% CI)**
Macrovascular diseases									
Amputation									1.24 (1.20-1.28)***
N	144	179	261	336	413	527	641	744	
Crude rate	(0.50)	(0.53)	(0.67)	(0.77)	(0.85)	(0.96)	(1.06)	(1.13)	
Standardized rate	(0.50)	(0.53)	(0.67)	(0.75)	(0.82)	(0.92)	(1.00)	(1.03)	
Myocardial infarction									1.10 (1.09-1.12)***
N	1093	1322	1637	1952	2339	2833	3243	3753	
Crude rate	(3.76)	(3.95)	(4.27)	(4.51)	(4.85)	(5.22)	(3.42)	(5.71)	
Standardized rate	(3.76)	(3.90)	(4.16)	(4.34)	(4.55)	(4.81)	(4.92)	(5.10)	
Stroke									1.033 (1.025-1.041)***
N	4294	5152	6132	7107	8239	9511	10797	12054	
Crude rate	(14.78)	(15.40)	(15.99)	(16.43)	(16.09)	(17.52)	(18.05)	(18.34)	
Standardized rate	(14.78)	(15.15)	(15.47)	(15.58)	(15.86)	(15.93)	(16.10)	(16.01)	
Coronary heart disease (CHD)									1.04 (1.03-1.05)***
N	6771	8168	9663	11224	12859	14783	16519	18367	
Crude rate	(23.31)	(24.41)	(25.20)	(25.95)	(26.68)	(27.23)	(27.62)	(27.94)	
Standardized rate	(23.31)	(24.15)	(24.70)	(25.17)	(25.49)	(25.70)	(25.82)	(25.88)	
Peripheral artery disease									1.13 (1.12-1.14)***
N	1617	2230	2883	3464	4113	4917	5575	6192	
Crude rate	(5.57)	(6.66)	(7.52)	(8.01)	(8.53)	(9.06)	(9.32)	(9.42)	
Standardized rate	(5.57)	(6.63)	(7.45)	(7.88)	(8.32)	(8.73)	(8.89)	(8.90)	

*: p<0.05; **: p<0.01; ***: p<0.001;

OR: odds ratio; CI: confidence interval;

Table 10-Annual incidence cases, rates and trends of complications in patients with type 2 diabetes in Taiwan, 2000-2007

	Year								Per 2 years
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**OR (95%)**
Acute complications									
Hypoglycemia									1.13 (1.06-1.20)**
N	47	68	72	89	115	145	152	201	
Crude rate	(1.62)[a]	(2.04)	(1.89)	(2.07)	(2.40)	(2.70)	(2.57)	(3.10)	
Standardized rate	(1.62)[a]	(1.99)	(1.79)	(1.92)	(2.25)	(2.33)	(2.21)	(2.66)	
Ketoacidosis									0.82 (0.78-0.85)***
N	218	176	220	201	185	249	225	204	
Crude rate	(7.59)	(5.35)	(5.85)	(4.75)	(3.93)	(4.71)	(3.87)	(3.20)	
Standardized rate	(7.59)	(5.37)	(5.90)	(4.88)	(3.86)	(4.61)	(3.69)	(3.25)	
Microvascular diseases									
Diabetic Retinopathy									1.01 (0.99-1.03)
N	614	598	845	882	1062	1249	1140	1215	
Crude rate	(22.43)	(19.18)	(23.84)	(22.33)	(24.36)	(25.73)	(21.60)	(21.11)	
Standardized rate	(22.43)	(19.11)	(23.71)	(22.40)	(24.61)	(26.04)	(22.23)	(22.04)	
Renal disease									0.84 (0.82-0.85)***
N	1286	1335	1344	1418	1480	1568	1415	1452	
Crude rate	(52.64)	(48.59)	(43.47)	(41.26)	(39.08)	(37.15)	(30.75)	(28.81)	
Standardized rate	(52.64)	(48.41)	(43.25)	(40.72)	(38.67)	(36.66)	(30.54)	(28.92)	
Renal failure									1.08 (1.04-1.11)***
N	231	287	332	453	501	607	623	735	
Crude rate	(8.18)	(9.50)	(9.55)	(11.53)	(11.45)	(12.32)	(11.51)	(12.38)	
Standardized rate	(8.18)	(9.45)	(9.37)	(11.14)	(10.85)	(11.24)	(10.44)	(11.45)	
Neuropathy									0.75 (0.73-0.76)***
N	1738	1458	1340	1330	1298	1420	1252	1210	
Crude rate	(67.65)	(51.45)	(42.24)	(37.74)	(33.36)	(32.62)	(26.31)	(23.17)	
Standardized rate	(67.65)	(51.40)	(42.55)	(37.66)	(33.49)	(32.60)	(26.75)	(23.62)	

*: p<0.05; **: p<0.01; ***: p<0.001;

OR: odds ratio; CI: confidence interval;

Table 10- Annual incidence cases, rates and time trends of complications in patients with type 2 diabetes in Taiwan, 2000-2007 (Continued)

	Year								Per 2 years
	2000	2001	2002	2003	2004	2005	2006	2007	OR (95%)
Macrovascular diseases									
Amputation									1.00 (0.93-1.07)
N	57	34	82	75	81	110	114	103	
Crude rate	(1.97)	(1.02)	(2.15)	(1.74)	(1.69)	(2.04)	(1.92)	(1.58)	
Standardized rate	(1.97)	(1.01)	(2.11)	(1.73)	(1.69)	(2.01)	(1.74)	(1.52)	
Myocardial infarction									0.989 (0.95-1.01)
N	252	225	305	311	391	468	403	506	
Crude rate	(8.94)	(6.95)	(8.24)	(7.47)	(8.45)	(9.01)	(7.07)	(8.10)	
Standardized rate	(8.94)	(6.87)	(8.17)	(7.43)	(7.96)	(8.43)	(6.64)	(7.65)	
Stroke									0.90 (0.89-0.92)***
N	756	827	935	952	1155	1152	1259	1228	
Crude rate	(29.64)	(28.38)	(28.20)	(25.66)	(28.09)	(25.08)	(25.04)	(22.37)	
Standardized rate	(29.64)	(28.07)	(27.32)	(24.60)	(26.33)	(23.08)	(22.97)	(20.17)	
CHD									0.88 (0.86-0.89)***
N	1287	1320	1397	1471	1646	1693	1642	1750	
Crude rate	(54.63)	(49.60)	(46.44)	(43.91)	(44.50)	(41.10)	(36.54)	(35.63)	
Standardized rate	(54.63)	(49.41)	(46.16)	(43.46)	(43.22)	(39.80)	(35.61)	(35.29)	
Peripheral artery disease									0.80 (0.78-0.82)***
N	650	599	634	568	675	732	633	585	
Crude rate	(23.15)	(18.82)	(17.56)	(14.07)	(15.08)	(14.61)	(11.54)	(9.73)	
Standardized rate	(23.15)	(18.81)	(17.44)	(13.92)	(14.87)	(14.06)	(11.15)	(9.70)	

***: p<0.05; **: p<0.01; ***: p<0.001**

OR: odds ratio; CI: confidence interval; CHD: coronary heart disease;

a: Incidence rates were presented as per 1000 individuals with type 2 diabetes

Table 11-Time trends in annual prevalence of laboratory tests in patients with type 2 diabetes during 1997-2007

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Albumin / Urine Creatinine Ratio (ACR)											
# of cases having lab tests	332	527	828	1047	1597	2908	3714	5178	6077	7312	9530
Prevalence rate (%)	2.02	2.56	3.25	3.60	4.77	7.58	8.59	10.74	11.19	12.23	14.50
Sex											
Female	1.86	2.38	3.15	3.52	4.80	7.55	8.68	10.69	11.33	12.15	14.70
Male	2.22	2.77	3.35	3.70	4.74	7.81	8.49	10.80	11.06	12.30	14.30
Age											
31-45	1.74	2.81	2.92	3.72	4.80	7.14	8.24	10.16	10.61	11.47	13.99
46-60	2.04	2.76	3.52	3.74	5.25	8.21	9.64	12.22	12.98	14.40	17.10
61-75	2.17	2.42	3.34	3.74	4.82	7.90	8.74	11.04	11.57	12.65	15.30
>75	1.40	1.74	1.96	2.29	2.93	5.12	5.84	7.22	7.32	8.06	9.21
Insurance premium											
Dependent population	1.72	2.30	3.10	3.49	4.72	6.68	8.66	10.59	10.90	11.70	13.77
<Median	2.03	2.36	3.13	3.80	4.34	7.31	8.07	10.08	10.58	11.21	13.49
≧Median	2.39	3.48	3.77	3.56	5.95	7.95	9.82	12.60	13.07	14.96	18.17
Urbanization degree											
1	2.36	2.68	3.26	4.13	5.24	7.85	9.28	11.26	11.55	12.72	15.33
2	2.19	2.93	4.06	4.06	5.37	8.22	9.21	11.22	12.37	13.33	15.05
3	1.79	2.73	2.69	3.10	4.80	7.44	8.69	10.82	10.52	12.05	14.10
4	1.88	2.23	3.21	3.54	4.19	7.30	7.95	10.76	10.48	11.40	14.39
5	1.93	1.14	1.22	2.51	2.61	5.23	4.39	5.96	8.69	10.48	12.54
6	0.68	1.66	2.14	1.69	2.88	6.43	7.26	8.59	8.98	9.92	12.20
7	1.61	1.38	2.10	1.89	3.49	5.44	6.28	10.22	12.04	11.37	13.91
Whether join the P4P											
Yes	—	—	—	—	20.00	47.77	41.16	44.21	46.27	50.44	55.86
No	—	—	—	—	4.77	6.37	6.18	7.03	6.50	6.81	8.96
HBA1C											
# of cases having lab tests	4456	5881	7397	8844	11184	14597	17435	21261	24386	28006	32731
Prevalence rate(%)	27.12	28.56	29.80	30.45	33.42	38.06	40.31	44.11	44.92	46.83	49.80
Sex											
Female	26.53	28.32	29.82	30.38	33.47	38.25	40.78	44.60	45.85	47.85	50.99
Male	27.82	28.83	29.77	30.53	33.37	37.87	39.83	43.62	44.00	45.83	48.64
Age											
31-45	26.59	26.83	27.06	27.54	30.01	35.07	36.23	40.03	40.30	41.69	45.56
46-60	27.58	28.86	30.78	31.44	35.55	40.27	43.31	47.93	49.44	52.28	55.52
61-75	27.03	29.20	30.36	30.99	33.74	39.06	41.48	45.55	46.73	49.25	53.34
>75	25.79	26.16	26.59	27.97	28.79	31.16	32.72	35.06	35.05	35.36	36.46
Insurance premium											
Dependent population	28.86	30.05	32.38	31.47	34.31	36.89	41.33	45.06	45.83	47.14	49.14
<Median	24.54	26.16	26.66	31.83	30.24	37.22	37.80	41.45	41.98	43.73	47.03
≧Median	32.21	33.24	34.92	29.51	38.91	38.25	44.22	49.77	50.39	53.22	57.68
Urbanization degree											
1	35.15	35.30	37.02	36.49	39.92	42.77	45.22	48.19	48.37	49.74	51.11
2	27.43	29.55	31.23	32.05	35.49	39.28	41.74	45.40	46.16	48.32	50.86
3	26.05	28.26	28.45	29.55	32.59	37.78	39.69	43.95	45.16	46.08	49.61
4	20.35	23.09	23.77	25.22	28.40	33.84	35.68	40.78	41.11	44.25	47.48
5	16.42	18.18	21.61	20.95	23.04	30.26	33.06	36.00	39.17	43.52	47.34
6	13.48	15.95	18.15	18.48	20.63	29.13	33.01	35.72	36.86	40.04	43.39
7	15.37	17.00	16.88	16.51	20.52	25.31	30.03	36.00	38.73	38.76	44.96
Whether to join the P4P											
Yes	—	—	—	—	100.00	98.75	98.55	98.61	98.94	99.49	99.58
No	—	—	—	—	33.41	36.24	36.01	38.07	37.69	39.36	43.13

Urbanization degree- 1: high density urban area; 2: medium density urban area; 3: newly developed area; 4: general area; 5: aging society area; 6: rural area; 7: non-developed area (seclusion area);

P4P: pay-for-performance; ADA: American Diabetes Association;

Table 11-Time trends in annual prevalence of laboratory tests in patients with type 2 diabetes during 1997-2007 (Continued)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Fasting Lipid Profile											
# of cases having lab tests	7567	9368	10940	11810	13960	16707	19181	22357	24522	26966	30741
Prevalence rate(%)	46.05	45.49	44.07	40.66	41.72	43.56	44.35	46.38	45.17	45.09	46.77
Sex											
Female	47.51	46.67	45.85	42.19	43.07	44.98	45.42	47.66	46.61	46.52	48.41
Male	44.32	44.13	42.07	38.99	40.28	42.10	43.25	45.11	43.75	43.69	45.19
Age											
31-45	39.95	38.31	37.73	35.44	36.22	38.46	38.46	41.11	39.74	40.32	42.55
46-60	46.25	46.64	44.90	42.87	44.12	46.74	48.23	51.00	50.35	50.94	53.26
61-75	48.38	47.67	46.52	41.53	43.15	45.12	46.34	48.10	47.54	47.60	50.08
>75	41.77	39.42	37.39	34.99	34.09	33.98	33.66	35.73	33.20	32.58	32.61
Insurance premium											
Dependent population	49.56	48.10	47.49	41.51	43.97	43.81	46.16	48.01	46.48	46.13	46.41
<Median	43.71	42.62	40.99	40.75	38.47	41.91	41.46	43.22	41.81	41.37	43.55
≧Median	48.09	49.99	47.88	40.34	46.90	44.03	49.01	51.65	51.01	51.80	55.31
Urbanization degree											
1	51.32	50.29	49.91	45.81	47.25	48.04	48.99	50.25	48.67	49.08	50.07
2	46.85	46.73	45.41	42.03	43.85	45.50	45.70	48.19	47.00	46.67	48.27
3	44.48	43.62	41.19	39.22	40.23	42.75	43.01	45.56	44.91	43.87	45.78
4	42.25	41.02	38.97	35.39	37.31	38.98	40.16	42.25	40.91	41.35	43.56
5	44.12	44.70	41.70	33.10	34.39	35.37	38.02	38.84	39.50	40.73	42.14
6	36.31	39.31	37.90	34.22	31.52	34.08	37.08	38.02	36.59	36.89	40.09
7	36.73	35.13	34.91	30.09	29.28	32.44	35.41	39.88	39.57	37.90	41.57
Whether join the P4P											
Yes	—	—	—	—	100.00	98.30	95.09	93.85	93.90	92.30	94.46
No	—	—	—	—	41.71	41.92	40.60	41.12	38.65	38.39	40.38
Serum Creatinine											
# of cases having lab tests	6106	7812	9208	10097	12135	14807	17398	20364	22576	24615	27463
Prevalence rate(%)	37.16	37.94	37.09	34.77	36.27	38.61	40.22	42.25	43.59	41.16	41.78
Sex											
Female	38.08	38.33	38.32	35.68	37.15	39.59	40.87	42.72	42.49	42.08	42.07
Male	36.07	37.48	35.71	33.76	35.32	37.59	39.56	41.78	40.69	40.25	40.89
Age											
31-45	30.29	30.14	29.06	27.79	28.56	31.85	32.71	34.59	33.26	33.31	34.70
46-60	36.90	37.19	36.30	34.81	36.84	39.27	41.22	43.60	42.79	43.29	44.21
61-75	39.50	41.03	40.38	36.59	38.34	40.847	42.64	44.43	44.51	43.94	45.39
>75	38.16	38.36	36.65	35.71	34.77	35.56	37.76	38.97	37.65	36.00	34.77
Insurance premium											
Dependent population	41.35	40.97	43.68	37.72	39.20	39..97	42.75	44.53	44.21	43.43	42.91
<Median	34.94	35.93	34.42	35.24	33.79	37.72	38.20	39.95	39.13	38.75	39.50
≧Median	37.91	39.39	38.13	33.54	38.55	38.48	41.52	44.40	43.35	43.13	45.04
Urbanization degree											
1	43.10	43.17	43.05	39.30	41.35	42.92	44.50	45.77	44.82	44.19	44.76
2	37.80	38.93	38.21	35.99	38.14	39.96	41.58	43.67	43.17	42.27	42.87
3	35.44	36.37	35.09	33.25	34.47	37.18	39.17	41.24	40.76	39.95	40.30
4	32.95	34.95	32.57	31.33	33.19	35.29	36.68	39.23	38.16	38.71	39.60
5	32.60	32.20	29.83	28.21	38.15	32.59	33.79	34.47	36.54	37.42	37.57
6	28.47	27.91	30.25	27.04	25.88	30.49	32.66	35.11	33.98	36.19	36.50
7	27.83	28.13	27.46	23.87	25.87	27.30	31.66	35.62	36.30	34.18	36.46
Whether join the P4P											
Yes	—	—	—	—	80.00	96.43	92.06	90.23	89.83	87.22	88.23
No	—	—	—	—	36.26	36.87	36.40	36.93	35.13	34.62	35.56

Urbanization degree- 1: high density urban area; 2: medium density urban area; 3: newly developed area; 4: general area; 5: aging society area; 6: rural area; 7: non-developed area (seclusion area);

P4P: pay-for-performance; ADA: American Diabetes Association;

Table 11-Time trends in annual prevalence of laboratory tests in patients with type 2 diabetes during 1997-2007 (Continued)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Serum Glutamic-Pyruvic Transaminase (SGPT)											
# of cases having lab tests	5283	6520	7571	8201	9867	12922	15690	18892	20926	22923	25663
Prevalence rate (%)	32.15	31.66	30.50	28.24	29.49	33.69	36.27	39.20	38.55	38.33	39.04
Sex											
Female	32.74	31.18	31.20	28.73	29.84	34.01	36.63	39.70	39.01	38.61	39.71
Male	31.44	31.06	29.71	27.70	29.11	33.37	35.91	38.69	38.09	38.05	38.40
Age											
31-45	31.37	28.12	27.61	26.36	27.50	32.26	33.13	35.37	34.30	35.54	36.63
46-60	33.18	32.84	31.94	30.55	31.69	36.50	39.49	42.75	42.14	42.57	43.78
61-75	31.79	32.32	30.89	27.91	29.51	34.05	37.07	40.28	40.19	40.13	41.38
>75	29.29	27.82	26.27	23.04	24.14	25.75	28.54	31.43	30.58	28.97	28.56
Insurance premium											
Dependent population	33.14	31.99	31.88	28.09	29.99	32.83	37.30	40.16	39.17	38.64	38.67
<Median	30.87	30.64	28.82	27.11	27.79	31.91	34.32	36.80	36.54	36.07	36.56
≧Median	34.50	34.07	33.25	28.77	33.11	34.55	39.74	43.57	42.28	42.92	45.42
Urbanization degree											
1	36.34	34.15	33.72	31.22	33.55	31.14	39.36	42.08	41.45	41.00	41.49
2	31.58	30.80	31.07	28.43	29.98	34.18	36.95	40.11	39.63	39.63	39.98
3	29.54	29.87	27.50	26.43	26.86	32.30	35.15	38.06	36.90	36.74	37.26
4	30.87	30.20	28.77	26.21	27.51	31.61	33.85	36.42	35.85	36.16	37.47
5	37.01	38.64	33.33	26.12	28.94	30.81	33.14	35.20	36.08	37.24	36.72
6	26.96	30.68	27.40	25.99	25.02	27.95	30.70	33.38	32.81	32.75	35.29
7	27.18	28.75	26.31	25.19	23.11	26.92	32.02	36.37	34.90	33.19	34.75
Whether join the P4P											
Yes	—	—	—	—	80.00	97.05	91.89	90.03	89.73	86.43	87.33
No	—	—	—	—	29.48	31.79	32.17	33.56	31.70	31.51	32.57
Microalbumin											
# of cases having lab tests	211	369	594	740	1222	2418	3132	4415	5714	7064	9152
Prevalence rate(%)	1.28	1.79	2.39	2.55	3.65	6.31	7.24	9.16	10.53	11.81	13.92
Sex											
Female	1.22	1.71	2.32	2.51	3.70	6.40	7.38	9.33	10.81	11.77	14.17
Male	1.36	1.89	2.47	2.59	3.60	6.20	7.10	8.99	10.25	11.85	13.69
Age											
31-45	1.25	1.91	2.12	2.51	3.44	6.11	7.01	8.78	10.20	11.21	13.61
46-60	1.45	1.99	2.62	2.71	3.93	6.76	8.28	10.45	12.40	14.03	16.71
61-75	1.20	1.69	2.48	2.62	3.88	6.62	7.27	9.43	10.82	12.19	14.66
>75	0.82	1.06	1.27	1.64	2.03	4.13	4.79	6.00	6.51	7.57	8.37
Insurance premium											
Dependent population	1.04	1.65	2.34	2.42	3.69	5.78	7.22	8.99	10.20	11.43	13.09
<Median	1.26	1.60	2.26	2.65	3.32	6.16	6.88	8.59	9.80	10.70	12.89
≧Median	1.69	2.52	2.82	2.57	4.45	6.52	8.22	10.83	12.35	14.84	17.82
Urbanization degree											
1	1.62	1.83	2.34	2.76	4.00	6.63	8.02	9.67	10.77	12.37	14.74
2	1.31	2.01	2.92	2.87	4.02	6.63	7.53	9.37	11.68	12.93	14.44
3	1.19	1.97	1.84	1.95	3.42	6.21	7.04	8.98	9.84	11.52	13.48
4	1.14	1.68	2.70	2.95	3.57	6.26	7.08	9.64	9.97	11.01	13.93
5	0.74	0.57	1.07	1.96	1.93	3.78	3.33	4.07	7.50	9.71	11.90
6	0.41	1.22	1.69	1.13	2.31	5.38	6.47	7.55	8.79	7.47	11.43
7	0.65	1.00	1.57	1.79	2.84	4.68	5.38	9.11	11.57	11.11	13.60
Whether join the P4P											
Yes	—	—	—	—	20.00	48.13	40.86	42.43	45.47	50.13	55.41
No	—	—	—	—	3.65	5.05	4.76	5.47	5.85	6.38	8.36

Urbanization degree- 1: high density urban area; 2: medium density urban area; 3: newly developed area; 4: general area; 5: aging society area; 6: rural area; 7: non-developed area (seclusion area);

P4P: pay-for-performance; ADA: American Diabetes Association;

Table 11-Time trends in annual prevalence of laboratory tests in patients with type 2 diabetes during 1997-2007 (Continued)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Urinalysis											
# of cases having lab tests	3936	5057	6095	6806	8420	10826	12645	15046	16699	17975	20121
Prevalence rate(%)	23.95	24.56	24.55	23.43	25.16	28.23	29.23	31.22	30.76	30.05	30.61
Sex											
Female	25.19	26.30	25.62	24.62	26.56	29.23	30.43	32.07	31.89	31.13	31.96
Male	22.48	22.54	23.36	22.13	23.67	27.19	28.01	30.36	29.64	29.01	29.30
Age											
31-45	23.41	22.87	22.54	20.77	22.30	26.28	26.81	28.67	27.59	27.76	29.11
46-60	23.92	24.59	24.73	24.38	26.72	29.82	31.03	33.70	33.24	33.07	34.16
61-75	24.21	25.36	25.33	23.72	25.57	29.00	30.34	32.07	32.15	31.53	32.40
>75	23.57	22.67	22.88	21.98	21.49	22.78	23.54	25.47	24.84	23.18	22.57
Insurance premium											
Dependent population	24.62	25.52	25.95	23.63	25.94	27.85	29.97	31.87	31.71	31.10	30.43
<Median	23.79	23.95	23.49	23.55	23.45	27.83	27.96	29.55	28.81	27.77	28.71
>=Median	23.53	24.94	25.55	23.32	28.44	28.48	31.39	34.30	33.87	33.57	35.61
Urbanization degree											
1	24.29	25.66	26.65	25.23	27.57	30.19	31.12	33.13	32.74	32.13	32.30
2	23.81	24.07	24.98	24.31	26.39	29.13	30.11	32.02	31.92	31.45	31.48
3	25.13	26.08	24.71	22.75	24.71	27.91	29.20	31.42	30.61	29.76	30.64
4	23.45	23.03	22.00	22.34	22.80	27.38	28.51	30.13	29.03	27.86	29.79
5	20.59	19.89	21.00	20.95	22.13	24.47	23.07	24.80	26.07	25.34	27.58
6	24.35	23.03	21.53	18.72	19.47	22.76	24.03	25.87	25.89	25.46	25.55
7	22.33	25.25	21.59	17.55	21.41	20.94	23.14	26.04	27.02	25.87	26.80
Whether join the P4P											
Yes	—	—	—	—	100.00	97.14	92.09	89.86	89.76	86.76	87.25
No	—	—	—	—	25.15	26.16	24.60	24.71	22.86	22.01	23.25
Ophthalmologic Exam											
# of cases having lab tests	401	552	676	936	1469	2653	3826	4936	5771	5939	6062
Prevalence rate (%)	2.44	2.68	2.72	3.22	4.39	6.92	8.85	10.24	10.63	9.92	9.22
Sex											
Female	2.42	2.70	2.76	3.18	4.25	6.92	8.78	10.28	10.97	9.96	9.58
Male	2.46	2.66	2.69	3.27	4.54	6.92	8.91	10.20	10.29	9.89	8.88
Age											
31-45	2.59	2.12	2.34	2.75	3.99	6.46	8.13	9.84	9.36	9.26	8.76
46-60	2.27	2.77	2.66	3.67	5.03	7.60	9.74	11.54	12.28	11.20	10.62
61-75	2.52	2.88	3.03	3.26	4.28	7.15	9.33	10.47	11.21	1073	10.06
>75	2.68	1.97	2.01	1.87	3.10	4.59	5.81	7.17	6.97	6.54	5.77
Insurance premium											
Dependent population	2.55	2.96	2.66	2.80	3.78	5.99	8.59	9.75	10.02	9.43	8.48
<Median	2.33	2.41	2.38	3.36	4.26	6.89	8.53	9.97	10.24	9.62	8.86
≧Median	2.61	3.05	3.77	3.31	5.56	7.22	10.04	11.65	12.47	11.32	11.29
Urbanization degree											
1	3.16	3.43	3.72	3.87	4.67	6.54	8.56	9.51	9.99	8.93	8.84
2	2.61	3.01	2.96	3.18	4.77	7.48	9.13	10.58	11.14	10.57	9.75
3	2.38	2.28	2.74	3.18	4.66	6.50	9.17	10.47	10.51	9.98	9.35
4	1.88	2.26	1.69	2.57	3.71	7.89	9.12	11.41	11.75	10.59	9.92
5	1.47	0.19	0.61	1.82	2.95	6.12	8.04	8.44	8.49	8.76	7.65
6	1.38	1.11	1.07	2.91	3.40	5.57	8.36	9.59	9.53	9.75	8.36
7	0.81	1.75	1.36	1.79	3.57	6.29	7.67	10.22	11.29	11.32	8.73
Whether join the P4P											
Yes	—	—	—	—	0.00	76.96	71.89	66.84	61.28	55.19	51.26
No	—	—	—	—	25.15	26.16	24.60	24.71	22.86	22.01	23.25

Urbanization degree- 1: high density urban area; 2: medium density urban area; 3: newly developed area; 4: general area; 5: aging society area; 6: rural area; 7: non-developed area (seclusion area);

P4P: pay-for-performance; ADA: American Diabetes Association;

Table 11-Time trends in annual prevalence of laboratory tests in patients with type 2 diabetes during 1997-2007 (Continued)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Guidelines and Recommendations for Laboratory Tests from ADA											
# of cases having lab tests	58	84	122	143	268	842	1263	1813	2059	2174	2355
Prevalence rate(%)	0.35	0.41	0.49	0.49	0.80	2.20	2.92	3.76	3.79	3.63	3.58
Sex											
Female	0.38	0.39	0.53	0.42	0.74	2.26	2.93	3.78	3.94	3.66	3.71
Male	0.32	0.43	0.45	0.57	0.87	2.13	2.91	3.74	3.65	3.61	3.43
Age											
31-45	0.31	0.36	0.31	0.44	0.76	1.88	2.25	2.98	3.16	2.81	3.25
46-60	0.36	0.42	0.50	0.51	0.92	2.29	3.17	4.25	4.45	4.15	4.04
61-75	0.36	0.41	0.58	0.52	0.75	2.47	3.26	3.94	3.99	3.95	3.99
>75	0.35	0.38	0.26	0.38	0.65	1.29	1.87	2.79	2.48	2.55	2.32
Insurance premium											
Dependent population	0.40	0.38	0.55	0.35	0.73	1.86	3.03	3.56	3.57	3.39	3.30
<Median	0.30	0.38	0.36	0.44	0.64	2.31	2.73	3.74	3.66	3.61	3.52
≧Median	0.35	0.53	0.77	0.56	1.32	2.26	3.24	4.14	4.44	4.04	4.18
Urbanization degree											
1	0.45	0.42	0.66	0.62	0.96	2.02	2.86	3.58	3.55	3.05	3.27
2	0.46	0.58	0.70	0.56	1.02	2.43	3.02	3.97	4.19	3.99	3.94
3	0.19	0.39	0.40	0.37	0.71	1.83	2.88	4.04	3.56	3.62	3.47
4	0.33	0.29	0.29	0.35	0.58	2.66	3.18	3.94	4.11	4.00	4.00
5	0.00	0.00	0.00	0.14	0.34	2.11	2.44	3.13	2.90	3.43	2.82
6	0.28	0.22	0.09	0.65	0.45	2.23	2.84	3.08	3.27	3.65	3.49
7	0.00	0.13	0.10	0.19	0.41	1.92	2.42	3.73	4.11	4.32	3.43

Urbanization degree- 1: high density urban area; 2: medium density urban area; 3: newly developed area; 4: general area; 5: aging society area; 6: rural area; 7: non-developed area (seclusion area);

P4P: pay-for-performance; ADA: American Diabetes Association;

Table 12-Multivariate-adjusted ORs of annual prevalence laboratory tests in patients with type 2 diabetes for calendar year

	ACR	HbA1C	Fasting lipid profile	Serum creatinine	SGPT	Microalbumin	Urinalysis	Ophthalmologic Exam
1997	1	1	1	1	1	1	1	1
1998	1.53 (1.34-1.76)	1.32 (1.27-1.38)	1.25 (1.21-1.29)	1.28 (1.24-1.32)	1.34 (1.18-1.53)	1.24 (1.20-1.28)	1.29 (1.23-1.34)	1.74 (1.47-3.05)
1999	2.31 (2.04-2.62)	1.67 (1.61-1.73)	1.43 (1.39-1.47)	1.49 (1.44-1.54)	1.62 (1.43-1.83)	1.40 (1.35-1.45)	1.53 (1.47-1.59)	2.74 (2.35-3.21)
2000	2.87 (2.54-3.24)	1.90 (1.83-1.98)	1.41 (1.37-1.46)	1.53 (1.48-1.58)	2.10 (1.87-2.37)	1.40 (1.35-1.46)	1.61 (1.55-1.68)	3.26 (2.80-3.80)
2001	4.60 (4.09-5.17)	2.62 (2.53-2.72)	1.79 (1.74-1.84)	1.92 (1.86-1.98)	3.49 (3.13-3.90)	1.75 (1.70-1.81)	2.10 (2.02-2.19)	5.67 (4.90-6.56)
2002	8.02 (7.17-8.98)	3.41 (3.29-3.54)	2.09 (2.03-2.15)	2.33 (2.26-2.41)	6.09 (5.49-6.77)	2.25 (2.18-2.33)	2.67 (2.57-2.78)	10.72 (9.30-12.35)
2003	10.96 (9.80-12.25)	4.52 (4.37-4.68)	2.60 (2.52-2.67)	2.89 (2.80-2.98)	9.35 (8.44-10.36)	2.94 (2.85-3.03)	3.29 (3.17-3.41)	14.92 (12.98-17.16)
2004	15.85 (14.20-17.69)	6.06 (5.85-6.27)	3.28 (3.20-3.38)	3.61 (3.50-3.73)	12.44 (11.24-13.76)	3.81 (3.69-3.93)	4.13 (3.98-4.28)	21.75 (18.94-24.97)
2005	18.71 (16.77-20.86)	7.28 (7.03-7.53)	3.67 (3.57-3.78)	4.07 (3.95-4.20)	14.51 (13.12-16.05)	4.27 (4.14-4.41)	4.63 (4.46-4.80)	28.58 (24.91-32.80)
2006	23.04 (20.66-25.70)	9.14 (8.23-9.45)	4.25 (4.14-4.37)	4.58 (4.44-4.72)	14.96 (13.53-16.54)	4.86 (4.71-5.02)	5.06 (4.88-5.25)	36.26 (31.61-41.59)
2007	31.40 (28.17-35.00)	12.10 (11.69-12.52)	5.31 (5.16-5.46)	5.40 (5.24-5.57)	15.41 (13.93-17.04)	5.72 (5.55-5.90)	5.89 (5.68-6.11)	49.05 (42.78-56.24)

ACR: albumin-creatinine ratio; HbA1C: glycated hemoglobin A1C; SGPT: serum glutamic-pyruvic transaminase; ADA: American Diabetes Association;

Table 13-Multivariate linear regression model that examined whether the annual prevalence rates of laboratory tests were different during 1997-2002 and 2003-2007

Items of laboratory tests	B (SE)			R^2
	Year	Period	Year*Period	
ACR	0.65 (0.13)**	-0.98 (0.79)	0.66 (0.16)**	0.99
HbA1C	1.45 (0.22)**	0.08 (1.37)	0.81 (0.27)**	1.00
Fasting lipid profile	-1.35 (0.31)**	-4.73 (1.98)*	1.83 (0.39)**	0.81
Serum creatinine	-0.50 (0.42)	-0.66 (2.66)	1.07 (0.53)	0.84
SGPT	-0.87 (0.39)	-1.56 (2.47)	1.80 (0.49)**	0.94
Microalbumin	0.55 (0.09)**	-2.79 (0.55)**	0.97 (0.11)***	1.00
Urinalysis	0.13 (0.27)	2.97 (1.68)	0.27 (0.33)	0.93
Ophthalmologic Exam	0.44 (0.30)	3.86 (1.86)	-0.01 (0.37)	0.92
ADA	0.10 (0.11)	1.05 (0.69)	0.16 (0.14)	0.96

ACR: albumin-creatinine ratio; HbA1C: glycated hemoglobin A1C; SGPT: serum glutamic-pyruvic transaminase; ADA: American Diabetes Association; SE: standard error;
*: $p<0.05$; **: $p<0.01$; ***: $p<0.001$

Chapter 5

Discussion

The present study used NHI claims data of a random sample of nationwide population to estimate the annual prevalence and incidence of type 2 diabetes during 2000-2007. We observed an incidence of 55% in both crude and age- and gender-standardized annual prevalence rates during 2000-2007. Furthermore, the annual prevalence and incidence of major diabetes-related complications among the identified patients with type 2 diabetic were determined. A significant and increasing linear trend in annual prevalence has been observed in all complications with 3% to 30% increase in odds for every 2-year period except renal failure with a decreasing linear trend. Some complications such as hypoglycemia and renal failure had an increasing trend in annual incidence whereas ketoacidosis, renal disease, neuropathy, stroke, CHD and peripheral artery disease had a decreasing trend in annual incidence. Regarding annual prevalence of laboratory tests, we observed a significant annual increase rate in ACR, HbA1C, fasting lipid profile, SGPT, and microalbumin after implementation of P4P program.

Results showed the annual prevalence of diagnosed type 2 diabetes and all its complications continues to rise in the studied period. The annual increase in prevalence rates of type 2 diabetes from 2000 to 2007 were 0.60% and 0.76% in female and male, respectively. By 2007, the adult prevalence of diabetes in Taiwan reached 11.03%, representing a 77% increase since 2000. This increase has already exceeded the 60% rise in global and similar with the Asia in 80% increase, that were projected from 1995 to 2030 (King, et al., 1998; Wild, et al., 2004). WHO predicted that a global prevalence of diabetes increase 39% would take

place between 2000 and 2030. However, in Taiwan, a 77% increase of prevalence has taken place over a 8-year period. During the same period, the crude incidence rate did not exhibit a linear growth trend. Instead, it increased slightly from 2000 to 2004 and fluctuated from 2005 to 2007. Thus, the increase in prevalence of type 2 diabetes may partly be explained by better diabetes care and longer survival.

The cross-sectional studies in Taiwan included Ann-Lo in 1988-1990 (Lin, et al., 1993), Kin-Hu and Kinmen in 1991-1994 (Lu, et al., 1998), Pu-li in 1987-1988 and 1991-1992 (Chou, et al., 1997), Tainan in 1996 (Lu, et al., 1998), Penghu Islands in 1995-1997 (Chen, et al., 1999), with prevalence of 5.6% - 9.0%. All of these studies were based upon small samples of size, thus their estimates may not be reliable. In additional, these studies had been conducted before 2000. After 2000, one large study estimating prevalence of type 2 diabetes with the same methodology with us. Although we adopted the same methodology with Chang et al., by using NHI database, our prevalence estimates were higher than their prevalence. Chang and colleagues used NHI datasets with all diabetes patients aged 20 years old and over (Chang, 2010). Thus their study was more powerful and precise. Although there were differences in inclusion criteria for study subjects of these 2 studies, Chang's findings were consistent with ours regarding the increasing trend in prevalence according to various age and gender groups.

The health insurance claims database is a valuable resource for evaluating chronic disease burdens, monitoring epidemic trends and evaluating the impact of care in disease prevention and outcome improvement. In Sloan's study, they used National Medicare claims files to estimate the annual incidence of type 2 diabetes during 1994-1995 and 2003-2004 (Sloan, et al., 2008). However, their study is sensitive to the

change of disease coding method. Due to A-code being adopted by disease diagnosis system before year 2000, the disease classification may be different between before and after 2000. Thus, the current study only focused on duration 2000-2007 for prevalence and incidence of type 2 diabetes and its complications.

In our study sample, the prevalence of all complications except renal failure continuously increased between 2000 and 2007 in Taiwan. The largest increase in prevalence trends of acute complications, microvascular diseases and macrovascular diseases in type 2 diabetics were amputation, diabetic retinopathy and peripheral artery disease. The incidence of hypolglycemia and renal failure increased significantly over study period, but ketoacidosis, renal disease, neuropathy, stroke, CHD and peripheral artery disease were significantly decreased. Thus health professionals should provide care programs that target reducing the occurrence of hypoglycemia and renal failure.

Diabetic neuropathy affects peripheral nerves, and peripheral sensory loss with the development of foot ulcers is the most common indication for lower-extremity amputation among diabetic patients (Birke, et al., 2000). Tseng and colleagues analyzed clinical characteristics of 234 amputees admitted to the National Taiwan University Hospital for 10-year period. They pointed out diabetes accounted for 37.2% of the amputations and was the most commonly associated disease (Tseng, et al., 1994). In our study, the age-and-sex adjusted amputation prevalence increased by 106%, from 0.5% in 2000 to 1.03% in 2007; and it was the largest increase in prevalence trends of the macrovascular diseases. Cheng and colleagues used Taiwan NHIRD to identify type 2 diabetes; the estimated incidence density of non-traumatic LEA for diabetic men and women were 410.3 and 317.0 per 100,000 patient-years in 1997-2002,

respectively. Our findings indicated that the age-and-sex adjusted amputation incidence during 2000-2007 ranged from 1.97 to 1.52 per 1000, and there is no significant trend of change. Our estimates were slightly lower than those by Cheng et al.

Lin et al analyzed renal disease and Tung et al studied diabetes retinopathy in residents with type 2 diabetes in Kinmen County from 1999 to 2002 by health survey (Lin, et al., 2007; Tung, et al., 2007). The prevalence of renal impairment was 15.1% and significantly higher in females (20.8%) than males (8.1%) and diabetic retinopathy at first eye screening among 715 diabetics was 18.5%. In recent years, there was no study estimating the prevalence and incidence of diabetes retinopathy or renal disease. Therefore, our study updated the prevalence and incidence of diabetes retinopathy and renal disease in patients with type 2 diabetes after 2000. Although the methodology in Lin's and our studies was quite different, the prevalence estimates were similar. The prevalence of diabetes retinopathy in our study was slightly lower than that in Lin's study whereas the estimate of renal disease in our study was slight higher than that in Tung's study by using health survey.

Three studies used NHI datasets to discuss macrovascular diseases in type 2 diabetes in Taiwan. Their findings showed the prevalence of stroke was 0.4-9.1% for women and 1.4-11.8% for men in different age groups from 2001-2002 (Tseng, et al., 2005). The 6-year cumulative incidence of hemorrhagic stroke was 2.10% for men and 1.68% for women in 1997-2002 (Chen, et al., 2009). In Hsiao's study, it investigated the association between oral antihyperglycaemics and the incidence rates of MI and stroke in those with rosiglitazone monotherapy were 12.71% and 0.80% and the incidence rates of MI and stroke in those with pioglitazone monotherapy were 8.89% and 0.41% (Hsiao, et al.,

2009). By comparing those estimates with ours, our incidence rates of MI and stroke were higher than those in Chen's study (Chen, et al., 2009) and in Hsiao's study (Hsiao, et al., 2009). After comparing the ICD-9 code used in these two studies with ours, our ICD-9 codes were more comprehensive than those in Chen's and Hsiao's studies. This could be the explanation for higher estimates observed in our study.

All previous studies showed the trends of prevalence of type 2 diabetes were increasing globally. It increased 28.3% for men and 25.9% for women in Sweden during 1972-2001 (Jansson, et al., 2007), 48% in America during 1990-1998 (Mokdad, et al., 2000), 47% in England during 1994-2001 (Lusignan, et al., 2005), 69% in Canada during 1995-2005 (Lipscombe, et al., 2007), and 38% for men and 25% for women in Taiwan during 1999-2004. Our findings demonstrated that the trend of prevalence of type 2 diabetes also increased, which was consistent with those conducted in other countries. Previous studies examining the trend of type 2 diabetes incidence showed that both incidence rates in men and in women were increasing during 1992-1996 (Chang, et al., 2010), but it remained stable in men and slightly decreased in women during 1999-2004 after considering age and gender. In our study, we did not observe linear trend in incidence of type 2 diabetes after taking age, gender, insurance premium, and urbanization degree into account.

The P4P program for diabetes care in Taiwan was designed to increase the quality of care. The major financial incentive of this program is to encourage regular follow-up visits and physical exams for better monitoring and control of diabetes. This study examined the prevalence of laboratory tests for type 2 diabetes and found the trends significantly increased over the studied period. To compare two periods (before and

after implantation of P4P program) of the annual prevalence of laboratory tests, we found the increase in annual prevalence after implementation of P4P program was larger than that before implementation of P4P program. Lee and colleague used population-based natural experimental design with intervention (joining the P4P program) and comparison groups (never joined the P4P program) to observe the effects of P4P program for diabetes care in Taiwan. They discovered before the P4P program, the average number of laboratory tests performed in a year was similar between the two groups. After implementation of a P4P plan, the average number of laboratory tests performed increased in the intervention group from 3.8 in 2006 to 6.4 in 2007, and increased slightly from 3.5 to 3.6 in the comparison group (Lee, et al., 2010).

Our study had 5 strengths. First, we used nationwide data with a large sample size, emphasizing prevalence and incidence trends with an "International Classification of Diseases, 9th Revision, Clinical Modification". Second, Taiwan's NHI provides continuing universal coverage for the whole population, and it can avoid the selection bias. Third, we used the NHIRD; it could avoid minimizing the numbers of subjects in the cohort who were lost to follow-up. Forth, insurance claim datasets have longitudinal records. Thus, we can easily obtain for a large sample of geographically dispersed patients. Finally, such a large number of study subjects made us easy to do age- and sex stratified analyses without compromising the required sample size.

Chapter 6

Conclusion and Recommendations

6.1 Conclusion

Annual prevalence of type 2 diabetes increased in Taiwan during 2000-2007 whereas annual incidence increased slightly during 2000-2005 and then fluctuated during 2005-2007. Diabetes caused complications, and the complications account for much of the social and financial burden of diabetes. The annual prevalence rates of diabetes-related complications continued to increase but annual incidence was contrary to annual prevalence. We conjectured this is due to the longer survival rate of diabetics in the study period.

The P4P program for diabetes care in Taiwan was designed to promote the quality of care. After implementation of P4P program, the annual prevalence of laboratory tests of ACR, HbA1C, fasting lipid SGPT and microalbumin significantly increased faster than that before implementation of P4P program. We conclude that the P4P program has successfully promoted the regular follow-up visits and thus might improve quality of care of these enrolled patients.

6.2 Recommendations

We suggested that the study in the future can use NHI datasets which contain all patients with diabetes to explore the prevalence and incidence of type 2 diabetes and its complications. For laboratory tests, we should take advantages of values of laboratory tests to explore the outcome of health care quality in patients with diabetes in the future.

6.3 Research Limitations

There were also several limitations in our study. First, this study might have falsely classified some cases of type 1 diabetes as type 2 diabetes. However, we included patients with diabetics aged 30 years old and over to minimize the misclassification. Second, our study depended exclusively on claim data, which might result in potential intentional or unintentional disease misclassification bias. However, we included patients with at least three ambulatory claims or at least one inpatients claims with a diagnosis of diabetes during the specific year period to minimize the error. Third, this study may overestimate the prevalence and incidence of complications by including patients with type 1 diabetes. Forth, we could not analyze trends in mortality because NHIRD did not include information on mortality. Finally, the body mass index, waist circumference, blood pressure, smoking, diseases family history and the values of lab test were not available in the claim database and thus combining above information to discuss the prevalence and incidence of type 2 diabetes was beyond the scope of this study.

Chapter 7

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Appendix 1-National Health Insurance program to improve diabetes care benefit payment standards

全民健康保險糖尿病醫療給付改善方案支付標準

通則：Appendix 1

一、本方案支付標準按表訂項目及點數辦理，相關檢驗檢查及未訂項目按現行全民健康保險醫療費用支付標準辦理。

二、符合本方案之糖尿病病人，若合併其它疾病且分屬~~本局~~保險人辦理之不同方案收案對象時(例如：氣喘、高血壓....等)，除依本方案支付標準申報外，得再依相關方案申報費用。

編號	診療項目	支付點數
P1406B	完整性照護醫師診察費 註1：本項目限地區醫院(含)以上層級申報，且必須與P1407C、P1408C、P1409C合併申報，並不得再依支付標準申報診察費。 註2：本項基層診所回歸本保險支付標準診察費申報。	450點/次
P1404B	開立慢性病連續處方-連續二次以上調劑、每次給藥28天以上者 註1：本項目限地區醫院(含)以上層級申報，且必須與P1406B合併申報。 註2：本項基層診所回歸本保險支付標準診察費申報。	200點/次
P1407C	糖尿病新收案管理照護費 註：1.照護項目詳附表一，除檢驗檢查項目外，其費用已內含於本項所訂點數內。 2.每一病患於同一院所限申報一次。	400點/次
P1408C	糖尿病追蹤管理照護費 註：1.照護項目詳附表二，除檢驗檢查項目外，其費用已內含於本項所訂點數內。 2.申報新收案後至少須間隔7週才能申報本項，本項每年最多申報三次，每次間隔至少11週。	200點/次
	糖尿病年度評估管理照護費 註：1.照護項目詳附表三，除檢驗檢查項目外，其費用已內含於本項所訂點數內。	

編號	診療項目	支付點數
P1409C	2.申報追蹤管理後至少間隔11週才能申報本項，本項限執行P1407C及P1408C合計達三次(含)以上者始得申報，本項每年限申報一次。	800 點/次

新收案診療項目參考表（適用編號 P1407C）Components of the initial visit

1. 醫療病史（Medical history）	2. 身體檢查（Physical examination）
(1) 與診斷關聯之症狀、檢驗室結果 Symptoms, laboratory results related to diagnosis (2) 營養評估，體重史 Nutritional assessment, weight history (3) 過去及現在治療計畫 Previous and present treatment plans A. 藥物 Medications B. 營養治療 Medical Nutrition Therapy C. 病人自主管理訓練 Self-management training D. 血糖自我管理及其使用結果 SMBG and use of results (4) 現在治療執行方案 Current treatment program (5) 運動史 Exercise history (6) 急性併發症 Acute complications (7) 感染病史 History of infections (8) 慢性糖尿病併發症 Chronic diabetic complications (9) 藥物史 Medication history (10) 家族史 Family history (11) 冠狀動脈心臟病危險因素 CHD risk factors (12) 心理社會／經濟因素 Psychosocial/economic factors (13) 菸酒之使用 Tobacco and alcohol use	(1)身高與體重 Height and weight (2)血壓 Blood pressure ＊(3) 23501C 眼底鏡檢 Ophthalmoscopic examination（視網膜散瞳檢查；散瞳劑內含）或 23502C 眼底攝影；惟如由眼科專科醫師執行間接式眼底鏡檢查(23702C)，則不需再執行上述項目。 (4)甲狀腺觸診 Thyroid palpation (5)心臟檢查 Cardiac examination (6)脈搏評值 Evaluation of pulses (7)足部檢查 Foot examination (8)皮膚檢查 Skin examination (9)神經學檢查 Neurological examination (10)口腔檢查 Oral examination (11)性成熟度評估（如屬青春期前後）Sexual maturation (if peripubertal)
3. 檢驗室評值（Laboratory evaluation）	4. 管理計畫（Management Plan）
※(1)09005C 空腹血漿葡萄糖或微血管血糖 Fasting plasma glucose or capillary blood sugar ※(2)09006C 醣化血紅素 HbA1C ※(3)空腹血脂 Fasting lipid profile（09001C 總膽固醇 cholesterol , total、09004C 三酸甘油脂 triglyceride(TG)、09043C 高密度脂蛋白膽固醇 HDL cholesterol、09044C 低密度脂蛋白膽固醇 LDL cholesterol） ※(4)09015C 血清肌酸酐 Serum creatinine ※(5)09026C 血清麩胺酸丙酮酸轉胺基酶 SGPT (or ALT) ※(6)06013C 尿液分析（尿生化檢查）Urinalysis ¤ (7)12111C 微白蛋白(免疫比濁法，視情況而定)Microalbumin (Nephelometry, if indicated) ¤ (8)13007C 細菌培養鑑定檢查（視情況而定）Urine culture (if indicated) ¤ (9)27004C 甲狀腺刺激素放射免疫分析（第一型病人）TSH (type 1 patients) ¤ (10)18001C 心電圖(成人) Electrocardiogram (adults)	(1)短期與長期目標 Short- and long-term goals (2)藥物 Medications (3)營養治療 Medical nutrition therapy (4)生活型態改變 Lifestyle changes (5)自主管理教育 Self-management education (6)監測接受指導遵循度 Monitoring instructions ＊(7)年度轉診至眼科專科醫師（視情況而定）Annual referral to eye specialist (if indicated) (8)其他專科醫師會診（視情況而定）Specialty consultations (as indicated) (9)同意接受持續性支持或追蹤的約定 Agreement on continuing support / follow-up (10)協助預約流行感冒疫苗（influenza vaccine）接種（視個別院所情況而定）
5. 糖尿病自主管理教育	（Diabetes Self-management Education）

(1) 糖尿病自主管理教育（Diabetes Self-management Education, DSME）：由糖尿病人和衛教人員共同參與的一種互動的、整合式及進行中的過程，包括：a)個體特殊教育需求的評估; b)確認個體特殊的糖尿病自主管理目標之設定; c)依個別的糖尿病自主管理目標進行教育及促進行為改變上的介入; d)依個別的糖尿病自主管理目標進行評價。

(2) 建議標準如下：

A. 結構面：病歷紀錄應包括：a)描述糖尿病疾病過程及治療之選項；b)營養管理之整合；c)日常身體活動之整合；d) 針對治療效益來利用藥物（必要時）的情形；e)血糖監測、尿酮（必要時）及運用相關檢驗數據來改善急性合併症之預防、偵測與治療之情形；f)慢性合併症之預防（由減少危險行為著手）、偵測及治療之情形；g)生活型態改變—個人問題的診斷；h)以促進健康為主來設定的目標，及日常生活中問題解決的方式；i)與日常生活中心理社會調適之整合；j)懷孕婦女及妊娠性糖尿病的管理（含 preconception care）。

B. 過程面：病歷紀過錄應包括：個案評估、衛生教育計畫、介入、評價及定期追蹤之情形，並記錄衛教人員、醫師及轉診資源等醫療團隊之整體式照護。

C. 結果面：提供糖尿病自主管理教育的單位或機構，應進行持續性品質改善計畫，以結果面來評估衛生教育之效益及提出品質改善的機會。

註：
1.參照 American Diabetes Association: Clinical Practice Recommendations 2001。
2.表列檢驗、檢查與服務項目中，「※」及「＊」註記表示為診療指引建議必要執行診療項目，「¤」註記表示為診療指引建議得視病人病情（if indicated）為選擇性執行項目。
3.本表所列項目除有「※」、「＊」及「¤」註記項目得另行核實申報費用以外，餘均內含於 P1407C 所訂費用之內，不得另行重複申報。

追蹤管理診療項目參考表（適用編號 P1408C）

Potential components of continuing care visits

<table>
<tr><td>1. 醫療病史（Medical history）</td><td>2. 身體檢查（Physical examination）</td></tr>
<tr><td>(1) 評估治療型態 Assess treatment regimen
A. 低或高血糖之頻率／嚴重度 Frequency/severity of hypo-/hyperglycemia
B. 自我血糖監測結果 SMBG results
C. 病人治療型態之調整 Patient regimen adjustments
D. 病人接受專業指導遵循度之問題 Adherence problems
E. 生活型態改變 Lifestyle changes
F. 併發症的症狀 Symptoms of complications
G. 其他醫療疾病 Other medical illness
H. 藥物 Medications
I. 心理社會方面 Psychosocial issues
J. 菸酒之使用 Tobacco and alcohol use</td><td>(1) 每次常規性糖尿病回診 Every regular diabetes visit
A. 體重 weight
B. 血壓 Blood pressure
C. 先前身體檢查之異常點 Previous abnormalities on the physical exam
(2) 足部檢查（視情況而定）：足部狀況屬高危險性者需增加檢查次數 Foot examination (if indicated): more often in patients with high-risk foot conditions</td></tr>
<tr><td>3. 檢驗室評值（Laboratory evaluation）</td><td>4. 管理計畫評值（Evaluation of Management Plan）</td></tr>
<tr><td>※(1)09006C 糖化血紅素 HbA1C
A. 三個月一次為原則，須配合初診及年度檢查的結果追蹤（Quarterly if treatment changes or patient is not meeting goals）
B. 如病情穩定一年至少二次（At least twice per year if stable）
※(2)09005C 空腹血漿葡萄糖或微血管血糖 Fasting plasma glucose or capillary blood sugar</td><td>(1) 短期與長期目標 Short- and long-term goals
(2) 藥物 Medications
(3) 血糖 Glycemia
(4) 低血糖之頻率／嚴重度 Frequency/severity of hypoglycemia
(5) 血糖自我管理結果 SMBG results
(6) 併發症 Complications
(7) 血脂異常之控制 Control of dyslipidemia
(8) 血壓 Blood pressure
(9) 體重 Weight
(10) 營養治療 Medical Nutrition Therapy
(11) 運動治療型態 Exercise regimen
(12) 病人接受自主管理訓練之遵循度 Adherence to self-management training
(13) 轉診之追蹤 Follow-up of referrals
(14) 心理社會之調適 Psychosocial adjustment
(15) 糖尿病知識 Knowledge of diabetes
(16) 自主管理技能 Self-management skills
(17) 戒菸（若為抽菸者）Smoking cessation, if indicated
(18) 協助預約流行感冒疫苗（influenza vaccine）接種（視個別院所情況而定）</td></tr>
<tr><td colspan="2">5. 糖尿病自主管理教育 （Diabetes Self-management Education）</td></tr>
<tr><td colspan="2">建議標準如下：
A. 結構面：按前次照護結果做追蹤應付，病歷紀錄應包括：a)描述糖尿病疾病過程及治療之選項；b)營養管理之整合；c)日常身體活動之整合；d) 針對治療效益來利用藥物（必要時）的情形；e)血糖監測、尿酮（必要時）及運用相關檢驗數據來改善急性合併症之預防、偵測與治療之情形；f)慢性合併症之預防（由減少危險行為著手）、偵測及治療之情形；g)生活型態改變一個人問題的診斷；h)以促進健康為主來設定的目標，及日常生活中問題解決的方式；i)與日常生活中心理社會調適之整合；j)懷孕婦女及妊娠性糖尿病的管理（含 preconception care）。
B. 過程面：病歷紀錄應包括：個案評估、衛生教育計畫、介入、評價及追蹤之情形，並記錄衛教人員、醫師及轉診資源等醫療團隊之整體式照護。
C. 結果面：提供糖尿病自主管理教育的單位或機構，應進行持續性品質改善計畫，以結果面來評估衛生教育之效益及提出品質改善的機會。</td></tr>
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2.表列檢驗及服務項目中，「※」及「＊」註記表示為診療指引建議必要執行診療項目。

3.本表所列項目除有「※」、「＊」註記項目得另行核實申報費用以外，餘均內含於 P1408C 所訂費用之內，不得另行重複申報。

年度檢查診療項目參考表（適用編號 P1409C）

Potential components of continuing care visits（annual exam）

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G. 其他醫療疾病 Other medical illness
H. 藥物 Medications
I. 心理社會方面 Psychosocial issues
J. 菸酒之使用 Tobacco and alcohol use</td><td>(1)年度身體檢查 Physical examination annually
＊(2) 23501C 年度散瞳眼睛檢查 Dilated eye examination annually 或 23502C 眼底攝影；惟如由眼科專科醫師執行間接式眼底鏡檢查(23702C)，則不需再執行上述項目。
(3)每次常規性糖尿病回診 Every regular diabetes visit
A. 體重 weight
B. 血壓 Blood pressure
C. 先前身體檢查之異常點 Previous abnormalities on the physical exam
(4)年度足部檢查：足部狀況屬高危險性者需增加檢查次數 Foot examination annually; more often in patients with high-risk foot conditions</td></tr>
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<tr><td>※(1) 09006C 糖化血紅素 HbA1C
※(2) 09005C 空腹血漿葡萄糖或微血管血糖 Fasting plasma glucose or capillary blood sugar
※(3) 年度空腹血脂 Fasting lipid profile annually, unless low risk（09001C 總膽固醇 cholesterol , total、09004C 三酸甘油脂 triglyceride(TG)、09043C 高密度脂蛋白膽固醇 HDL cholesterol、09044C 低密度脂蛋白膽固醇 LDL cholesterol）
※(4)09015C 血清肌酸酐 Serum creatinine
※(5)09026C 血清麩胺酸丙酮酸轉胺基酶 SGPT (or ALT)
※(6)06013C 尿液分析（尿生化檢查）Urinalysis
¤ (7)12111C 微白蛋白(免疫比濁法，視情況而定)Microalbumin (Nephelometry, if indicated)
¤ (8)18001C 心電圖(成人)Electrocardiogram (adults)</td><td>(1) 短期與長期目標 Short- and long-term goals
(2) 藥物 Medications
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