UNIVERSITY OF SOUTHAMPTON

FACULTY OF LAW, ARTS & SOCIAL SCIENCES

School of Social Sciences

Socioeconomic status and diabetes among Mexican adults

Analysis of the 2000 National Health Survey and the Mexican Family Life Surveys 2002 and 2005

by

Ivonne Yedid Nava-Ledezma

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ABSTRACT

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Diabetes is a significant health problem in Mexico and one of the leading causes of death. Studies in other countries have suggested that socioeconomic status (SES) contributes to the development of type 2 diabetes. However, only few studies in Mexico have dealt with SES differentials in diabetes. The aim of this thesis is to examine the association between SES and type 2 diabetes among Mexican adults aged 20-69. In contrast with previous studies, we use individual, household and municipality measures of SES simultaneously when investigating: prevalence of total, diagnosed and undiagnosed diabetes in the year 2000; and incidence of diagnosed diabetes during the period 2002-2005. Furthermore, we explore the effects of diabetes on employment status, and changes in waist circumference (WC) among adults with diabetes.

Data were used from the 2000 National Health Survey (NHS-2000) and the Mexican Family Life Surveys 2002 and 2005 (MxFLS-2002 and MxFLS-2005). Diabetes was defined using self-reports (in both surveys) and outcomes from capillary blood tests (only in the NHS). SES was measured through educational attainment, household income, household wealth and municipality deprivation. The index of household wealth was calculated and evaluated using the National Survey of Household Income and Expenditure (ENIGH-2000). The Human Development Index (HDI) and the Deprivation Index (DI) at the municipality level are official statistics obtained from the 2000 Mexican Census of population. Two level logistic regression models were estimated, and the analyses were stratified mainly by sex, urban/rural stratum and municipality deprivation.

Our findings confirm an association between socioeconomic status and diabetes. However, this relationship varies by SES measure, sex, urbanisation and deprivation. A consistent result was that diabetes was more common among the less educated, in the least deprived municipalities, and in urbanised localities. Variations in diabetes between municipalities were better explained by genetic, biological and lifestyle factors, than by SES. Diabetes was associated with working status, but not with employment status or changes in WC. Increases in urbanisation and further socioeconomic development, in combination with increased life expectancy, will lead to a higher prevalence of diabetes particularly among the most vulnerable groups. In addition to the promotion of healthy behaviours in the overall Mexican population, health sustainability should be prioritized in those communities at early stages of the nutritional and epidemiological transition.

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Declaration of authorship

I, **Ivonne Yedid Nava-Ledezma** declare that the thesis entitled **Socioeconomic status and diabetes among Mexican adults. Analysis of the 2000 National Health Survey and the Mexican Family Life Surveys 2002 and 2005,** and the work presented in it are my own and has been generated by me as the result of my own original research. I confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University;
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
- Where I have consulted the published work of others, this is always clearly attributed;
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
- I have acknowledged all main sources of help;
- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
- None of this work has been published before submission.

Signed: ……………………………………………………………………………………….

Date: ..………………………………………………………………………………………

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Abbreviations

ADA	American Diabetes Association
AGEB	Area Geo-Estadística Básica (Basic Geo-Statistical Area)
BMI	Body Mass Index
BRFSS	Behavioural Risk Factor Surveillance System
CHD	Coronary Heart Disease
CONAPO	Consejo Nacional de Población (National Population Council)
DI	Deprivation Index
ENIGH	Encuesta Nacional sobre Ingresos y Gastos de los Hogares (National Survey of Household Income and Expenditure)
ENURBAL	Encuesta Urbana de Alimentación y Nutrición en la zona metropolitana de la Ciudad de México (Mexico City Urban Food and Nutrition Survey)
FHD	Family History of Diabetes
HDI	Human Development Index
IDF	International Diabetes Federation
IMSS	Instituto Mexicano del Seguro Social (Mexican Social Security Institution)
INEGI	Instituto Nacional de Estadística, Geografía e Informática (National Institute of Statistics, Geography and Informatics)
ISSSTE	Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado (Government Worker's Social Security and Services Institute)
MxFLS	Mexican Family Life Survey (Encuesta Nacional sobre los Niveles de Vida de los Hogares)
NHANES	National Health and Nutrition Examination Survey
NHEFS	NHANES I Epidemiologic Follow-Up Study
NHS	National Health Survey (Encuesta Nacional de Salud)
NHSNUT	National Health and Nutrition Survey (Encuesta Nacional de Salud y Nutrición)
NPHS	National Population Health Survey
SEP	Socioeconomic position

SES	Socioeconomic status
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WC	Waist Circumference
WHO	World Health Organization
WHR	Waist-to-hip ratio

1 INTRODUCTION

1.1 Motivation of the study

Diabetes is a significant public health problem in the world. The estimated prevalence of diabetes in developing countries is about 6%, and about half is undiagnosed (WHO, 2002). Mexico has a high number of cases of diabetes mellitus and estimations predict that there will be a considerable increase after 2025. The World Health Organization estimated that there were about 2 million Mexican people with diabetes in the year 2000 (WHO, 2006). An estimate for 2003 reported two times this figure among people aged 20-79 years (IDF, 2003). Moreover, it located Mexico as the ninth country with a large number of people with diabetes. It was projected that these figures will increase to between 6 and 9 million after 2025 (IDF, 2003; WHO, 2006). However, these figures may have already been reached. A recent study that updated the International Diabetes Federation (IDF) figures showed that the estimated number of people with diabetes for 2010 is 6.8 million, and the new projection for 2030 is of 11.9 million (Shaw et al., 2010).

The National Health Survey 2000 (NHS-2000) estimated that 7.5% of the adults aged 20 years and over has diabetes mellitus (Olaiz et al., 2003). Alarmingly, 20% of the adults with diabetes were unaware of having this condition. For 2003, the IDF calculated that the crude prevalence was 7.4% for the population between 20 and 79 years old and it projected that it would increase to 10.3% for 2025 (IDF, 2003). However, studies in urban areas (Amato et al., 2005; Avila-Curiel et al., 2007) and restricted to the 20-69 age group (Velazquez-Monroy et al., 2003) have revealed a prevalence of diabetes higher than in the national population. Hence, it can be concluded that the prevalence of diabetes in Mexico appears to be higher than the average prevalence for a developing country.

In the long term diabetes leads to health complications such as heart disease, blindness, nerve damage, and kidney damage (ADA, 2004). Nerve damage affects blood circulation leading gradually to stomach dysfunction and amputations. Therefore, the presence of complications may affect the mobility of people, their quality of life and life expectancy. In Mexico, diabetes mellitus is one of the leading causes of death among adults. Diabetes mortality trends have increased from 1980 to 2000 (Barquera et al., 2003b). In 2003, diabetes mellitus was the second biggest cause of mortality in women (15.4 x 100,000 inhabitants) and the third in men (10.3 x 100,000 inhabitants), (INEGI, 2010).

The complications of diabetes can be prevented by controlling the blood glucose levels to prevent hyperglycaemia. However, the majority of the people with diabetes in Mexico do not achieve glycaemic control (Olaiz et al., 2003). Studies in developed countries have shown that poor glycaemic control occurs more frequently among the more disadvantaged (Bihan et al., 2005; Larranaga et al., 2005; Reisig et al., 2007; Weng et al., 2000). Therefore, mortality rates among people with diabetes are higher among the lowest SES groups (Chaturvedi et al., 1998; Gnavi et al., 2004; Weng et al., 2000).

Glycaemic control and the management of the complications derived from diabetes can be very expensive for the government and the uninsured population (Amato et al., 2005; Arredondo et al., 2007; Arredondo et al., 2004; Arredondo et al., 2005). In 2000, about 60% of the population was uninsured (INEGI, 2000). Since the Mexican Social Security Institution (IMSS), Government Worker's Social Security and Services Institute (ISSSTE) and other public medical services are available only for salaried workers and their families (Pagan et al., 2005), the rest of the population has to pay for private health care.

Moreover, poor health may result in a lower socioeconomic status (Brown et al., 2004). Diabetes may have an effect firstly, on the employment of the people and, subsequently, on their income. People with diabetes are more likely to have work limitations (Tunceli et al., 2005; Vijan et al., 2004) or to rate themselves as having disabilities (Vijan et al., 2004). These limitations and disabilities may lead firstly to low productivity (Bastida et al., 2002), and higher absenteeism from work (Vijan et al., 2004); and afterwards, to a lower probability of working (Bastida et al., 2002; Kraut et al., 2001; Tunceli et al., 2005), or early retirement (Vijan et al., 2004).

The evidence on the link between diabetes and income is conflicting. A study in the United States did not show differences in income between people with and without diabetes (Kahn, 1998). Other studies in Canada and the UK showed that, if differences exist, it may be due to the presence of complications (Holmes et al., 2003; Kraut et al., 2001).

The increase in the prevalence of diabetes in Mexico and its clinical and socio-economical consequences, have led health policy and health programmes to focus on the prevention, screening and control of this condition with the purpose of providing a better quality of life to the individuals (Aguilar-Salinas et al., 2000; Aguilar-Salinas et al., 2006). Information about risk groups is fundamental for the design of health policies and programmes. Most of the work conducted in Mexico related to diabetes has focused mainly on clinical outcomes, and rarely on demographic characteristics, risk factors, co morbidities, and complications. Few studies have investigated the association between socioeconomic factors and the prevalence of diagnosed and undiagnosed diabetes (Avila-Curiel et al., 2007; Olaiz-Fernandez et al., 2007; Olaiz et al., 2003; Vazquez-Martinez et al., 2006). Currently, the government is giving priority to the prevention of chronic diseases, and proposes a multidisciplinary strategy for public health policy design; nevertheless, studies rarely include a multidisciplinary aspect. In this context, the purpose of this study is to examine the socioeconomic factors associated not only with the prevalence of diabetes, but with diabetes incidence. In addition, the high prevalence of type 2 diabetes among adults suggests that the studies target this type of diabetes.

This thesis adds to previous studies in Mexico by undertaking analysis of the first two waves of a nationally representative longitudinal survey to examine the association between diabetes and socioeconomic status. In contrast with former studies, we analyze the influence of area deprivation on diabetes by using two level logistic regression models and by evaluating two municipality deprivation measures: the Human Development Index (HDI) and the Deprivation Index (DI). Therefore, we incorporate socioeconomic factors at the individual, household and community levels while controlling for potential mediators. Furthermore, we introduce a household wealth measure that is constructed and validated using auxiliary data with accurate information on income and expenditure. Additionally, the analyses are carried out by municipality deprivation and urban-rural areas to reveal SES differentials in diabetes within these strata.

1.2 Aims of the study

The aim of this thesis is to determine the association between socioeconomic status (SES) and the prevalence and incidence of diabetes in Mexican adults. The study focuses in adults aged 20-69 years old because, firstly, a high prevalence of type 2 diabetes (10.7%) was reported by the NHS-2000 in this age group (Velazquez-Monroy et al., 2003). Secondly, because it includes the working-age population (15-64 years), (INEGI, 2010). And thirdly, because it includes a minimum age in which adults finish high school (at least 18 years old).

Since the NHS-2000 includes diabetes self-reports and capillary blood tests, it gives the opportunity to analyze three aspects of the prevalence of diabetes: total diabetes, self-reported diabetes, and undiagnosed diabetes. Total diabetes was defined by self-report and a capillary blood test. In the Mexican Family Life Surveys 2002 and 2005 (MxFLS-2002 and MxFLS-2005) only the incidence of "self-reported diabetes" is analyzed. The SES measures investigated in this thesis are: education, household income, household wealth, and municipality deprivation.

We hypothesise that the relationship between type 2 diabetes and socioeconomic status is: 1) the same as the one presented in other countries or regions with a similar economic development and at similar stages of the nutritional and epidemiological transition; and 2) the same as the relationship between SES and obesity in Mexico, since obesity is a relevant risk factor for diabetes.

Mexico is a country with a high human development that can be considered at an advanced stage of the epidemiological transition. In the period from 1998 to 2000 it was ranked as one of the top ten countries with medium human development; and then among the last 20 places with high human development from 2001 to 2005 (UNDP, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2008). In addition, the increased burden of non communicable diseases locates Mexico at an advanced stage of the epidemiological transition (Stevens et al., 2008). Developed countries are distinguished by a high prevalence of obesity and chronic and degenerative diseases, characteristics of countries that are at an advanced stage of the epidemiological and nutritional transition (Popkin, 2002). Therefore, the association between diabetes and SES in Mexico could be close to that of developed countries.

Our literature review showed that, in countries with a high human development, the relationship between SES and the prevalence of diabetes tends to be negative. This agrees with a review of the literature that observed that countries with higher socio-economic development tend to present a negative association between obesity and socioeconomic status (McLaren, 2007). Furthermore, a study in Mexico revealed that obesity has a negative association with SES at the country level (Rivera et al., 2004). Hence, a negative relationship between socioeconomic status and the prevalence of diabetes (self-reported and total) is expected at the national level.

In our literature review we found that the negative association between SES and the prevalence of diabetes occurred more frequently in the measures of education, household income, and area SES. However, there were not any studies that examined the association between the prevalence of diabetes and assets and material belongings. We hypothesize that the negative relationship between the prevalence of diabetes and SES at the national level occurs across all our SES measures.

Within Mexico, the regions may experience different stages of the epidemiological and nutritional transition according to their economic development and levels of urbanisation. According to the report of the 2000 Human Development Index (HDI) calculated for Mexican states, while the HDI of Mexico City (0.871) is comparable to that of Portugal or Slovenia, the HDI of Chiapas (0.693) is similar to that of countries such as Algeria and Vietnam (CONAPO, 2001a). If the economic development of the countries can be reflected in the Mexican regions, then the negative association at the national level may not be homogenous across regions with different socio-economic development.

Our literature review showed that countries with large variations in the economic development of their regions, such as India, tend to have: a positive association between diabetes and urbanisation (Ramachandran et al., 2008); a negative relationship between diabetes and SES in urbanised areas; and a positive relationship between diabetes and SES in less urbanised areas (Reddy et al., 2007). In Mexico, the possibility of a positive association between diabetes and SES in less urbanised areas is supported by findings that suggest that there may be a positive relationship between Body Mass Index (BMI) and SES in the poorest rural populations (Fernald et al., 2007). Therefore, a negative relationship between diabetes and SES is expected in urban areas and in municipalities with lower deprivation; and a positive relationship is expected in rural areas and municipalities with higher deprivation. In addition, we expect a positive association between diabetes and urbanisation.

According to our literature review, only few studies examined the association between the incidence of diabetes and SES. Consequently, it was not possible to detect patterns in the associations. The analysis by education and household income slightly resembles the pattern of the prevalence of diabetes. Thus, we hypothesize that the association between SES and the incidence of diabetes is similar to that between SES and the prevalence of diabetes.

Undiagnosed diabetes was mostly not associated with SES in our literature review, especially with education and household income. Only one study in Mexico found a negative association between undiagnosed diabetes and SES (Vazquez-Martinez et al., 2006). However, it lacked adjustment for risk factors. Since undiagnosed diabetes may be linked to the lack of health insurance, we expect that adults in the lowest SES groups or living in rural areas are more likely to have undiagnosed diabetes compared with adults in higher SES groups or living in urban areas.

The MxFLS-2002 and MxFLS-2005 is the first longitudinal national representative survey; hence, we use it to investigate two more questions on the relationship between diabetes and SES. Firstly, we explore the relationship between diabetes and employment status. We investigate if adults with diabetes have a lower probability of being employed than adults without diabetes; and if this association is stronger among adults with a longer duration of diabetes.

Weight control is important for the prevention and management of diabetes. On one hand, obesity is a strong risk factor for diabetes (WHO, 2002). On the other, decreases in weight have been associated with improvement of glycaemic levels among people with Impaired Glucose Tolerance (IGT), (Pan et al., 1997a; Tuomilehto et al., 2001); and even reversal of this condition (Schafer et al., 2007). However, only few people with diabetes in Mexico achieve weight control (Aguilar-Salinas et al., 2003). In Mexico, socioeconomic status is associated with obesity (Fernald, 2007; Gomez et al., 2009). However, little is known about the association between SES and changes in weight among people with and without diabetes.

Studies show that adults recently diagnosed with diabetes have a higher prevalence of obesity than adults with a longer duration of diabetes (Aguilar-Salinas et al., 2003). It is possible that adults recently diagnosed with diabetes had obesity at the time of diagnosis, and then achieved (or kept) a normal weight as part of the diet and exercise treatment. In addition, it is possible that wealthier adults and the more educated were more likely to follow this treatment.

In chapter 6 we explore the association between diabetes and weight control. Moreover, we explore if this association differs by SES and time of diagnosis. We consider "achieving a normal weight" or "keeping a normal weight" as measures of good weight control. We selected abdominal obesity (measured by waist circumference) because it may be the most important predictor of diabetes among the measures of obesity. Hence, we explore if adults with abdominal obesity in the highest SES groups were more likely to achieve a normal waist circumference after being diagnosed with diabetes than adults with abdominal obesity in the lowest SES groups. We also explored the association between SES and diabetes among adults with normal waist circumference at baseline.

In summary, the research questions for this study are:

- Is there a relationship between the prevalence and incidence of diabetes and SES? If so, what is the nature of this relationship? Does the relationship between diabetes and SES vary by urban/rural areas, level of municipality deprivation and sex?
- What is the relationship between diabetes and employment status?
- Is there a relationship between diabetes and waist circumference change? If so, is change in waist circumference related to SES?

1.3 Structure of thesis

The thesis is organized in six chapters. Chapter two covers the literature review. It begins describing how diabetes mellitus is defined and characterized. Then, we present a systematic literature review on the association between diabetes and socioeconomic status. After that, we present a simplified theoretical framework to explain the mechanisms that link diabetes and socioeconomic status. The chapter finishes with a review on the types of asset-based measures of socioeconomic status at the household level, and the methods used to compute them.

Chapter 3 introduces the data and statistical methods used in the analyses. It describes aspects of the collection of the data and general characteristics of the three main datasets: the National Health Survey (NHS-2000); the Mexican Family Life Surveys 2002 and 2005 (MxFLS-2002 and MxFLS-2005); and the National Survey of Household Income and Expenditure (ENIGH-2000). It also illustrates how the measures of municipality deprivation were computed. The statistical methods section is divided in two parts. Firstly, it presents the ordinary linear regression and logistic regression that were used in the analyses of chapters 5 and 6. Then, it introduces the method of principal components analyses used in chapter 4.

Chapter four refers to the calculation and validation of an index of household wealth to be used in the NHS-2000. The chapter begins introducing the data and methods used to construct this index. In the first section of the results, linear regression was used to select which household assets, materials and facilities should be included in the index of household wealth. In the second section, the selected indicators were aggregated using principal components analysis. Then, the index of household wealth was compared against different measures of income and expenditure. In the third section, the index was categorized in order to approach the poverty lines.

Chapter five covers the analysis of the prevalence of diabetes. The analysis begins with an introduction to the data and methods used. Then it presents the analysis of the relationship between socioeconomic status and: diabetes, self-reported diabetes and undiagnosed diabetes.

Chapter six presents the analyses of the MxFLS-2002 and MxFLS-2005. Firstly, the data and methods used are introduced. Then, the chapter is divided in three sections. The first section examines the relationship between socioeconomic status and the incidence of diabetes. The second section explores the association between diabetes and employment status. And finally, the third section explores the association between diabetes and waist circumference change.

Last of all, chapter seven presents the conclusions of the thesis organized according to the research questions; the policy implications; and the recommendations for further work. The appendices and references are presented at the end of the thesis.

2 BACKGROUND, REVIEW OF THE LITERATURE AND THEORETICAL FRAMEWORK

2.1 Introduction

This chapter provides the background information and fundamental theory for this study. Section 2.2 begins with the definition of diabetes mellitus. Additionally, it describes how diabetes mellitus is classified; how it is diagnosed; and the risk factors for diabetes. In section 2.3 we present a systematic literature review on the association between diabetes and socioeconomic status. This section begins describing the methodology used for the search and analysis of the sources of information. Then, the section is divided in three parts that describe the relationship between socioeconomic status and: the prevalence of self-reported and total diabetes; the prevalence of undiagnosed diabetes; and the incidence of diabetes. In section 2.4 we present the theoretical framework for the relationship between diabetes and SES. We considered necessary to construct and validate a measure of socioeconomic status at the household level. Therefore, section 2.5 presents a review about asset-based measures of socioeconomic status at the household level. A summary of the chapter is presented in section 2.6.

2.2 Diabetes mellitus: definition, classification, diagnosis and risk factors

According to the World Health Organization (WHO, 2002): "diabetes mellitus is a group of diseases characterized by an elevated blood glucose level (hyperglycaemia) resulting from defects in insulin secretion, in insulin action, or both". The endocrine system consists of endocrine glands situated in different parts of the human body that synthesise and secrete chemical messengers called hormones (Waugh, 2006). The insulin is a hormone generated by the pancreatic β cells whose function, among others, is to enhance the entry of glucose into the cells; and to enhance the storage of glucose as glycogen, or conversion to fatty acids (Waugh, 2006). Hence, insulin acts as a regulator of the glucose in the blood.

Currently, diabetes mellitus is classified as: type 1 diabetes mellitus, type 2 diabetes mellitus, gestational diabetes mellitus, and other specific types of diabetes mellitus (WHO, 2002). Type 1 diabetes is distinguished by the destruction of the isle β-cells and, although it can occur at any age, it mainly develops during childhood and adolescence. Type 1 diabetes is caused by genetic factors, and probably by virus infections and nutritional factors (WHO, 2002). Individuals who have this condition may require insulin for survival (ADA, 2004). Type 2 diabetes is caused by insulin resistance or reduced insulin sensitivity which results in a relative insulin deficiency (WHO, 2002). Approximately 90% to 95% of people with diabetes have this form of diabetes (ADA, 2004). Gestational diabetes mellitus (GDM) occurs if there is glucose intolerance during pregnancy (WHO, 2002). The presence of GDM can alter the duration of pregnancy or contribute in the development of placental failure, hypertension, or high birth weight of the newborn (WHO, 2002). The "other types of diabetes" are due to genetic defects of the islet β-cell function or insulin action, to diseases of the pancreas, to anomalies in the endocrine system, drugs, chemicals, infections, genetic syndromes and others (WHO, 2002). Of the several types of diabetes, this study focuses on type 2 diabetes.

The presence of diabetes symptoms, the presence of risk factors, and the measurement of glucose through laboratory tests, are used for the screening of type 2 diabetes and identification of individuals at high risk of this condition (WHO, 2002). The most common symptoms of diabetes mellitus are excessive thirst, frequent urination, weight loss, blurred vision and susceptibility to infections (ADA, 2004). However, type 2 diabetes is usually undiagnosed for several years during which symptoms may not be noted (ADA, 2004).

The risk of type 2 diabetes increases with family history of diabetes (FHD) particularly in parents or siblings; obesity or abdominal obesity; age over 45; previously identified Impaired Glucose Tolerance (IGT) or Impaired Fasting Glycaemia (IFG); hypertension (over 140/90 mmHg in adults); high cholesterol level or triglyceride levels; reduced physical activity; history of GDM or babies delivery of more than 4.5 kg (WHO, 2002); low birth weight (Whincup et al., 2008); and being members of some ethnic groups such as Hispanic American, Native American, Asian American, African American (ADA, 2004), Asian Indians, Chinese, Australian Aborigines, Polynesians and Micronesians

(WHO, 1999). Age, obesity, family history of diabetes, and ethnicity were used as control variables in the regression models of chapters 5 and 6.

The purpose of the laboratory tests is to measure the glucose concentration in specimens such as: whole blood (capillary or venous blood), plasma, serum, urine and others (WHO, 2002). The most common laboratory measures are fasting plasma glucose (FPG), fasting blood glucose (capillary or venous), glucosuria, glycated haemoglobin (HbA_{1c}), and oral glucose tolerance test (OGTT), (WHO, 2002). The blood glucose values for diagnosis of diabetes mellitus depend on the laboratory measure that was used. FPG is recommended as the first step of screening, followed by a confirmation test (WHO, 2002). The American Diabetes Association (ADA) recommends classifying people as having diabetes if they have random (casual) plasma glucose levels of 200 mg/dL or higher and present symptoms; or fasting plasma glucose levels of 126 mg/dL or higher (ADA, 2004). HbA_{1c} is also recommended although it is more expensive than FPG (WHO, 2002). A person who has FPG values between 100-125mg/dL is considered as having impaired glucose tolerance (IGT) which is a pre-diabetes condition where people do “not” have diabetes but are at high risk of developing it (ADA, 2004).

Capillary blood glucose is not only a good approximation to FPG (WHO, 2002), but it is useful in epidemiological studies because it is not as costly as others, and it is easier to measure. The respective values for capillary blood are 200 mg/dL for random and 126 mg/dL for fasting using the ADA criteria (ADA, 2004); or 110 mg/dL for fasting using the WHO criteria (WHO, 1999). The IGT values for capillary blood are 100-110 mg/dL (WHO, 1999). In chapter 5, the values for capillary blood according to the WHO criteria were used to classify adults as having diabetes or not.

For a person with diabetes, having good glycaemic control is important to prevent diabetes related complications. People have adequate management of diabetes or good glycaemic control if they are able to maintain their blood glucose levels as close to normal as possible (WHO, 2002). Insulin resistance may improve with weight reduction and pharmacological treatment of hyperglycaemia (ADA, 2004; Schafer et al., 2007; Tuomilehto et al., 2001). People with a more severe hyperglycaemia may require a continuous self-monitoring which is normally easier using blood glucose meters for the measurement of capillary blood glucose (WHO, 2002). Chronic hyperglycaemia can result in long-term complications such as ischemic heart disease (IHD), stroke, retinopathy, nephropathy, neuropathy, cataracts, diabetic foot, among others (WHO, 2002).

When epidemiological studies are designed, age of diagnosis and the use of insulin are important variables to differentiate individuals with type 1 and type 2 diabetes. WHO suggests that type 1 diabetes can appear before age 35 (WHO, 2002). In one study all adults under 30 years old were categorized as having type 1 diabetes (Geyer, 2004). In another, all people with diabetes were classified as having type 1 diabetes if they were under 35 years old and had a requirement of insulin (Evans et al., 2000). Two studies classified as adults with type 1 diabetes those with an age of diagnosis before 31 years and current treatment with insulin (Connolly et al., 2000; Xu et al., 2006). Others classified as adults with insulin dependent diabetes mellitus those with an age of diagnosis before 40 years and current treatment with insulin (Hazuda et al., 1988; Robbins et al., 2001; Stern et al., 1984). In chapter 5, age 30 and current insulin use were considered to distinguish between adults with type 1 and type 2 diabetes, as in other studies (Ismail et al., 1999).

The thesis focuses on the prevalence and incidence of diabetes. In epidemiology, prevalence refers to the total number of events of a given disease in a given population at a specific time (Last, 2001). We analyze the prevalence of diabetes, number of adults with diabetes, in the year 2000. For this year we analyze three aspects of diabetes: self-reported diabetes, undiagnosed diabetes and total diabetes. On the other hand, incidence refers to the number of new events or cases during a defined period and population (Last, 2001). The incidence of diagnosed diabetes in Mexican adults is analyzed over the period 2002-2005.

2.3 Review of the literature on type 2 diabetes and socioeconomic status in adults

In this section we present a systematic review of the literature on the association between "type 2 diabetes and socioeconomic status in adults". To our knowledge, this topic has not been reviewed; however a previous study reviewed the association between socioeconomic status and obesity, a major risk factor for diabetes (McLaren, 2007). In their review, the selected articles covered countries with different levels of socioeconomic development and varying types of socioeconomic indicators (from personal to area measures of SES). Findings revealed that negative associations between obesity and SES (higher prevalence of obesity among the lowest SES groups) were more likely to be observed among the more developed countries; and positive associations (higher prevalence of obesity among the highest SES groups) were more frequent among less developed countries. Moreover, in highly developed countries, negative associations were more commonly found with education and occupation measures; and in countries with medium and low human development, positive associations were more commonly observed with income and material possessions.

Because obesity is an important risk factor for diabetes, it is possible that the association between diabetes and SES reflects the association between obesity and SES. Thus, it may be significant to explore the association between diabetes and SES by level of socioeconomic development of the countries. Moreover, we analyze the review separately in three sections that are the main topics of the thesis: prevalence of diabetes; incidence of diabetes; and prevalence of undiagnosed diabetes. For each of these topics, the research questions are:

- What is the nature of the association between type 2 diabetes and socioeconomic status in adults (e.g. positive, negative)?
- Does the association between type 2 diabetes and socioeconomic status in adults vary by socioeconomic development of the country?
- Are negative (or positive) associations more common among specific SES measures?

2.3.1 Methods

2.3.1.1 Study identification

The articles were searched for in the database ISI Web of Knowledge in the period up to May 2009. ISI Web of Knowledge comprises the databases web of science, BIOSIS Previews, and MEDLINE. Search terms (in the title) included "diabetes" and related terms (e.g. glucose, insulin resistance, OGTT and HBA1C) and "socioeconomic" and related terms (e.g. socio-economic, social and economic, educational attainment, occupation, income, household wealth, deprivation, poverty and urbanis(z)ation). The terms glucose/insulin resistance with deprivation were avoided because most of the resulting articles were related to biology and pharmacology. Search language was restricted to English. The title and the abstract (if available) of the articles returned were examined. The full-article was retrieved for those which pointed out some sort of association between type 2 diabetes and SES in adults; whether in prevalence or incidence of diabetes (total, self-reported or undiagnosed). Articles were retrieved whether the association was significant or not, or even if they did not present a measure of the strength of the association. Only articles were taken into account; thus, reviews, commentaries, letters, meeting abstracts and editorials were excluded. Afterwards, additional articles were retrieved from the reference list of the selected papers and from online searches (e.g. Google).

2.3.1.2 Eligibility criteria

The studies were restricted to adults, preferably close to the working ages (between 20 and 69 years). Thus, studies restricted to children, adolescents, young adults, and the elderly, were excluded. Because the review focuses on the current socioeconomic status of adults, studies of the impact of childhood or adolescence SES on diabetes during adulthood were also excluded. Among the topics of the articles that indicated an association between diabetes and SES, but that were excluded were:

1. Studies where all ages were included; or restricted to adults with diabetes
2. When type 1 diabetes or gestational diabetes were specified; or when it was specified that both type 1 and type 2 diabetes were included
3. Differences in race/ethnicity of adults within the same SES
4. Where SES was not reported, though it was included in the statistical analysis

5. Analyses where occupation was a categorical variable because occupation is not ordered to indicate a direction in the association with diabetes (e.g. positive, negative)
6. Studies about insulin resistance, metabolic syndrome and blood glucose that did not distinguish individuals with diabetes
7. Studies that compared undiagnosed with diagnosed diabetes

2.3.1.3 Analysis of selected studies

For the analysis of the articles, firstly, data was classified in three categories of diabetes: prevalence of diabetes; incidence of diabetes; and prevalence of undiagnosed diabetes (see Figure 2.1).

Secondly, within each subsection, following the methodology of McLaren (2007) for the analysis of the articles seemed appropriate with the purpose of being able to make a comparison of findings. We captured the following features from this methodology: a) the association is the unit of analysis (not the study); b) findings are classified according to SES measurements and economic development of the country or region; c) SES measurements were classified in eight categories; d) adjusted associations were preferred to unadjusted ones when both were available; and e) the economic development of the country was measured by the 2003 Human Development Index (HDI). The SES categories are: 1) income (including poverty; however, we made a distinction between personal and household income); 2) education; 3) occupation (including employment grade); 4) employment status (being employed or not); 5) composite indicator (combined indicators of SES); 6) area-level indicator (including deprivation; however urbanisation was a separate category); 7) assets and material belongings; 8) others.

2.3.2 Results

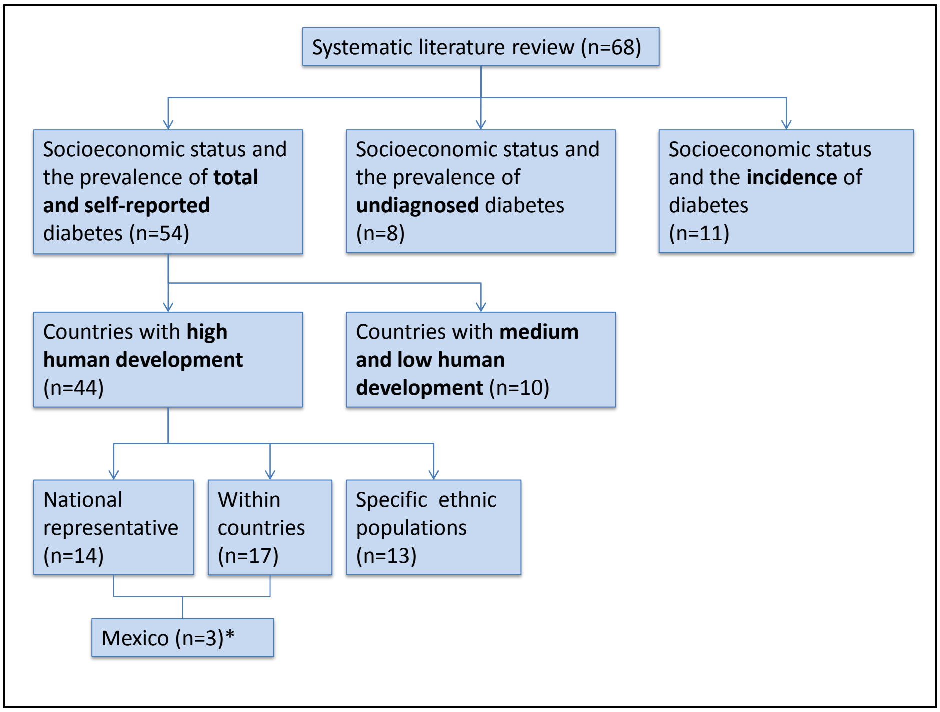
The database search resulted in 438 articles from which 30 articles met the eligibility criteria. After including additional articles from the reference list of the selected papers and from online searches, a total of 68 articles were taken into account for the analysis. Table 8.1 to Table 8.3 (in appendix B) classify the articles in three categories of diabetes: prevalence of diabetes; prevalence of undiagnosed diabetes; and incidence of diabetes. The studies are ordered according to the human development of the country. The tables display: the number of adults included in the study (N, where reported); the age groups included; how diabetes was identified (e.g. self-report or OGTT); the variables used to measure socioeconomic status; and the form of the association between diabetes and socioeconomic status (e.g. positive or negative). The superscripts give an overview of the type of statistical methods used in the analyses and the variables that were adjusted for. In addition, Table 8.4 displays how the socioeconomic status variables were classified.

The following subsections present our current findings and analyses of this review. Figure 2.1 shows how this section is organized. Firstly, the systematic literature review is divided in three parts which focus on the relationship between SES and: the prevalence of total and self-reported diabetes; the prevalence of undiagnosed diabetes; and the incidence of diabetes. Of the 68 articles included in the review, 54 studies analyzed the association between SES and the prevalence of self-reported and total diabetes. Fewer studies examined the association between SES and: undiagnosed diabetes (8); and the incidence of diabetes (11). The number of articles in the three subsections does not sum up to 68 because of the studies that analyzed the prevalence of diabetes, five also examined undiagnosed diabetes. Due to the large number of studies carried out in countries with a high human development, the studies in that subsection were presented in three groups: studies carried out at the national level; studies within countries with a high human development carried out in specific cities, regions or working populations; studies that covered specific ethnicities; and studies in Mexico.

2.3.2.1 Socioeconomic status and prevalence of total and self-reported diabetes

There were 54 articles that examined the prevalence of diabetes and socioeconomic status in adults (Table 8.1). Of them, 44 studies were carried out in countries with a high HDI and 10 in countries with a medium HDI. Diabetes was identified only by self-reports in 17 of the studies; at least by blood samples in 30 of the studies; and at least by physician or medication registers in 7 studies (but not by blood samples, although they could be identified by other methods).

Figure 2.1 Organization of the systematic literature review



*One study is nationally representative and the other two are set in specific regions or populations

The studies included 9 socioeconomic measures (Table 8.5). The most common SES measures were education (in 36 of the 54 studies); household income (19/54); area SES (12/54); and occupation (11/54). The studies covered 232 associations across all the measures of socioeconomic status and their stratified analyses. Table 8.6 classifies these associations by direction of the association, gender, and urbanisation. Overall, negative associations (107/232) were slightly more frequent than no associations (98/232). However, when the associations were counted separately according to HDI; negative associations were more frequently observed in countries with high human development (99/189); and positive associations occurred more frequently in countries with medium human development (22/43). The following subsections present our findings.

2.3.2.1.1 Countries with a high human development

Studies at the national level

Of the studies set in countries with a high human development, there were 14 studies based on national representative data. Most of the studies were based on self-reported diabetes (11/14). Five studies used household income as a SES measure; one used the occupation of the household head; and the rest education. The studies accounted for 75 associations: 33 in men; 23 in women; and 19 in both sexes combined. The proportion of associations that were negative was: 12/33 in men; 17/23 in women; and 17/19 in both sexes combined. The rest showed no association with diabetes.

Of the 14 studies, two were based on several health surveys across Europe (Dalstra et al., 2005; Espelt et al., 2008); three were carried out in Canada (James et al., 1997; Millar et al., 1986; Tang et al., 2003); one in Spain (Regidor et al., 2002); one in Italy (Lavecchia et al., 1987); one in Qatar (Bener et al., 2009); one in Mexico (Olaiz-Fernandez et al., 2007); and the rest in U.S. (Beckles et al., 2002; Mokdad et al., 2001; Mokdad et al., 2000; Pincus et al., 1987; Smith, 2007).

Espelt et al. (2008) analyzed ten national health surveys from European countries, conducted around 2000 (see Table 8.1 in appendix B). Negative associations between diabetes and education were found in both sexes in the pooled datasets, in three countries in men, and in five countries in women. On the other hand, the study by Dalstra et al. (2005) analyzed national health surveys from eight European countries from the 1990s. All the analyses with the pooled datasets showed a negative association between diabetes and education. In addition, there was a negative association between diabetes and education in the Netherlands, Belgium, France, Italy and Spain. No association was found in Denmark and Great Britain. Moreover, inequalities were larger among the working-age population compared with the elderly.

In both studies, differences in diabetes by education were larger among women than among men. Although in both studies the variable education was coded according to international standards set by the United Nations Educational, Scientific and Cultural

Organization (UNESCO); it was classified differently (Table 8.4 in appendix B). Risk factors were not included in any of the analyses.

The three studies in Canada showed a negative association between self-reported diabetes and SES. One study was based on the 1978-79 Canada Health Survey, a national representative sample (Millar et al., 1986). Men and women in the lower education groups had a higher prevalence of diabetes. Another study was based on the National Population Health Survey 1994/95 (NPHS), (James et al., 1997). It showed that lower household income was associated with a higher prevalence of diabetes. In both studies, although the prevalence rates were weighted, no measure of the strength of the association was presented. The third study in Canada showed that the prevalence of diabetes had a negative association with SES in men and women (Tang et al., 2003). Education and household income were used as measures of SES. After further adjustment by age, area of residence, BMI, and physical activity the association held only for women in both SES variables. Complex survey design was accounted for in the estimation of the confidence intervals.

The study in Spain analyzed health perception and four chronic conditions in relation to socioeconomic level (Regidor et al., 2002). The results showed a negative association between diabetes and education only in women. Risk factors were not included in the analyses. Social class was also examined in relation to diabetes. However, there was an inconsistency in the measurement of social class. While for most of the men social class was represented by their own occupation; women's social class was represented by the occupation of the household head. The data was from three National Health Surveys which allowed the comparison of prevalence of diseases over time. Another study was also based in a national health survey, the 1987 Italian NHS (Lavecchia et al., 1987). It showed that diabetes was more prevalent among the less educated. Although the study was based on self-reports, the NHS covered a large sample size. Only relative risks were calculated adjusted by age and sex.

A study in the Qatari population found a negative association between education and diabetes (Bener et al., 2009). The survey covered primary health care centres from urban and semi-urban areas. However, there was a lack of adjustment for age and other risk factors. The association between occupation and diabetes was also examined. Nevertheless, occupation was a qualitative variable.

There were three studies based on data from the Behavioural Risk Factor Surveillance System (BRFSS) which is a telephone survey. Studies based on the BRFSS 1990, 1998 and 2000 found a negative association between diabetes and education in American adults (Mokdad et al., 2001; Mokdad et al., 2000). Another study based on the BRFSS 2000 examined the association between diabetes and SES in women aged 25 years or more (Beckles et al., 2002). Lower education and income were associated with an increased risk of diabetes. Although the associations were adjusted for age, ethnicity and living arrangements (marital status, household size and employment status), there was a lack of adjustment for risk factors. Limitations of the studies included: that diabetes, weight and height were self-reported; a distinction between type 1 and type 2 diabetes could not be made; eight states were excluded because there was no information on diabetes; a low response rate was observed in some states; and the estimates may be biased because people without telephone may have lower SES. However, it was possible to distinguish gestational diabetes since a question on this topic was included in surveys from 1994.

A study of three National Health and Nutrition Examination Surveys (NHANES) analyzed self-report, undiagnosed and the total prevalence of diabetes in American men (Smith, 2007). Findings showed that the prevalence of diabetes was negatively related to education and income. However, after adjustment for risk factors, income remained significant in most of the analyses and education was significant only in the NHANES III (for total prevalence). The analyses of undiagnosed diabetes were not taken into account in our analysis since they were conditional on being diabetic. In chapter 5 the analyses are conditional on being non diabetic. The study also showed that men in the lowest education group were more likely to be Latino or African-American, less likely to do physical activity, and more likely to be obese. The study excluded women because it was not clear if they had gestational diabetes or not.

A study of chronic diseases showed that diabetes had a graded significant negative relationship with years of education (Pincus et al., 1987). The analysis was based on cross-sectional data from the 1976 Health Interview Survey. The analyses covered only self-reported diabetes and lacked of adjustment for risk factors, including age.

In summary, most of the studies based on national representative data showed that diabetes was more common in groups with low levels of education and household income. However, this was more evident in the overall populations, in women, and among the working-age population compared with the elderly. Furthermore, the majority of the studies relied on self-reported data and lacked of adjustment for risk factors. The use of self-reported diabetes limited that a distinction between the types of diabetes could be made.

Studies within countries with a high Human Development Index

There were 17 studies carried out within countries with a high Human Development Index, but not national representative or targeted to specific ethnicities. The most common SES measures were: area SES (8/17); education (7/17); and occupation (7/17). The studies accounted for 47 associations: 10 in men; 10 in women; and 27 in both sexes combined. The proportion of associations that was negative was: 7/10 in men; 8/10 in women; and 13/27 in both sexes combined. The rest showed no association with diabetes.

A study showed a graded negative relationship between diabetes and education and income, which was more evident in the 21-64 year age group (Gnavi et al., 2008). The study targeted all residents from Turin, Italy. People with diabetes were identified through NHS registers, hospital discharges and prescriptions for antidiabetic drugs (with at least two prescriptions at two different times). The prevalence of diabetes was adjusted for undercount using capture-recapture methods. Although the study used multiple sources to identify accurately people with diabetes and their level of education, there were two main limitations. First, census tract income was used as a proxy to individual income. Thus, in Table 8.1 income was considered as an area level measure. And second, there was a lack of adjustment for risk factors.

There were three studies in New Zealand that found a negative association between diabetes and household income. A cross-sectional analysis comprised 41 companies in

Auckland and Tokoroa (Scragg et al., 1991). The companies had at least 50 staff of all ages. The study also analyzed diabetes and the Elley-Irving socioeconomic status, an indicator based on occupation. However, no association was evident between occupation and diabetes. The relationship was examined for both sexes combined since differences in the prevalence by sex were not found. Prevalences of newly and previously diagnosed diabetes were reported, but not in relation to SES. To investigate if any biases could have been produced by a low response rate (67%), the analyses were repeated for worksites with response rates over 80%. The results were similar.

Another study based on the same data confirmed these results (Metcalf et al., 2007). Moreover, no association was found between diabetes and education. In contrast with the previous study, simultaneous adjustment for all SES measures was performed. Furthermore, the study differed in the age range covered and in the categorization of income and occupation.

The third study in Auckland investigated four SES measures in relation with self-reported, newly diagnosed and total diabetes: occupation, education, household income and area deprivation (Metcalf et al., 2008). The study was based on the Auckland Diabetes, Heart and Health Survey 2001-2003. After adjusting for age, sex and ethnicity, lower occupational class, lower income and higher area deprivation were associated with higher prevalence of diabetes and self-reported diabetes. However, after further adjustment for the other SES measures, only the association between diabetes and household income remained significant. Moreover, lower occupational class, lower income and higher area deprivation were associated with higher waist-to-hip ratio; lower income and higher area deprivation were associated with less time spent exercising per week; and lower levels of education and higher area deprivation were associated with higher mean BMI measurements.

A study based on several German health surveys found a negative association between self-reported diabetes and a social class index (Helmert et al., 1994). The index included education, occupation and income; and it was divided in approximate quintiles. Estimates were adjusted for smoking, obesity and pattern A behaviour. Furthermore, the analyses revealed that obesity was the strongest predictor of diabetes.

A study in the Augsburg region, in the South of Germany, showed a negative association between diabetes and SES (Rathmann et al., 2006). However, the association was not significant after adjustment for obesity, physical activity, smoking, alcohol intake, and C-reactive protein (a predictor of diabetes). For this study, a SES index was derived for both sexes by combining education, occupation and income. Sampling weights and two-stage clustering were accounted for. One disadvantage of the study is that it had a low response rate (62%).

A study of insured adults in Germany revealed a negative graded association between diabetes and occupation (Geyer, 2004). However, the confidence intervals of the occupation groups were fairly wide due to the small number of people with diabetes in the highest occupational position. When the analyses were repeated by age strata, the negative association between education and diabetes was replicated, but with increased magnitudes. Data were retrieved from administrative registers: data on medication and hospital diagnosis. Thus, the study may be free from recalling bias and problems caused by response rates. Occupation was classified according to the groups defined by the German Institute of Labour Market and Occupation Research (Table 8.4). Retired adults were assigned the occupation attained during their working life.

A posterior study on the same data found a negative association between diabetes and three measures of SES: education, occupation and individual income (Geyer et al., 2006). Furthermore, it showed that education was the stronger predictor of diabetes. However, the confidence intervals for education were wide; this may have been due to using a reference category with small size. Moreover, many people could not be classified by occupation because they were retired; receiving welfare; they were unemployed; or they were single women.

The Whitehall II study, a study of civil servants from London offices, found a negative association between self-reported diabetes and employment grade (Marmot et al., 1991). Employment grade was clearly defined according to salary (Table 8.4). Social and demographic characteristics, biological and behavioural risk factors, and psychosocial factors (stressful work and lack of social support) were also described in relation with employment grade. It reported that unhealthy behaviours and adverse work environments were more common among the lowest employment grades.

A study of Hong Kong Chinese showed a negative association between diabetes and education and occupation (Ko et al., 2001). Subjects were recruited from hospitals if they had risk factors for glucose intolerance: gestational diabetes, FHD, or abnormal fasting plasma glucose concentrations. Thus, women in reproductive ages were overrepresented. Men and women in the lowest education groups were more likely to have diabetes than adults in the highest education groups. Unskilled women, the lowest occupation group, were more likely to have diabetes than women in the highest occupation group. However, there was not a significant association between occupation and diabetes in men.

Most of the studies that compared the prevalence of diabetes with area deprivation showed a negative relationship between these variables. In appendix B “area” SES refers to a measure where the lowest category represents the most deprived. Although one British study showed that diabetes prevalence was not related to deprivation in adults (Eachus et al., 1996); other studies in Great Britain found a greater prevalence of diabetes in the most deprived districts, wards and postcode levels (Andersen et al., 2008; Connolly et al., 2000; Ismail et al., 1999). In these studies deprivation measures such as the Townsend’s index, the Jarman index, or the Carstairs score were used. However, few studies controlled for individual and community SES measures simultaneously.

Andersen et al. (2008) showed that the prevalence of diabetes increased with higher area deprivation. This association persisted after adjustment for individual SES, health behaviours, and risk factors. The analysis included women from 23 British towns. Area deprivation was measured through the Carstairs score which is a measure derived from census data: male unemployment; household overcrowding; car ownership; and social class. The score was measured at the ward level and categorized into quintiles. The lowest quintile represented the most affluent women. The largest attenuation on the odds ratios of area deprivation was produced when obesity was adjusted for.

Eachus et al. (1996) explored the association between deprivation and several self-reported diseases in Somerset and Avon. The sample comprised forty general practices from urban, inner city and rural areas. Although diabetes was assessed by self-reports, this data was confirmed through records in 20% of the respondents. There was no association between diabetes and the Townsend score, neither in men nor in women. The Townsend score is a deprivation measure at the district level. It was derived from census data: unemployed population; household tenure; car ownership; and overcrowding. The Townsend score was categorized into fifths where the top fifth represented the most affluent districts. Moreover, a relative inequality index was computed from the Townsend index in order to compare the extreme socioeconomic hierarchies. However, no association was found between this index and diabetes.

Connolly et al. (2000) described a positive association between type 2 diabetes and ward deprivation in Middlesbrough and East Cleveland. The accuracy of the information was one of the strengths of this study. The detection of people with diabetes was based on registers, and the neighbourhood information was based on the 1991 Census. The deprivation score was calculated based on the variables: male unemployment; manual workers; one parent households; self-reported chronic health and disability; pensioners living alone; car ownership; overcrowding; and housing tenure. The lowest fifth represented the least deprived. However, the study did not include individual information related to chronic disease.

A study in an urban district from North Liverpool found a positive association between type 2 diabetes and ward deprivation (Ismail et al., 1999). The study was based on lists of hospitals and general practitioners. Diabetes was identified through multiple registers which allowed the use of capture-recapture methods to adjust for undercount. The Townsend index was used as a continuous variable.

In Spain, a cross-sectional study reported that diabetes was more prevalent in the most deprived census sections of residence (Larranaga et al., 2005). Moreover, SES differences were more marked in women than in men. Complications from diabetes and worse glycaemic control were also more prevalent in the most deprived areas. For this study, a Deprivation Index was calculated by principal components analysis using measures such as: unemployment rate; proportion of unskilled manual workers; proportion with primary or lower education level; and proportion of households with low standard living. Living standards was an index calculated from household amenities; number of rooms; living area; and age of the building. Data on diabetes and complications were retrieved and validated from 61 general practitioners in the Basque Country.

To summarise, within countries with high Human Development Index diabetes was slightly more common in the lowest SES groups. Because the studies targeted specific populations or regions, in some cases it was possible to detect or confirm diabetes through multiple data sources. Adjustment for risk factors and different SES measures simultaneously may be important to reveal the true association between SES and diabetes. Studies that adjusted by risk factors showed that they could produce considerable attenuations on the odds ratios of the SES measures, particularly by obesity. This could occur because obesity, physical activity and other adverse psychosocial factors were more common among the lowest SES groups.

Studies in specific ethnic populations

Several studies carried out in developed countries analyzed the prevalence of diabetes in specific ethnic populations: Black, Mexican-American, and White adults (Cubbin et al., 2001; Winkleby et al., 1999; Winkleby et al., 1998); Mexican-Americans and non-Hispanic whites (Hazuda et al., 1988; Stern et al., 1984); African-American and whites (Brancati et al., 1996; Cowie et al., 1993; Robbins et al., 2001); Filipino-Americans (Cuasay et al., 2001; Langenberg et al., 2007); Japanese-Americans (Leonetti et al., 1992); South Asian adults residing in the Netherlands (Middelkoop et al., 1999); and Melanesian ni-Vanuatu adults from Australia (Taylor et al., 1991).

The three analyses that covered Black, Mexican-American, and White men and women were based on data from the NHANES III 1988-1994. Some of the advantages of this survey are that it has a high response rate and few missing data. In addition, minorities were oversampled to obtain reliable estimates. One study on risk factors for CVD found a negative association between diabetes and SES (Winkleby et al., 1998). The analysis was restricted to women and SES was measured by education and the poverty income ratio. Differences in diabetes between ethnicities were hardly explained by educational attainment. Thus, it was concluded that ethnicity and education were independently associated with diabetes. The estimates were adjusted for the sample survey design. In addition, matched pair analysis based on age and education was carried out to confirm the results. Mexican-Americans had lower levels of education and income, and higher prevalence of diabetes, physical inactivity and BMI when compared with white women of the same SES. A posterior study found a negative association between diabetes and education in men and women; and between diabetes and household income only in women (Winkleby et al., 1999). Income was represented by the residuals of the regression between education and the log of the (annual family income divided by family size).

Another study found a negative association between SES and diabetes, although significant effects were more consistent for black women (Cubbin et al., 2001). Three measures of SES were included in the analyses: education, income-to-needs ratio and neighbourhood material deprivation (measured by the Townsend Deprivation Index). The latter was constructed as an index derived from Census data at the tract level: unemployment; car ownership; rented housing; crowded housing. Unadjusted analyses showed a negative association between diabetes and the three measures of SES. After adjustment for age and the three SES measures simultaneously; education, income and deprivation were associated with diabetes only among black women. Education and income were associated with diabetes among white women; and only education among white men. No association was found between diabetes and SES among Mexican-Americans. It was suggested that the residential spatial distribution of ethnicities was a protective factor among Mexican-Americans, probably because of social and cultural factors.

There were two studies that encompassed Mexican-Americans and non-Hispanic whites (Hazuda et al., 1988; Stern et al., 1984). The studies were based on the 1979-1982 San Antonio Heart Study which covered three neighbourhoods of different socioeconomic levels: a low-income barrio, a middle income transitional neighbourhood, and a high-income suburb. Only Mexican-Americans were residing in the low-income barrio. The transitional neighbourhood was characterized by recent immigration of young Mexican-American families, and emigration of Anglo families. Most of the residents of the high-income suburb were of Anglo origin. Response rates were higher for the interviews (90%) than for the medical exams (between 60.1 and 69.5%). Thus, biases derived from non-response were investigated. In each ethnicity group, the prevalence of diabetes declined from barrio to suburbs in men and women (Stern et al., 1984). However, the decline was steeper in women.

A posterior study found a negative association between occupation and diabetes, but only in women (Hazuda et al., 1988). This association was somewhat mediated by obesity. Occupation was identified by the Duncan Socioeconomic Index, a measure of occupational prestige. If the participants were married, the highest of their occupations was assigned to both. In addition, increased acculturation was associated with a lower prevalence of diabetes. Acculturation measured functional integration, the level of integration to the host society (use of English and interaction with non-Hispanic whites); how much value was placed on preserving Mexican cultural origin (such as customs and celebration of Mexican holidays); and which the attitude was toward traditional family structure and sex-role organization (such as having close relationships with extended families; or the married living close their parents). When occupation and acculturation were controlled for simultaneously, only higher functional integration was associated with a lower prevalence of diabetes. Hence, acculturation was more important than occupation as a determinant of diabetes. However, the previous study showed that diabetes had a negative association with neighbourhood SES. In this study, acculturation was investigated only in relation to occupation and not in relation to neighbourhood SES. Thus, it is possible that the association between diabetes and acculturation may be due to a close association between acculturation and neighbourhood SES.

Three studies observed that the prevalence of diabetes was higher among African-Americans when compared with whites (Brancati et al., 1996; Cowie et al., 1993; Robbins et al., 2001a). Risk factors of diabetes did not explain these differences completely. However, obesity and lower SES were more common among blacks than among whites. A study based on the NHANES II found that only education was associated with diabetes, not income (Cowie et al., 1993). Furthermore, there was a significant interaction between race and obesity. Among adults with obesity, blacks had a higher risk of diabetes than whites. Among adults with normal weight the prevalence of diabetes was similar between blacks and whites.

A posterior study showed that SES differences were greater among blacks than among whites (Brancati et al., 1996). Data was from the Three Area Stroke Study 1972-1974, which covered Pueblo, Colorado; Savannah, Georgia; and Hagerstown, Maryland. SES was measured by education and the Green Index. The latter is an indicator of education and occupation that takes into account ethnicity. After adjustment for risk factors, none of the SES measures was associated with diabetes. However, a significant interaction was observed between race and SES. It showed that diabetes was more common among whites in the upper SES classes, and among African-Americans in the lowest SES classes.

Another study found a negative graded association between diabetes and poverty income ratio among African-American women, non-Hispanic white women, and non-Hispanic men (Robbins et al., 2001). Furthermore, body size was the most important mediator between diabetes and SES. No association was found between diabetes and education or the Duncan Socioeconomic Index score. The analysis was based on 4,978 adults from the NHANES III. Sensitivity analyses did not find any biases produced by excluding proxy reports; imputed BMI values; time of the OGTT; or exclusion of people with type 1 diabetes.

There were two studies that showed that Filipino-American women with lower household income had a higher prevalence of diabetes. One study covered Filipino-Americans living in Houston, Texas (Cuasay et al., 2001). No associations were found between household income and diabetes in men; or between education and diabetes in either men or women. However, a convenience sample was selected which resulted in a very small response rate. Diabetes was defined by self-report and it was confirmed by questions regarding medication and time of diagnosis. In contrast with other studies, this analysis included measurements of acculturation; and history of gestational diabetes and delivery of a baby weighting >9 lb. Sensitivity analyses were carried out after excluding participants with missing data.

The results of this study were confirmed by an analysis that recruited Filipino-American women residing in the north of San Diego (Langenberg et al., 2007). Furthermore, the results were unchanged after using alternative measures of obesity. Diabetes was well identified by OGTT or medications. In contrast with the previous study, the use of an opportunistic sampling in the recruitment of participants was compensated by a high response rate (85.7%). Nevertheless, the sample was very small. Even though diabetes was not associated with education, obesity was. Less educated women had a greater BMI and waist circumference.

A study showed that the prevalence of diabetes was higher among adults with technical school when compared to adults with high school or college education (Leonetti et al., 1992). This association was not explained by age, BMI, dietary intake or physical activity. The study included second-generation Japanese-American (Nisei) men living in King County, Washington. Although the sample was small, it was representative of the Nisei male population of this county. A higher percentage of adults with diabetes had skilled occupations. However, the association was marginally significant. In addition, there was no association between household income and diabetes.

A study analyzed the prevalence of diabetes among South Asians living in The Hague, Netherlands (Middelkoop et al., 1999). A higher prevalence of diabetes in more deprived areas was found among the youngest age groups, but not among the oldest. The deprivation score was calculated from the average income and percentage of unemployed between 15 and 64 years old. However, diabetes was identified by self-reports. Response rates were very low ranging from 37.6% in the youngest age group, to 48.3% in the oldest age group. To control for non-response, information from additional telephone interviews was used. However, it may have excluded adults whose telephone numbers were not in the register used. In addition, there was a lack of adjustment for individual risk factors.

A study included Melanesian ni-Vanuatu adults from Australia from rural, semi-rural and urban areas (Taylor et al., 1991). Although the prevalence of diabetes was higher in more urbanised areas, the difference was not statistically significant. Similar results were found between modernity scores and diabetes. The modernity scores were calculated from data on education, employment, place of residence and housing type. Even though diabetes was not associated with urbanisation and modernity, obesity and physical activity were. Physical activity decreased with increasing urbanisation and modernity, while obesity increased.

To sum up, several studies carried out in developed countries analyzed the prevalence of diabetes in specific ethnic populations. As in the previous subsection, negative associations between diabetes and SES were common in these studies, particularly among women. Furthermore, obesity mediated the association between diabetes and SES, but did not explain it fully. Studies in US suggested that non-white Americans tend to have higher prevalence of diabetes, lower SES and more unhealthy behaviours when compared to white Americans. However, SES and obesity do not completely explain differences in ethnicity. Hence, SES and ethnicity, as well as obesity and ethnicity may be independently associated with diabetes.

Mexico

Few studies in Mexico have documented an association between diabetes and socioeconomic status. Two studies and one report that were based on the NHS-2000 showed a negative association between diabetes and education. The three analyses were based on adults aged at least 20 years and they used the ADA criteria for the diagnosis of diabetes based on capillary blood glucose. The report described a negative association between levels of education and the prevalence of diabetes in men and women combined (Olaiz et al., 2003). Unfortunately a measure of the strength of this association was not presented. A posterior study confirmed a negative association between education and diabetes in men and women (Olaiz-Fernandez et al., 2007). However, it was only significant in women. For this study, logistic regressions were carried out by sex and adjusted for age, waist circumference, family history of diabetes, urban-rural stratum, blood pressure, renal disease and hypercholesterolemia. The estimates were adjusted for the sampling design of the survey. Household income, divided in number of minimum salaries, was also examined in relation to diabetes. Weighted prevalences (and their CIs) showed a negative association between diabetes and income overall and in women. Household income and abdominal obesity were not associated with diabetes in men. Additionally, living in an urban area was associated with diabetes only in men.

The second study based on the NHS-2000 was restricted to the IMSS population (Vazquez-Martinez et al., 2006). Weighted prevalences showed that having low levels of education was associated with self-reported, total and undiagnosed diabetes.

However, no measure of the strength of these associations was reported. A logistic regression model was fitted only for total diabetes and combining men and women. The association between education and diabetes remained significant after adjustment for age, sex, obesity (waist circumference and BMI), family history of diabetes, and region. Even though waist circumference and BMI were in the same model, BMI was not statistically significant. Moreover, it found the prevalence to be 8.7%, higher than in the national population.

A survey that included families of low socioeconomic strata in the metropolitan areas of Mexico City (the Mexico City Urban Food and Nutrition Survey ENURBAL-2002) found no association between SES and total, self-reported and undiagnosed diabetes (Avila-Curiel et al., 2007). The no association between socioeconomic status and total diabetes was confirmed after adjustment for age, sex, BMI, nutrition awareness, and fat consumption. Socioeconomic status was measured through education and an index integrated by household characteristics, overcrowding, income and expenditure. Diabetes was assessed by self-reports and capillary glucose. Only random glucose was measured, so that the identification of diabetes coincided with the ADA and WHO criteria. The prevalence of diabetes in this area was 13.8%, higher than in the national population and in the insured population.

In summary, only few studies have examined the association between diabetes and SES in Mexico. At the national level, education seems to have a negative association with diabetes even after adjustment for risk factors. However, this association is more evident in women than in men. Additionally, the no association between diabetes and education in a poor urban area suggests that the form of the association between SES and diabetes may differ by region.

Summary

In this section we presented a review of the literature on the association between socioeconomic status and diabetes in countries with a high human development. Most of the studies showed that the prevalence of diabetes was higher among the lowest socioeconomic groups. Moreover, this association was more evident among women and both sexes combined than among men. Studies that adjusted for risk factors showed that mainly obesity mediated the association between diabetes and SES. It was also observed that unhealthy behaviours and adverse psychosocial factors were more common among the lowest SES groups. Studies in specific ethnic populations suggest that SES and ethnicity may be independently associated with diabetes. Few studies were carried out in Mexico.

2.3.2.1.2 Countries with a medium and low human development

In our analysis, there were ten studies conducted in countries with medium human development. No studies were found in countries with low human development. The studies accounted for 43 associations: 3 in men; 3 in women; 19 overall; 13 in the urban area; and 5 in the rural area. In men, there was one positive association with area SES; one positive association with urbanisation; and no association between diabetes and education. In women, there was one positive association with urbanisation; one negative association with area SES; and one negative association between diabetes and education. In both sexes combined, (11/19) associations were positive; two were negative; one was non-linear; and in the rest there was no association between diabetes and SES (5/19). In the urban area seven associations were positive (7/13); (3/13) negative; and there was no association in the rest (3/13). In the rural area there was one positive association; one negative; no association in the rest (3/5). Thus, most of the studies in the combined populations showed positive and no associations between diabetes and SES. By level of urbanisation, positive associations were more evident in the urban area, and no associations in the rural area.

There were six studies that examined the association between urbanisation and diabetes. Most of them concluded that the prevalence of diabetes was higher among the more urbanised areas (5/6). In one study the association between diabetes and urban-rural area disappeared after adjustment for social class (AbuSayeed et al., 1997). This might be due to social class being purposely defined within each urban and rural area. Within the urban stratum, social class was determined by wealth residence area. Individuals were selected either from slums or from housing estates for government employees. Within the rural area the landless farmers were classified as poor, and the landholders as rich. Physical activity was an important characteristic that distinguished these two classes: the poor had an active labour whereas the rich were described as “maintaining a sedentary habit”. It was shown that adults in the higher social classes were more likely to have diabetes than adults in the lower social classes.

A study in Malaysia observed an association between urbanisation and diabetes among Malays, but not among an aboriginal population, the Orang Asli (Ali et al., 1993). Moreover, the Orang Asli had a lower prevalence of diabetes than the Malays, and a better diet. The study comprised six areas that ranged from aboriginal settlements in the jungle to modern Malay villages. Furthermore, increasing age, higher income, fewer daily activity and obesity were associated with diabetes. Although the study was small, it was clearly shown that the areas represented different levels of urbanisation and lifestyle as they were reflected in the types of economical activity and infrastructure of the communities.

A nationally representative study conducted in Oman revealed that adults living in urban areas were more likely to have diabetes than adults living in rural areas, even after considering confounding factors such as age, marital status, waist circumference and blood pressure (Al-Moosa et al., 2006). There was no association between education and diabetes in the whole population and in the urban area. Only in rural areas, individuals with higher levels of education were less likely to have diabetes than individuals with lower levels of education. Although the government defines the criteria to differentiate urban and rural areas, this study classified only the capital, Muscat, as an urban area. This was decided on the basis that Muscat is different from the other towns in several aspects: population density, location of commercial banks, vehicles on the road, electricity connections, telephone lines, health facilities, airports, and presence of American companies.

A study conducted in China found a positive association between diabetes and personal income (Pan et al., 1997b). Moreover, there was a negative association between diabetes and education, but only among adults with higher income. The study included residents from 19 provinces and areas across urban and rural China. Diabetes was identified by questionnaires and capillary glucose, which were confirmed by OGTT tests.

Another study also found that family income and urbanisation were positively associated with diabetes (Xu et al., 2006). Moreover, stratified analyses revealed that the association between diabetes and family income was only significant in the urban area. This study covered urban and rural areas randomly selected from a municipality in China, Nanjing. Although it included only self-reported diabetes, there was a confirmation through medical records that stated the date of diagnosis, prescriptions and treatment. The estimates were adjusted for age, sex, area of residence (urban or rural), BMI, education, smoking, occupation, leisure-time physical activity, hospital category and how the health-care fees were paid (by government, employer, private insurance, or themselves). In addition, it was accounted for clustering within village.

A study in the Metropolitan Cairo area and surrounding agricultural villages revealed an association between urbanisation and diabetes (total and undiagnosed) in men, women, and both sexes combined (Herman et al., 1995). Areas with low and high socioeconomic status were represented in the urban stratum. The analysis showed a positive association between area socioeconomic status and diabetes (total and undiagnosed) only in men and in both sexes combined. In women, there was a negative association between total diabetes and area socioeconomic status; and no association was found between undiagnosed diabetes and area SES. The estimations accounted for the sampling design and used post stratification by age and sex. Diagnoses of diabetes were confirmed by self-reports, random capillary glucose, and OGTTs.

There were four studies in India. Three studies found a positive association between income and diabetes, but only in urban areas (Ramachandran et al., 2008; Ramachandran et al., 2001; Ramachandran et al., 2002). The 2001 study covered adults from six major cities across India. Diabetes was associated with family income independently of age, sex, BMI, waist-to-hip ratio (WHR), education, occupation, family history of diabetes (FHD) and physical activity. The study conducted in 2002 focused on participants with high and low family incomes living in urban Madras. The association between diabetes and family income was independent of age, BMI, WHR, and physical inactivity.

The study carried out in 2008 comprised locations with different levels of urbanisation: Chennai city; Panruti, a periurban area; and Kanchipuram, a town located 80 kilometres from the city. Although the city and town were selected for convenience, within them there was a random selection of streets, areas or wards. Moreover, in this study the prevalence of diabetes increased with level of urbanisation. The association between education and diabetes differed by level of urbanisation. While in the city, education had a negative association with diabetes; in the three areas combined there was a positive association between diabetes and education. No association was found between diabetes and education in the town and periurban areas. Furthermore, income was not associated with diabetes in all the areas combined, in the town and periurban areas. The association between income and diabetes in the city was independent of age, FHD, waist circumference, BMI, and education.

Another study showed a negative association between education and the prevalence of diabetes, but only in highly urbanised and urban areas (Reddy et al., 2007). A direct association was found in periurban areas. Additionally, a negative association between diabetes and education was observed in women but not in men. All analyses were adjusted for age and occupation. The study included employees and their families from ten industries of different sizes in India.

To summarise, in this section we presented a review of the literature on the association between diabetes and SES in countries with medium and low human development. However, no studies were found in countries with low human development. Positive and no associations were more frequent between diabetes and SES. While in the urban areas positive associations were more evident, in rural areas “no associations” were more common. In most of the studies, the prevalence of diabetes increased as the level of urbanisation increased. This association was independent of risk factors and potential mediators.

2.3.2.1.3 Summary

This section presented our review on the association between the prevalence of diabetes and socioeconomic status in adults. Most of the studies were carried out in countries with a high Human Development Index. Negative associations between diabetes and SES were more common in countries with high human development; mainly among women and with the variables education, household income, and area SES. In countries with medium human development, positive and “no associations” occurred more frequently. Positive associations were more common in urban areas with income. In addition, negative associations were found with education, especially in more urbanised areas. Moreover, the prevalence of diabetes was higher in urban than in rural areas.

As in countries with a high Human Development Index, studies in Mexico also reveal a negative association between diabetes and education at the national level. This association is independent of risk factors and seems more evident in women than in men. A study in a poor urban area found no association between diabetes and SES.

All the studies in this section were cross-sectional which limited inferences about causal pathways. Studies that adjusted by risk factors showed that obesity is the most important marker of diabetes and that it mediates the association between diabetes and SES. However, less than half of the studies adjusted for age and obesity, the main risk factors of diabetes. Unhealthy behaviours and unfavorable psychosocial factors were more common among the lowest socioeconomic groups. In addition, ethnicity may be independently associated with diabetes.

The most common statistical methods were the calculation of prevalences across SES variables and logistic regression. Few studies accounted for the sampling design of the survey, or for some clustering. Response rates were over 70% in most of the studies. Lower response rates were observed in studies that included multiple surveys, in medical exams, convenience samples, or where the sampling was stratified by smaller areas or age groups. Use of convenience samples or small sample sizes were mostly observed in studies that targeted specific populations. Thus, none of these studies were excluded because of a low response rate or small sample sizes.

2.3.2.2 Socioeconomic status and prevalence of undiagnosed diabetes

We found eight studies that compared the socioeconomic status of adults with undiagnosed diabetes with adults without diabetes. The studies covered 26 associations: 8 in men; 9 in women; and 9 in both sexes combined. Overall and in each stratum, the majority indicated “no associations”.

We have previously mentioned five studies that made an analysis on both diabetes and undiagnosed diabetes. In the study of British women, there was no association between the Carstairs area deprivation score and undiagnosed diabetes (Andersen et al., 2008). The study in Auckland found that, after adjustment for age, sex and ethnicity; newly diagnosed diabetes was associated only with income and area deprivation (Metcalf et al., 2008). However, the associations disappeared after adjustment for the other SES variables. Occupation and education were not associated with new diabetes. The study in Cairo found that higher urbanisation was associated with a higher prevalence of undiagnosed diabetes in men, women, and both sexes combined (Herman et al., 1995). Additionally, there was a positive association between area SES and undiagnosed diabetes but only in men and both sexes combined. One study in Mexico, restricted to the insured population, found a negative association between education and undiagnosed diabetes (Vazquez-Martinez et al., 2006). However, no measure of the strength of the association was reported. Another study in Mexico found no association between undiagnosed diabetes and two measures of SES: education and a composite indicator (Avila-Curiel et al., 2007). Moreover, further analyses to incorporate risk factors were not made in any of the two studies.

A cross-sectional study investigated to what extent risk factors and psychosocial factors can explain the socioeconomic differences in type 2 diabetes (Agardh et al., 2004). All adults aged 35-56 that were registered in the County Councils of four municipalities in Stockholm were contacted firstly through a postal questionnaire. Then, adults without diagnosed diabetes were selected to undertake an OGTT test and to have weight and height measurements. Occupational position was categorized according to the system elaborated by the Central Bureau of Statistics in Sweden for Censuses purposes (Table 8.4). Risks factors included BMI, FHD and physical activity. There were two psychosocial factors assessed: decision latitude at work, an ability to master work activities; and sense of coherence, an ability to cope with stressors. They found a negative association between occupation and diabetes in men and women; however, this association disappeared in women after further adjustment for both risk factors and psychosocial factors. In men about 36-42% of the excessive risk of diabetes was explained by risk factors, while psychosocial factors had no effect. In women, most of the excess risk of diabetes was explained by the combined risk factors and psychosocial factors. Family history of diabetes included diabetes in parents or siblings, and in two second-degree relatives (grandparents, uncles, or aunts).

A posterior analysis based on the same data investigated the relationship between previously undiagnosed type 2 diabetes and socioeconomic position (SEP) at three points of life (Agardh et al., 2007). In this study, childhood and adolescence SEP were measured by father's occupational position; and adulthood by education and occupational position. In women, there was a negative association between diabetes and education; and an inverse u-shaped association between diabetes and adulthood occupation. In men, there was a negative association between diabetes and adulthood occupation; and there was no association between education and diabetes. After adjustment for occupation, family history of diabetes, physical activity, BMI, smoking, latitude at work and sense of coherence, the association between women’s education and diabetes disappeared. The adjusted relative risk ratios for occupation were not reported.

Both studies in Sweden demonstrated a careful selection of the participants in terms of fulfilling the criteria of FHD in first or 2nd degree relatives with diabetes, intake of medication, pregnancy and breast-feeding. However, some occupations were excluded such as the self-employed, farmers and unclassified workers; as well as the category “other education”.

In Germany, a higher prevalence of undiagnosed diabetes was more common only among women with low occupation (Rathmann et al., 2005). Three SES measures were analyzed: education, occupation and income. The analyses were controlled for age, waist circumference, blood pressure, triglycerides, physical activity, smoking and alcohol intake. The analyses took into account the sampling weights and clustering. In women all SES measures had a significant negative association with BMI, waist circumference and low physical activity. In men, there was only a significant negative association between education and BMI; and between physical activity and occupation and income. The study was based on the KORA 2000, a population based survey carried out in Augsburg and surrounding villages. The definition and classification of these variables was described in the previous section. One limitation of the study was its low response rate (62%).

To summarise, only few studies examined the association between undiagnosed diabetes and socioeconomic status. Most of them were set out in countries with high human development and they found no association between these variables. However, negative associations were found between SES and risk factors.

2.3.2.3 Socioeconomic status and incidence of diabetes

This section presents our review on the association between socioeconomic status and the incidence of diabetes. Among the 68 articles selected, there were 11 studies that examined this association. All the studies were carried out in countries with very high human development: nine in United States and two in United Kingdom. Education and occupation were the most common measures of SES used in these studies. The studies covered 39 associations: 13 in men; 14 in women; and 12 in both sexes combined. Overall and in each sex group, there was approximately the same number of negative associations and “no associations”.

A longitudinal study found that lower education, income and occupation were associated with an increased incidence of diabetes (Maty et al., 2005). However, these associations disappeared after adjusting for demographic confounders (age, gender, race and marital status), and other components of the causal pathway (physical inactivity, smoking, alcohol consumption, body composition, hypertension, depression and health care access). Moreover, time dependent SES effects were not significant after full adjustment, and the SES variables were not measured simultaneously. The sample covered adults from the Alameda County, California, who were free of diabetes at baseline. The participants were followed during five waves for 34 years. It concluded that education was a good predictor of incidence at baseline; occupation was a better predictor in middle or later adulthood; and time dependent income was a weak predictor of diabetes. Limitations of the study included the use of self-reports of diabetes; difficulties in distinguishing individuals with type 1 and type 2 diabetes; and survival bias.

Another study showed a negative association between the incidence of diabetes and income, education and occupation among women in US; and only with income and education among men (Robbins et al., 2005). Initial analyses were adjusted for age and ethnicity. After adjustment for body size, diet, physical activity, alcohol and tobacco use, most of the associations were attenuated, and the association between household income and diabetes incidence disappeared. Therefore, potential mediators did not account completely for the association between diabetes incidence and SES. The simultaneous effect of the three SES measures was not analyzed. The study covered men and women from the NHANES I Epidemiologic Follow-up Study 1971-1992 (NHEFS), who were free of diabetes in 1980. The mean follow up was 10 years. In addition to self-reports, record of hospitals admissions or discharges were used to identify diabetes.

Two previous studies confirmed a negative association between education and the incidence of diabetes in the NHEFS. However, they were limited to African Americans and non-Hispanic whites. A study found a negative association between diabetes incidence and education, but only in the entire cohort, all women, and white women (Lipton et al., 1993). This association was independent of age, sex, race, BMI, subscapular triceps, systolic blood pressure, and activity level. The study was based on the NHANES I Epidemiologic Follow-up Study 1971-1987. Although some of the information was collected from proxies, almost half of the diagnoses were verified by multiple sources. In addition, no distinction was made between types of diabetes. Another study confirmed a negative association between education and the incidence of diabetes in men and women separately (Resnick et al., 1998). The associations were independent of BMI and subscapular-to-triceps skinfold ratio. The study included adults from the NHFES 1971-1992, five more years of follow-up than in the previous study. In contrast with the previous study, more adults were excluded due to more restrictions in the definition of diabetes at baseline.

An analysis showed that lower adult SES (spouse's education) was associated with a higher incidence of diabetes, independently of childhood socioeconomic status (measured by father's occupation), (Lidfeldt et al., 2007). Obesity partly accounted for these associations. The analyses included married or widowed women from the Nurses Health Study. The participants were followed up by questionnaire every two years during ten years. Although diabetes was self-reported, it was confirmed by questions on tests and medications. Moreover, the participants were homogenous in terms of education and occupation. In addition, the analyses were adjusted for BMI, physical activity, diet, alcohol consumption, smoking, hypertension, hypercholesterolemia, family history of diabetes, menopausal status, use of hormone replacement therapy, ethnicity, birth weight, and breastfeeding.

There were three studies based on data from the San Antonio Heart Study follow up. The participants enrolled any year from 1979 to 1988 and then had a 7-to-8 year follow up examination. Diabetes was defined by self-reports, and then confirmed by medical examinations or use of medications. However, the response rate was low (61-68%). One study found a negative association between incidence of diabetes and education (Haffner et al., 1991). This association was independent of age, sex, ethnicity and BMI. The study included Mexican Americans and non-Hispanic whites. A study among Mexican-Americans found no association between SES and diabetes incidence neither in men nor in women (Monterrosa et al., 1995). SES was measured by the Duncan Socioeconomic Index, a measure of occupation prestige. BMI was a strong predictor of diabetes especially in women. A posterior study found a negative association between the incidence of diabetes and the neighbourhood SES that was independent of BMI (Burke et al., 1999). However, BMI reduced the odds ratios of neighbourhood SES considerably. No association was found between diabetes incidence and the Duncan Socioeconomic Index. The study included Mexican Americans and non-Hispanic whites who did not have diabetes at baseline and whose diabetes status was known. It was concluded that the rise in the prevalence of diabetes was due to an increased number of cases more than to an increased survival of people with diabetes.

A study in the U.S. revealed a negative association between military rank and diabetes incidence (Paris et al., 2001). The study was restricted to the military population on active-duty status. Individuals were selected if they had an initial diagnosis of type 2 diabetes. Then, they were age-matched to control subjects on a 4-to-1 basis. After recruitment, the mean time of service at diagnosis was 13.5 years. Diabetes was assessed by military records and confirmed in a small sample by registers at a medical treatment facility. However, misclassification of diabetes could have occurred because the criteria for diagnosis could have varied by physician.

A study in nine British towns revealed a higher incidence of type 2 diabetes among towns with worse SES (Barker et al., 1982). The towns were selected to represent each of the three different latitudes (north, centre and south) and each of the three different SES (better, intermediate and worse): York, Wakefield, Preston, Chester, Derby, Stoke, Ipswich, Plymouth, and Newport. SES was calculated using a combination of the towns levels of income, overcrowding, unemployment, and car ownership. Moreover, a lower incidence of diabetes was observed in the two lowest social classes. New cases of diabetes were identified through records from hospitals. Incidence rates were compared using different standardisations to control for several biases: differences in rigor of screening between general practitioners; social class measured by occupation; and duration of residence. However, no measure of the strength of the association was presented and there was a lack of adjustment for individual risk factors.

In the Whitehall II study, lower employment grade was associated with an increased risk of the incidence of diabetes among men, but not among women (Kumari et al., 2004). The association was independent of age, length of follow-up, ethnicity, family history of diabetes, height, systolic blood pressure, electrocardiographic abnormalities, BMI, exercise, and smoking. The participants were followed-up during 5 phases, from 1985 to 1999. According to civil service grade and salary, employment grade was classified as: administrative, executive and clerical. Housing tenure, car ownership and material problems were also examined. Material problems were associated with an increased incidence of diabetes among both men and women. Not having a car was associated with a higher incidence of diabetes only among men.

In conclusion, this section presented our review on the association between socioeconomic status and the incidence of diabetes. There was a small number of studies that examined this association and all of them were set in highly developed countries. Risk factors tended to attenuate or to vanish the associations between the incidence of diabetes and SES. There was approximately the same number of negative associations and “no associations”. Negative associations were more common with the variables education and area SES.

2.3.3 Main findings

In this section we presented a systematic literature review on the association between diabetes and socioeconomic status. The analyses focused on the topics of the thesis: prevalence of total and self-reported diabetes; prevalence of undiagnosed diabetes; and incidence of diabetes. For each of these topics we asked the same research questions: What is the nature of the association between type 2 diabetes and socioeconomic status in adults (e.g. positive, negative)? Does the association between type 2 diabetes and socioeconomic status in adults vary by socioeconomic development of the country? Are negative (or positive) associations more common among specific SES measures?

For the prevalence of total and self-reported diabetes, we found that the association between diabetes and SES varied by socioeconomic development of the country: being more negative in countries with high human development; and positive or of "no associations" in countries with medium human development. The association between diabetes and each SES measure depended on the socioeconomic development of the country and, within countries with medium HDI, it depended also on urbanisation. Negative associations were more common with education, household income, and area SES in countries with high HDI. Urbanisation was positively associated with diabetes in countries with medium HDI. Furthermore, in urban areas of countries with medium HDI: positive associations were more common with income; and negative associations were found more frequently with education.

For the prevalence of undiagnosed diabetes the majority of the studies found no association between undiagnosed diabetes and SES. Moreover, an analysis by socioeconomic development of the country and SES measure could not be made because only a small number of studies was found, and most of them were set in countries with high HDI.

For the incidence of diabetes, there was roughly a similar number of negative associations and "no associations". An analysis by HDI of the country could not be made because of the small number of studies. Furthermore, all the studies were set in highly developed countries. Negative associations were more frequent with education and area SES.

Limitations with previous research on diabetes and SES in Mexico

Only three studies have analyzed the association between type 2 diabetes and socioeconomic status among Mexican adults. From previous research in other countries, we found several aspects that shape the association between diabetes and SES that have not been investigated in the Mexican context.

First, the two studies at the national level in Mexico found a negative association between diabetes and education. Research from studies carried out in countries that have large inequalities within their regions suggests that the association between diabetes and SES varies by level of urbanisation and modernisation. For instance, the study in a Mexican poor urban area found no association between diabetes and education. So far, no studies have been carried out in rural areas. Therefore, stratification by level of urbanisation or economic development of the regions in Mexico may reveal different associations between diabetes and SES (particularly with family SES).

Second, studies in developed countries reveal that there is a negative association between diabetes and deprivation. Nonetheless, there has been a lack of research of this topic in Mexico. In addition, the association between diabetes and area deprivation may be independent of risk factors and other SES measures. Further research is needed to investigate the determinants of diabetes at the community level.

Third, the associations between undiagnosed diabetes and SES were not further adjusted for risk factors or other potential mediators of the relationship between diabetes and SES. Future studies should consider including these variables. In addition, no studies have investigated the association between the incidence of diabetes and SES in Mexico.

And fourth, only one study adjusted for SES measures at different levels simultaneously. In addition, it has been suggested that the SES measures should not be used interchangeably since they may influence health differently (Geyer et al., 2006). According to Geyer et al. (2006), variables such as income, education and social class are often used interchangeably on the assumption that all describe the same concept (such as material deprivation). However, they represent different causal processes:

occupation describes characteristics of the work place and its organization; income is a determinant of access to resources; and education relates to the ability to turn information into practical measures and behaviours. One of the advantages of using education is that it is a stable measure in adults, contrary to income and occupation that are more likely to fluctuate over seasons or in early adulthood, especially in rural areas. A careful selection and use of different SES measures and at different levels should be taken into account in further studies.

Comparison with the review of the literature on obesity and SES

In contrast with McLaren (2007) study, we found a smaller number of studies. Therefore, a similar analysis of the information could not be carried out. In addition, our analyses had to be separated by prevalence, incidence and undiagnosed diabetes since they underlie different public health problems. However, there were some similarities in the studies of the prevalence of diabetes and those of obesity. Firstly, a higher number of studies were found in countries with high human development than in countries with medium human development. Nevertheless, we did not find any studies in countries with low human development. Secondly, in countries with a high human development, the majority of associations were negative while in countries with medium human development, positive associations were more common than the negative ones. Therefore, the association between diabetes and SES seems to mirror that of obesity and SES when it is analyzed by socioeconomic development of the country. And thirdly, in relation to SES measures, only education had a negative association with diabetes in highly developed countries; and only income had a positive association with diabetes in countries with medium development.

Limitations of our literature review

Several limitations of the systematic literature review need to be considered. First, if publication bias existed, restricting the search to published articles may have excluded studies with no associations. Then, the proportion of negative and positive associations that were found may be lower. Second, we encountered several problems when calculating the number of associations. Firstly, some studies presented adjusted and unadjusted SES associations. In some cases unadjusted estimates show an association that disappears after controlling for other factors. When we considered unadjusted variables that were not further adjusted, we may have over counted the number of positive/negative associations. And secondly, some studies represent many associations particularly if their results are displayed by strata: sex, age groups, ethnicity, year of the survey, identification of diabetes, level of urbanisation. Third, there was a large variation in the studies in terms of sample designs; representativeness of the samples; controlling variables; definition and classification of SES measures; and identification of diabetes. Hence, the comparison of the studies should be taken into account with caution. Fourth, although we tried to select the articles that represented the adult population, the studies differed in the minimum and maximum ages included. And fifth, the articles were selected even if a measure of the strength of the association was not reported. This was done to keep as many studies as possible to detect patterns in the data, since the number of studies was very small.

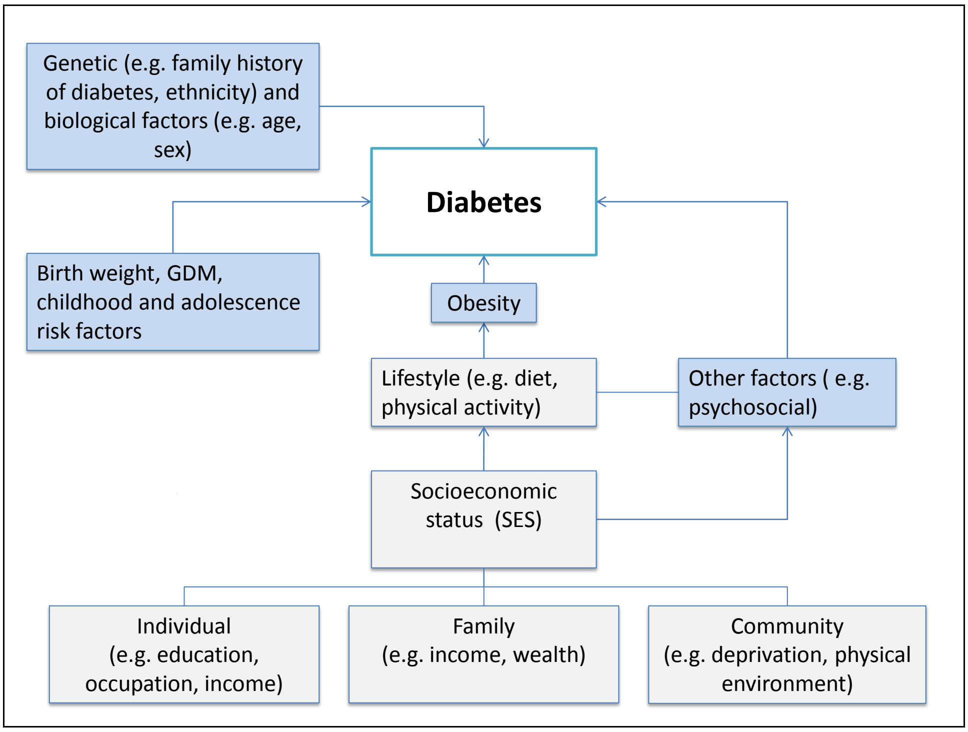
2.4 Theoretical framework for the relationship between diabetes and SES

The review presented in the previous section points out that there is an association between diabetes and SES in adults that is independent of genetic, biological, lifestyle and psychosocial factors. However, this association varies by level of socioeconomic development of the country, sex, age group, ethnicity, and level of urbanisation (within developing countries). Several mechanisms have been suggested to explain how social and economic factors interact with biological ones through the life course in the development of diabetes during adulthood. These relationships are represented in Figure 2.2. The relationships related to socioeconomic status focus on the current socioeconomic status of the adults. Besides, adult SES may be a more important determinant of diabetes in adulthood than, for instance, childhood SES (Lidfeldt et al., 2007).

First, the figure shows that there are four factors that play an important role in the acquisition of type 2 diabetes: genetic and biological factors; birth weight, the presence of Gestational Diabetes Mellitus (GDM) in the mother, and the presence of risk factors during childhood and adolescence; obesity; and other factors, such as psychosocial factors. The first two factors predispose the development of diabetes during adulthood. The third factor, obesity, has become the major contributor to the development of type 2 diabetes mellitus. Among other factors, psychosocial factors such as stress may be responsible for lifestyle choices and may cause biological effects.

Second, obesity is caused by lifestyle factors such as an unhealthy diet and reduced physical activity. And third, in addition to other factors, the choice of unhealthy behaviours may be determined by socioeconomic status. Therefore, socioeconomic status may be related to diabetes through obesity and other factors. Socioeconomic status encompasses the individual and family levels as well as the socioeconomic environment.

Figure 2.2 Theoretical framework for the relationship between diabetes and SES



The relationships in Figure 2.2 are explained with more detail in the following subsections. The first subsection describes how diabetes is related to genetic and biological factors. The second subsection covers the relationship between diabetes and birth weight, GDM, and the presence of risk factors during childhood and adolescence. The third subsection presents the relationship between diabetes and obesity (including lifestyle factors); as well as how obesity is related to socioeconomic status. Finally, the fourth subsection describes other factors that are associated with diabetes and how they are related to lifestyle and SES. The evidence for the existence of these associations in Mexico and their possible explanations are presented in each subsection.

2.4.1 Genetic and biological factors

Genetic predisposition is one of the most accepted causes of diabetes. This is demonstrated by the high prevalence of diabetes among adults whose relatives have this condition (Cowie et al., 1993; Pan et al., 1997b; Ramachandran et al., 2008; Ramachandran et al., 2001; Smith, 2007); or among some ethnic groups: Native American (Carter et al., 1989); Hispanic American, Asian American, African American (ADA, 2004); Asian Indians, Chinese, Australian Aborigines, Polynesians and Micronesians (WHO, 1999). In Figure 2.2 genetic predisposition is represented by family history of diabetes and ethnicity.

In Mexico, two studies demonstrated that the prevalence of diabetes was higher among those whose parents had diabetes (Olaiz-Fernandez et al., 2007; Vazquez-Martinez et al., 2006). About ethnicity, studies in Mexican indigenous populations have found a lower prevalence of diabetes when compared to the national figures. This contrasts with the higher prevalence of diabetes observed among Native Americans when compared to the US population. A study of 798 Mazateca indigenous of Oaxaca showed a prevalence of diabetes of 2.0%, lower than the national prevalence in some age groups (Castro-Sanchez et al., 1997). A study in 93 subjects aged 30 to 64 of the Tepehuano, Huichol and Mexicanero tribes of Durango, did not present any cases of non-insulin-dependent diabetes mellitus (NIDDM) and family history of diabetes (GuerreroRomero et al., 1997). Moreover, the prevalence of obesity was very low (7.2%).

Indigenous populations have a low prevalence of diabetes probably because they keep a more traditional lifestyle and diet. A study where the diet of the last 24 hours was recorded, showed that Otomi Indian diet was mostly based on complex carbohydrates, fibre, low animal protein and low saturated fat (Alvarado-Osuna et al., 2001). Another study showed that the Tarahumara benefit from a nutritious diet high in complex carbohydrates and low in fat (Cerqueira et al., 1979). Hence, subsequent migration to the cities or changes in lifestyle may result in metabolic alteration.

To show the link between diet and metabolic alteration, a study compared the health of the Pima Indians living in Sonora, Mexico, with those living in Arizona, USA. It showed that the Pima Indians of Sonora had lower body mass indices, lower plasma total cholesterol levels, and lower prevalence of NIDDM; probably because their diet includes less animal fat and more complex carbohydrates, and they spend greater energy in physical labour (Ravussin et al., 1994). Another example was given in the Tarahumara population, where the traditional diet low in fat and high in fibre, was substituted by a more "affluent diet" which contained excessive calories, total fat, saturated fat, and cholesterol (McMurry et al., 1991). After five weeks the population experienced increases in plasma lipid and lipoprotein levels and body weight, which are risks for heart diseases. Therefore, among indigenous groups, an increased risk of diabetes is observed when they are exposed to changes in diet.

The metabolic alteration resulting from changes in lifestyle is further supported for the higher prevalence of obesity and diabetes observed among adults that migrate from rural to urban areas. A study of 433 women from four states of Mexico showed that increases in body fat are associated with a background of migration from rural to urban areas (Gonzalez-Barranco et al., 2001). A higher prevalence of diabetes in Otomi Indian men when compared with women was partly explained because they migrate to the cities to work, modifying their diet (Alvarado-Osuna et al., 2001). Hence, rapid increases in weight may be responsible for the increased rates of diabetes. A longitudinal study among Mexican-Americans showed that dieting was associated with a higher incidence of diabetes in men (Monterrosa et al., 1995). This was explained by the variation in weight that included episodes of rapid weight gain.

Biological factors also play an important role in the development of type 2 diabetes. Higher age has been consistently associated with an increasing risk of diabetes across several populations (WHO, 2002), including Mexico (Avila-Curiel et al., 2007; Olaiz-Fernandez et al., 2007; Vazquez-Martinez et al., 2006). Of the studies in Mexico, an association between sex and diabetes has not been found. It is possible that differences in diabetes exist when sex interacts with other variables, such as obesity (Ali et al., 1993). However, this has not been investigated.

2.4.2 *Low birth weight, GDM and risk factors during childhood and adolescence*

Low birth weight and the presence of gestational diabetes (GDM) in the mother increase the risk of diabetes in adult life (Whincup et al., 2008). For instance, Forohui et al. provided an extensive review on the association between birthweight and diabetes (Kuh et al., 2004). Their analysis, across several populations, showed a negative relationship between birthweight and: the prevalence of glucose intolerance (or insulin resistance) in adults; gestational diabetes (GDM) risk in women; and plasma glucose levels in children and early adulthood (after an oral glucose test). They also found a weak or inconsistent association between low birthweight and impaired beta-cell function. Most of the associations were independent of obesity.

Foetal undernutrition and intergenerational effects are some of the explanations for the association between birthweight and diabetes (Kuh et al., 2004; Ramakrishnan, 2004). Another explanation relies on a “thrifty genotype hypothesis” (Kuh et al., 2004). It proposes that small babies that have an accelerated growth during infancy or adolescence have a higher predisposition to diabetes. This has also been shown for coronary heart disease (Barker et al., 2001; Eriksson et al., 1999).

The presence of risk factors during childhood and adolescence may increase the risk of obesity and diabetes during adulthood. For instance, childhood obesity has been associated with adulthood obesity and adult levels of insulin (Freedman et al., 2001; Wright et al., 2001). Adolescence obesity has also been associated with obesity during adulthood (Engeland et al., 2004). Although there is some evidence for the association between SES and low birth weight, GDM, and childhood and adolescence risk factors (Currie et al., 2003; Torres-Arreola et al., 2005); and between childhood SES and adulthood obesity (Gonzalez et al., 2009); this is not explained in this section since the theoretical framework focuses on adulthood SES.

2.4.3 *Obesity and lifestyle factors*

Obesity is the most important risk factor for the development of diabetes. In Mexico, studies based on a cross-sectional study in 1992 and the National Health Survey of 2000 showed that increased BMI and waist circumference are more common in people with diabetes (Aguilar-Salinas et al., 2003; Aguilar-Salinas et al., 2002; Vazquez-Martinez et al., 2006); and even more common in adults under 40 years old when compared to adults over 40 years old (Aguilar-Salinas et al., 2002).

Studies in developed countries have concluded that unhealthy behaviours such as poor diet, physical inactivity and obesity occur more frequently in adults with lower SES (Brunner et al., 1997; Marmot et al., 1991; Metcalf et al., 2008; Rathmann et al., 2006). This may be due to the more educated being more likely to make choices on nutrition requirements (Geyer et al., 2006). Moreover, in environments where healthy food is costly only persons with a higher income may be more likely to access it. Alternatively, current income and occupation may determine where people settle which in turn determines which environmental risks people are exposed to. Therefore, individual and family socioeconomic status may play a role in diet and residence choices.

Some evidence indicates that lifestyle choices such as physical activity and diet are consequences of social and economic development, modernization and urbanisation. For instance, it has been observed that individuals living in rural areas are less sedentary and have a lower prevalence of obesity (Ali et al., 1993; Herman et al., 1995). Because western and industrialized societies experience higher increases in obesity, inactivity and population ageing, it is in these societies that there is an increased prevalence of diabetes (Winer et al., 2002). Therefore, demographic and epidemiological transitions partly explain the association between diabetes and SES. According to Popkin (2002), as countries develop economically and go through a process of urbanisation and industrialization, they advance to a stage of the epidemiological and nutritional transition characterized by high prevalence of obesity and chronic and degenerative diseases. Hence, socioeconomic development leads to changes in lifestyle which in turn increase the risk of diabetes: more sedentary jobs and sedentary leisure activities that occur parallel to the increased consumption of diets high in calories and fat.

The concepts of “risk regulators” (Glass et al., 2006), “ecological factors” or “place effects” (Brown et al., 2004; Macintyre et al., 2002; Pickett et al., 2001) have emerged to describe social influences on individual action. Risk regulators include: cultural norms (such as food preference and body image norms); area deprivation (such as poverty and overcrowding); psychosocial hazards (such as crime and social disorganization); built environments (such as connectivity and places to walk); physical environment (local food environment: presence of fast food and availability of healthy foods); social environment (social networks, psychosocial stress); economic (systems of food distribution, policies and pricing, food prices and taxes, economic insecurity); and commercial messaging.

For instance, a healthy environment is that where there is access to affordable and healthy food and there are places to exercise: parks, recreational spaces, or sport facilities. Exercising in public areas may be encouraged by safe neighbourhoods or transportation, or discouraged by stressful conditions such as high density, noise and traffic. If health care facilities are present in the area, health information and prevention programs may pursue healthy behaviours in the population (municipal services). Cultural factors may determine lifestyle and preferences (such as the preparation and consumption of food), (Murcott, 1982); and norms and attitudes towards physical activity (Ramanathan et al., 2009). Commercials advertising may promote the consumption of high-calorie and low-nutrient foods (Kumanyika et al., 2006).

The high prevalence of obesity among the lowest SES groups in developed countries does not seem to be homogenous within developing countries. It has been suggested that the burden of obesity spreads gradually and over decades from higher to lower socioeconomic groups according to their ability to adopt healthy or unhealthy behaviours. According to Reddy (2007), at initial stages of the epidemiological and nutritional transition, the wealthier and more educated have higher incomes that make mediators of risk available to them, such as unhealthy foods and automated transport. In a posterior stage these mediators are available for the rest of the population independently of their socioeconomic status; and in the last stage the population with better SES adopts healthy behaviours, health information and access more efficiently to health care.

This is supported by findings that suggest that the relationship between obesity and individual SES tends to be negative in countries with high levels of socioeconomic development; and positive in countries with medium and low levels of socioeconomic development (McLaren, 2007; Sobal et al., 1989). Moreover, the comparison of 37 developing countries showed that, in low-income countries, women who have low education have lower prevalence of obesity than those with high education (Monteiro et al., 2004). However, in upper-middle income countries, women with low education have a higher prevalence of obesity than women with high education. These differences were noticeable when countries reached a GNP of US$2,500 per capita. Therefore, the association between obesity and SES may be determined by the socioeconomic development of the country or region.

Obesity and socioeconomic status in Mexico

In Mexico, it has been suggested that obesity has a negative association with SES at the national level (Fernald, 2007; Rivera et al., 2004). However, a study found that the prevalence of obesity had an inverse u-shaped association with education; and a positive or inverse u-shaped association with household SES (Gomez et al., 2009). In addition, living in an urban area was associated with a higher risk of obesity.

Evidence from other studies suggests that the association between obesity and SES vary according to the level of urbanisation and sex. A study based on the NHS-2000 found that there is a negative association between obesity and SES (education and assets) among urban women (Buttenheim et al., 2010). In rural women, there was a non-linear association between obesity and SES. In urban men, there was a positive association between assets and obesity. And in rural men, there was a positive association between obesity and SES. A study in seven of the poorest communities of Mexico showed a positive association between BMI and SES (education, occupation, housing quality, household assets and subjective social status) both in men and women (Fernald, 2007). The same study also found a positive association between BMI and household income but only in women. Therefore, there is not a clear pattern of association between obesity and SES in Mexico.

2.4.4 Other factors

Psychosocial factors have also been linked to a higher prevalence of diabetes. For instance, a study in Sweden showed that most of the excess risk of diabetes in women was explained by risk factors (BMI, physical activity, smoking and FHD) and psychosocial factors (decision latitude and sense of coherence), (Agardh et al., 2004). In the Whitehall study, of the psychosocial factors examined, only effort-reward imbalance, anxiety and depression were related to a higher incidence of diabetes in men (Kumari et al., 2004). Cubbin and Hadden (2001) speculated that the concentration of Mexican-Americans in specific areas protect them from developing risk factors (through social processes and cultural factors). In addition, it has been suggested that chronic stress (caused by neighbourhood features such as noise, violence and poverty) may be related to components of the Insulin Resistance Syndrome (Diez Roux et al., 2002).

Two explanations have been given for the association between diabetes and psychosocial factors. Firstly, that psychosocial factors may have an influence on the onset of the metabolic syndrome through the central nervous system (Brunner et al., 1997). Psychosocial factors include financial strain; job insecurity; low perceived control at work; stressful life events; poor social networks; depression; low self-esteem; and hostility. For instance, stress is related to the increase of blood sugar levels through the hormone cortisone (Gorn et al., 2005). And secondly, there may be a reciprocal effect between obesity and psychosocial factors such as depression (Luppino et al., 2010; Roberts et al., 2003). Moreover, psychosocial factors are more prevalent among the lowest SES groups (Adler et al., 2003; Everson et al., 2002).

Among the psychosocial factors, social support has been proven to influence health and life expectancy (Rankin-Esquer et al., 2000; Wyke et al., 1992). Marital status is seen as an indicator of social support (Kumari et al., 2004) or social integration (Umberson, 1992). Being single has been linked to an increased risk of developing diabetes (Schwandt et al., 2010). However, another study did not find an association between marital status and incidence of diabetes (Kumari et al., 2004). Although there is little evidence for an association between diabetes and marital status, several studies have shown that married people have better health than the non married (Lillard et al., 1996; Verbrugge, 1979). An explanation for this association is that the married may be more encouraged to follow healthy behaviours (social control), and they may benefit from higher emotional support or social companionship (Hummer et al., 1999; Umberson, 1992; Wyke et al., 1992; Zhang et al., 2006). In chapters 5 and 6 marital status is used as a measure of social support.

Exposure to cadmium is another possible cause of diabetes. However, only few studies have analyzed this relationship (Edwards et al., 2009; Haswell-Elkins et al., 2008; Satarug et al., 2010; Schwartz et al., 2003).

2.5 Asset-based measures of socioeconomic status at the household level

According to Krieger (1997), socioeconomic status has two components: class and position. The first refers to the location of individuals in the society derived from the economic, social and legal relationships among a group of people; and the second refers to the assets and their use for the generation of income and posterior consumption expenditure (Krieger et al., 1997). Among the dimensions of socioeconomic position are wealth and income (Krieger et al., 1997).

In the studies of health several measures have been used as proxies to socioeconomic status such as education, occupation, area of residence, quality of housing, ownership of assets, and others. A review of the different proxies used can be consulted in Morris et al. (2000) for measures in Africa, and in Montgomery et al. (2000) for measures in various countries.

Income and consumption expenditures are considered some of the best indicators of poverty and living standards, from which consumption expenditure is preferred (Montgomery et al., 2000). Consumption expenditure is especially preferred in developing countries where income is measured with difficulty derived from earnings seasonal variability and self-employment (Sahn et al., 2003), particularly in rural areas (Morris et al., 2000). However, consumption expenditure is also subject to measurement bias and it may not be considered as the true value of household wealth (Sahn et al., 2003).

In health studies, asset-based proxies have several advantages as alternative measures to income and expenditure. Firstly, they are easier to measure and they are less subject to reporting bias and measurement bias derived from pricing imputation (Sahn et al., 2003). Secondly, they are especially useful in epidemiological studies because income and expenditure are usually not included in health surveys (McKenzie, 2005). And thirdly, they are good proxies for permanent income or long-term wealth (Sahn et al., 2003). Long-term income may be more important than current income in the relationship between socioeconomic status and health (Benzeval et al., 2001). Asset-based indices could also be viewed as a proxies for household wealth (Morris et al., 2000), economic status or living standards.

Various techniques have been considered in the construction of indices of household wealth based on household assets, materials and facilities. Filmer et al. (2001) describe four methods to build these indices: using equal weights of all the assets; using the price of the assets; using the assets separately; and using a different weight for each asset. They argued that equal weights give arbitrary solutions; the price of assets could be unavailable and inaccurate; and using the assets separately may not enable to see the effect of household wealth when it is used as a control factor. However, they explain that an advantage of using the assets separately is that it allows to analyze if the assets have a direct or indirect effect on the outcome (Filmer et al., 2001). For example on the outcome of having type 2 diabetes or not, which is closely related to obesity, having a bicycle and/or a car may play a role on physical activity; and having television may have an impact on sedentary lifestyle, habits and disease awareness.

When the method of using different weights for each asset has been chosen, some of the statistical techniques that have been used are: principal components analysis (PCA), factor analysis (FA), (Sahn et al., 2003); multiple correspondence analysis; latent variables; and a weighted sum of assets (Morris et al., 2000).

The most popular technique in the studies related to health has been principal component analysis (PCA), (Filmer, 2001). PCA has been preferred over other similar techniques because: it may be as good as a latent variable in the measurement of permanent income (Ferguson et al., 2003); it intends to measure the variance more than to detect structure in the data when compared to factor analysis; it is easier to compute; and it gives good results when compared with consumption expenditure. Researchers who use principal components analysis use this technique to derive the weight of each household asset, material and facility. The first component is used as a proxy for long-run household wealth (Filmer et al., 2001), economic status (Houweling et al., 2003), or just household wealth (Hargreaves et al., 2007).

Filmer (2001) calculated an index using PCA. The index included eight assets, twelve characteristics of the households' dwelling, and whether the house owned more than six hectares of land. The resulting index was validated using data of Indonesia, Pakistan and Nepal, which contained information on both expenditures and asset variables. It produced internally coherent results and had a good correspondence with State Domestic Product and poverty rates data.

However, PCA is not an appropriate method because it was originally designed for continuous data, which is mostly not the case in health surveys. Howe et al. (2008) made a comparison of PCA against appropriate techniques for categorical data. The study was based on the Malawi Integrated Household Survey 2004-5, and compared the resulting indices from five different techniques: PCA; PCA using dichotomised versions of categorical variables; equal weights; weights equal to the negative of the proportion of households owning the item; and Multiple Correspondence Analysis (Howe et al., 2008). Among the variables included were: toilet facility, electrical appliances, having a domestic servant, and agricultural land. Even though all the methods had disadvantages, their application showed a modest agreement between the indices, and an agreement of the indices with consumption expenditure. The author concluded that the choice of the variables included had a greater influence on the index than the method used; and among the methods, PCA was the recommended method to assign weights to the indicators.

Another study also suggested that not only the type of assets, but the number of assets included in the indices has a different impact on the outcomes. The study used four indices that included different assets in order to analyze their sensitivity on health inequality in children (Houweling et al., 2003). It was based on DHS data of 10 developing countries. The base index was the World Bank asset index which includes durable consumer goods, housing quality, water and sanitary facilities, and others. From these assets, the second and third indices excluded assets that affect directly health such as the ones related to sanitary facilities. The fourth index also left out electricity, a public service, in order to exclude community effects. The indices were divided in quintiles and each index categorized the households in different groups. Furthermore, the indices affected the magnitude and direction of the impact of inequality on the mortality rates. The percentage of explained variance increased with fewer items in the index to about 35%. However, very few items were not useful to discriminate households.

There is no consensus in which assets should be included in the index. PCA assigns a lower weight to the assets that are equally distributed, which also have low standard deviations because most of the households have it or almost none of them (Vyas et al., 2006). Therefore, one choice is to select the assets that few households or most households have. Alternatively, Vyas and Kumaranayake (2006) propose to use the indicators that are most correlated to expenditure.

In conclusion, PCA is the most popular technique to compute indices of household wealth. However, there is not a uniform method to select the number and type of assets to include in the indices. Several issues may be considered when calculating this type of index: the type of assets included in the index are more important than the number or method used; the assets could be selected according to their standard deviations or to their correlation with expenditure; a smaller set of variables results in a higher variance in the first component, but very few items may not be useful to discriminate households; and different assets may be considered for the urban and rural stratum. To validate the household wealth indices, researchers compare them to measures such as income and expenditure through correlations, regressions and measures of agreement.

2.5.1 Asset-based measures of household SES in Mexico

In Mexico, household wealth indices have been calculated by principal components analyses in studies of nutrition (Barquera et al., 2003a; Rivera et al., 2003a) and obesity (Fernald, 2007; Gomez et al., 2009). A study calculated two indices, one for household assets and another for housing quality (Fernald, 2007). The household assets index included twelve variables: car, van, refrigerator, blender, television, gas heater, boiler, radio, stereo, video cassette recorder, washing machine and fan. The housing quality index included quality of roof, number of rooms, presence of indoor bathroom, and presence of indoor toilet. The indicators were selected on the basis that, according to the literature, they provided a good estimation of consumption. The study included 12,783 adults from the National Welfare Survey which is representative of the poorest rural towns. Both indices were positively associated with obesity.

Another index included household flooring material, potable water, and ownership of washing machine, refrigerator, television, radio, and stove (Gomez et al., 2009). These indicators were selected because they were proposed in a previous survey. The first component explained 51.6% of the total variance. The index was divided in tertiles. The study included 15,901 adults aged 20-69 years from the National Health and Nutrition Survey 2006. The index had an inverse u-shaped association with obesity in women, and a positive one in men.

In a study of nutrition, an index was calculated based on flooring material, availability of piped water, and ownership of home appliances: washing machine, refrigerator, television, radio, stove, video player, telephone and computer (Rivera et al., 2003a). The first component explained 56% of the variance of the set of variables. The index was divided in four categories according to deciles. The study included 18,311 women aged 12-49 years from the National Nutrition Survey 1999. There was a negative association between anaemia and SES.

Therefore, indices of household wealth in Mexico are useful to predict outcomes related to diabetes. However, there is no homogeneity in the type of assets, materials and facilities to include, or in the method to select the indices.

2.6 Summary

This chapter covered four main topics. Firstly, it introduced the definition and characteristics of diabetes. We observed that diabetes is characterized by high blood glucose levels, and that, of the several types of diabetes, most of the cases have type 2. We also described the main symptoms and risk factors of diabetes; as well as the different measures for its diagnosis.

Secondly, we presented a systematic review of the literature on the association between diabetes and socioeconomic status in adults. We observed that the association between diabetes and SES varies by socioeconomic development of the countries and urbanisation. We found that negative associations occurred more often in countries with a high Human Development Index; and that positive and ‘no associations’ were more common in countries with medium HDI. However, we could not confirm this pattern for the prevalence of undiagnosed diabetes or for the incidence of diabetes. We also observed that the relationship between type 2 diabetes and SES in Mexico has been investigated by a small number of studies.

Thirdly, we described a theoretical framework for the relationship between socioeconomic status and diabetes. We identified four factors that contribute to the development of diabetes in adults: genetic and biological factors; birth weight and GDM; obesity; and other factors (e.g. psychosocial factors). We concluded that socioeconomic status may be related to diabetes through obesity (as a result of lifestyle) and other factors.

And fourthly, we carried out a review about asset-based measures of socioeconomic status at the household level. We observed that there are different techniques to compute an index of household wealth (being PCA the preferred one); and that across studies, there is variation about the number and type of assets to include in the indices. We finished this section by drawing a set of suggestions to calculate and validate these indices.

3 METHODS

3.1 Introduction

This chapter presents an overview of the Mexican context, as well as the data sources and statistical methods used in the study. The chapter is divided in four sections. Section 3.2 describes the geographical location of Mexico and the sociodemographic and health characteristics of its population. Section 3.3 describes the characteristics of the data used in the study. It is divided in five subsections that correspond each to a source of information: the National Health Survey (NHS-2000); the Mexican Family Life Surveys 2002 and 2005 (MxFLS-2002 and MxFLS-2005); the National Survey of Household Income and Expenditure (ENIGH-2000); the Municipality Deprivation Index (DI); and the Municipality Human Development Index (HDI). Section 3.4 presents the statistical procedures used in the analyses. Finally, section 3.5 presents a summary of the chapter.

3.2 Mexico: location and characteristics of the population

The official name of Mexico is Mexican United States (Presidencia, 2009). The currency is the peso. At the north, Mexico is bordered by the United States (along 3,152 kilometres) and on the south east by Guatemala and Belize (Figure 8.1 in appendix A). On the east and west it is framed by the Gulf of Mexico and the Pacific Ocean, respectively. Mexico is divided in 32 states where the Distrito Federal is the capital of the country. There are six states on the north of Mexico that have a border with United States, and four states on the south border.

According to the last count from 2005, that year Mexico had a population of about 103 million (INEGI, 2010). The population has increased four times since 1950 (INEGI, 2010), and it is expected to grow to 121 million in 2050 (CONAPO, 2010). Currently, about 70% of the population is below 40 years old. During the last 20 years the population pyramid has started to acquire a different shape. The population growth in groups under 20 years of age has been more stable.

Although the majority of the population speaks Spanish, there are 68 groups of indigenous languages spoken in Mexico (CDI, 2010). Of the population aged 5 years or older, 0.8% speaks only an indigenous language and 5.7% speaks both an indigenous language and Spanish (INEGI, 2010). Spanish and the indigenous languages are official and equally valid languages (Presidencia, 2009).

During 2000, about half of the population had low levels of education and lived in poverty. According to the 2000 Census, 47.3% of the adults had an education level of primary school or below (INEGI, 2010). Only 28% of the population completed at least high school. In addition, about 45.7% of the households were living below the poverty line (CONEVAL, 2009).

Table 3.1 shows the distribution of people, localities and municipalities living in deprivation during 2000. In this table, deprivation is measured by the Human Development Index and the Deprivation Index (sections 3.3.4 and 3.3.5 describe their meaning, composition and calculation). Deprivation is represented by lower values of the Human Development Index and higher values of the Deprivation Index. According to the Human Development Index, the majority of the municipalities were classified as non poor: with medium-high and high HDI. In contrast, the Deprivation Index classified a higher proportion of municipalities, and also localities, as poor: with a high or very high deprivation. However, the figures for the DI by number of persons show the opposite trend. This is because areas with lower deprivation tend to be more urbanised and denser than areas with higher deprivation. The urban population has increased constantly from 66.3% in 1980, to 70.6% in 1990, 74.8% in 2000, and 78% in 2010.

Table 3.1 Percentage of people, localities and municipalities living in deprivation in 2000

			Municipalities(N=2443) /Localities (N=107,218)	Persons (N=97,483,412)
Municipality (%)	Index of human development	Low	1.2	-
		Medium-low	25.6	
		Medium-high	64.9	
		High	8.3	
	Deprivation Index*	Very high	15.8	4.6
		High	37.1	14.0
		Medium	19.9	12.0
		Low	17.1	15.7
		Very low	10.1	53.7
Locality (%)	Deprivation Index**	Very high	31.6	4.6
		High	45.9	16.1
		Medium	13.8	11.8
		Low	6.6	25.8
		Very low	2.1	41.2

Source: CONAPO (2010) based on data from Census 2000 *Missing information on one municipality **Excludes 525 708 people residing in 91,648 confidential localities, and 72 910 people from 525 localities without information on their households.

Mortality and morbidity statistics indicate a tendency toward improvements in the health of the Mexican population (CONAPO, 2010). There has been a significant decrease in infant mortality rate and an increase in life expectancy during the last 15 years. Infant mortality has declined substantially from 1990 (39.2 per thousand) to 2005 (16.8 per thousand); and it is expected to drop significantly by 2050 (3.2 per thousand). The life expectancy at birth for both men and women increased from 70.6 years in 1990 to 74.6 years in 2005. Life expectancy is forecast to increase to 82 years in 2050. In addition, the fertility rate has declined from 3.4 in 1990 to 2.2 in 2005, and it is expected to decline to 1.85 by 2050. However, only 40.1% of the population had access to public health care in 2000.

3.3 Data

We used data from the National Health Survey (NHS-2000); the National Survey of Household Income and Expenditure (ENIGH-2000); the Mexican Family Life Survey 2002 and 2005 (MxFLS-2002 and MxFLS-2005); and the 2000 Municipality Deprivation Index and Human Development Index. A summary of how the data is used to answer the research questions is described in Figure 3.1.

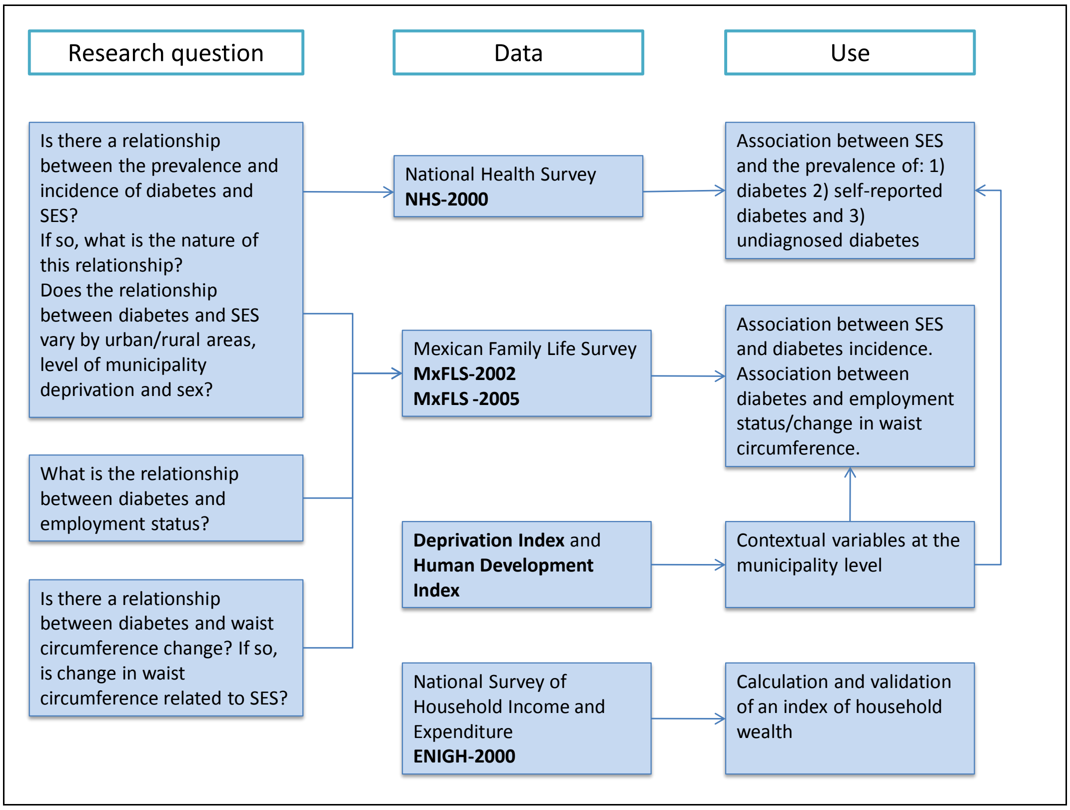
The NHS-2000 is a cross-sectional survey that was used in this study to investigate the socioeconomic factors associated with the prevalence of diabetes. The NHS-2000 was mainly selected for this analysis because not only does it contain information on self-reported diabetes, but it also includes a capillary blood test that allows the detection of adults with newly diagnosed diabetes (or undiagnosed diabetes). In addition, knowing the prevalence of self-reported diabetes and undiagnosed diabetes contributes to the estimation of the total prevalence of diabetes. Even though there is a 2006 Mexican Survey of Health and Nutrition (NHSNUT-2006), the NHS-2000 was preferred for two reasons. Firstly, the NHSNUT-2006 was not available when this study started. And secondly, the NHS-2000 was collected during the same year as the Census, which presents an opportunity to use contextual variables collected contemporaneously.

The MxFLS-2002 and MxFLS-2005 is a panel survey that was used to analyze the association between SES and the incidence of diabetes. In addition, this survey was used to explore the association between diabetes and employment status; and between diabetes and change in waist circumference.

The ENIGH-2000 was used to calculate and validate an index of household wealth. This was done to use the selected assets and materials to compute an index of household wealth in the NHS-2000. The ENIGH-2000 was selected because it has information about household assets, materials and facilities, as well as detailed income and expenditure, which allow the validation of the index.

The Deprivation Index and the Human Development Index at the municipality level were used as contextual variables. These are official statistics and they are recognized as deprivation measures for government planning. The Human Development Index is only reported at the state and municipality level. The Deprivation Index is reported at the state, municipality, and locality levels. The municipality level indices were selected so they could be compared.

Figure 3.1 Data, research questions and use



3.3.1 National Health Survey 2000 (NHS-2000)

The National Health Survey 2000 is a nationally representative cross-sectional survey conducted between November of 1999 and June of 2000 (Valdespino et al., 2003). The sampling design was probabilistic, multistage, stratified and clustered. Sampling weights were calculated to take into account the complex survey design. Moreover, corrections were made to adjust for non-response and to adjust for the effect of underrepresented or overrepresented groups in the NHS-2000 in relation to the 2000 Mexican Census (post-stratification). Additional information about the survey design and methodology can be found in a previous report (Valdespino et al., 2003).

The total sample size was 47,040 households, deriving 1,473 households by state, number that was rounded to 1,470. The steps for the selection scheme were:

- The number of households in the sample was allocated proportionally to the urban and rural stratum

- Within each state, 14 municipalities were selected, with replacement and with probability proportional to the number of households.
- Within each municipality, 5 AGEB's were selected with probability proportional to the size. AGEB (Basic Geo-statistic Area) is a small geographic area defined by the National Institute of Statistics, Geography and Informatics (INEGI) with sampling purposes.
- Within each AGEB, 3 blocks were selected with the same probability
- Within each block, 7 households were selected with the same probability
- Finally, within each household, with the same probability were selected: one child, one adolescent and one adult.

The information was obtained via a direct interview to the informant using five different questionnaires. The first was the home questionnaire and it was applied to all homes in the households, and all members of the home. INEGI defines a "home" as a unit with one or more members whether they belong to the same family or not, that reside habitually in the same household and that have a common expenditure (INEGI, 2000). The second questionnaire was applied only to those members that used a health service during the previous year, whether it was preventive or not. The other three questionnaires were applied individually to only one child (ages 0 to 9 years old), one adolescent (aged 10 to 19 years old) and one adult (aged at least 20 or more years) selected randomly into each household. The information from the adult and home questionnaires is used in this study. In the adult's questionnaire, self-reported diabetes was assessed through the question: has a doctor told you that you have diabetes or high blood sugar?

Nurses were trained during 30 days about the standardisation and procedures to collect anthropometric (height, weight, waist circumference) and biological samples (capillary blood glucose). Height was measured with a tape measure and a square and registered to the nearest millimeter. Weight was measured using a daily-calibrated solar scale and registered to the nearest gram. Waist circumference was measured at the midpoint between the highest point of the iliac crest and the lowest part of the ribs margin of the median axial line.

Some random error may have existed when measuring waist circumference, especially in adults with morbid obesity where it is more difficult to determine the reference points for the measure (highest point of the iliac crest and lowest part of the ribs). A study used four reference points to measure waist circumference: the superior border of the iliac crest, midpoint between the iliac crest and lowest rib, umbilicus, and the minimal waist (Mason et al., 2009). According to this study, the point of reference had a higher effect on the prevalence of abdominal obesity (when waist circumference was categorized) than on the continuous measurement of waist circumference. These effects were observed across all levels of BMI. However, using a different point of reference may not bias the association between abdominal obesity and diabetes. A posterior study showed that the four points of reference classified similarly people with an without high glucose (Mason et al., 2010).

Capillary glucose (fasting or random) was measured using glucometers “Accutrend” (Lakeside). Although Fasting Plasma Glucose (FPG) is recommended as the first step for screening diabetes (WHO, 2002), capillary glucose is a good approximation for plasma glucose measurements. For instance, three studies in India measured capillary glucose in all subjects in the sample, and plasma glucose only in every tenth subject. Two of these studies showed that there was a Pearson correlation of r=0.9 or higher between the two glucose measurements (Ramachandran et al., 2008; Ramachandran et al., 2001). The other study found a good agreement between the two methods (Ramachandran et al., 2002). Unfortunately, no measures of the reliability of the anthropometric and biological measurements were presented in the NHS-2000. Additional information on the procedures to collect anthropometric and biological data can be consulted in a previous report (Olaiz et al., 2003).

At the end of the survey, there was information from 45,726 households and 190,214 people. Of the total, 23.5% were children, 21.2% were adolescents, and 55.4% were adults. There were 83,157 blood samples from the 94,000 expected (88% response rate), (Sepulveda et al., 2007).

3.3.2 Mexican Family Life Survey (MxFLS-2002 and MxFLS-2005)

The 2002 Mexican Family Life Survey was collected between May and August of 2002 by the National Institute of Statistics, Geography and Informatics (INEGI), and researchers from the Centre for Economic Research (CIDE), the Iberoamerican University (UIA) and the National Institute of Perinatology (INper), (Rubalcava et al., 2004). Subsequent waves were collected in 2005 and 2008 as part of the first panel survey in Mexico.

The design of the survey was probabilistic, multistage, stratified and by clusters, where the last unit of selection was the household and the last unit of observation was the home. The sample was based on the proportion of the population that migrates out of the country and a non response rate of 15%, which derived a sample of 9,860 households, a number that was rounded to 10,000. The selection of the households was independent for each region, stratum and zone. Firstly, the sample was assigned equally to the 5 regions in which Mexico is divided for National Planning purposes: south-southeast, centre, centre-occident, northwest, and northeast. Then into each region, the sample was assigned proportionally to 3 zones: the National Survey of Urban Employment zone (which includes 48 cities and metropolitan areas); the Urban Complement zone (which is constituted of the cities from 2,500-99,999 inhabitants and by those not included in the ENEU zone with 100,000 inhabitants and over); and the Rural zone, which includes localities of less than 2,500 inhabitants. Finally into each zone, the sample was assigned proportionally to 3 strata: high, medium and low based on socioeconomic variables of the primary sampling units (PSU's). Additional information about the survey design and methodology can be found in the report by Rubalcava et al. (2004).

Current and retrospective questions about social, economic, demographic and health factors were asked during the survey at the household and individual levels. The MxFLS also includes anthropometric measures and biomedical indicators for each individual. Diabetes was assessed through the question: Have you ever been diagnosed with diabetes? In 2005, the blood glucose was measured, however, by the time of our analysis, this information was not reported.

The 2002 Mexican Family Life Survey includes information from 8,440 households and 35,677 individuals. There was about 16% of non-response in this survey. People who were interviewed in 2002 were interviewed again in 2005, even if they moved to another household, and even if they moved to reside in the United States. In comparison with the 2002 survey, the MxFLS-2005 additionally includes questions about attitudes and expectations, as well as a test of general knowledge according to the Mexican context.

3.3.3 National Survey of Household Income and Expenditure 2000 (ENIGH-2000) and poverty lines

The ENIGH-2000 measured the structure and distribution of income and expenditure of the households taking into account monetary and non monetary sources (INEGI, 2010). The survey also obtained information on household members' characteristics and household building materials and assets. The ENIGH-2000 is comparable with the ENIGH's of 1984, 1989, 1992, 1994, 1996 and 1998, in methodology, information collection procedures, and seasons of collection.

The design of the survey was probabilistic, multistage, stratified and by clusters, where the last unit of selection was the household and the last unit of observation was the home. The sample was based on the proportion of income for rent of the property, a 90% confidence, a maximum relative error of 16.4%, a non response rate of 15%, a design effect of 3, and an average of 1.73 recipients of income by household; which derived a sample of 10,000 households. The selection of the households was independent for each state and stratum and varied according to the zone. The probabilities of selection and sampling weights for each zone and stratum, as well as the estimates for national characteristics and precisions are given in the sampling design document of the ENIGH-2000. The information was collected through questionnaires on the third quarter of 2000. The final sample had 10,108 households. The non response rate was 14.2%.

The ENIGH is used in Mexico to calculate the official poverty lines. Their aim is to classify the households and individuals according to their capabilities to afford the basic requirements for living (CONEVAL, 2009). The poverty lines in 2000 were calculated by the Mexican Technical Committee for the Study of Poverty in Mexico (Comite Tecnico para la Medicion de la Pobreza 2000). The poverty lines are based on the total net income per capita, that is, the total net income divided by the household size. There are three levels of poverty:

a. Food poverty. Includes the households that do not have the minimum income to afford the basic food basket;
b. Capabilities poverty. Includes the households that can not afford the basic food basket plus basic health and education;
c. Patrimony poverty. Includes the households that can not afford food, health, education and other basic needs such as shoes and clothes, housing, electricity, fuel for cooking, and transportation, to have an acceptable quality of life.

The total net income is derived from the current income minus gifts. The total current income per month is calculated as the average of the real incomes in the six months of reference. It is calculated as the sum of the monetary and non monetary earnings of the household members. The monetary incomes are considered as those derived from job wages, income from own business, cooperative societies, property rents and transfers. The non monetary incomes are those derived from the imputed value of self-consumption, payment in kind, received gifts, and the estimate of the rent for the dwelling use. The monetary and non monetary incomes are expressed in pesos at August of 2000, using the National Index of Consumption Prices (Indice Nacional de Precios al Consumidor, INPC). Therefore, income and expenditure are measured in detail in the ENIGH-2000, in contrast with the NHS-2000 (see section 4.1). Although problems with the variability of earnings may be addressed when asking about different sources of income (especially for people with seasonal employment and self-employment); measurement bias can exist when the prices of non monetary incomes are imputed; and recall bias may exist when people are asked to report their income.

3.3.4 Municipality Deprivation Index (DI)

The Deprivation Index (DI) is a measure that differentiates municipalities and states according to the lack of basic needs that have an impact on the quality of life (CONAPO, 2001b). The municipality Deprivation Index 2000 was calculated by the

National Population Council (CONAPO) and it was based on nine indicators from the Census 2000:

1. Percentage of population that does not know how to read and write aged 15 or older
2. Percentage of population with incomplete primary school aged 15 or older
3. Percentage of population with income up to 2 minimum salaries
3. Percentage of population in households without sewage and without toilet
4. Percentage of population in households without electricity
5. Percentage of population in households without piped water
6. Percentage of population in households with soil floor
7. Percentage of households with overcrowding
8. Percentage of population in localities with less than 5000 inhabitants

These nine indicators were aggregated and reduced using Principal Components Analysis. The first component was retained and considered the Deprivation Index. The first component explained 58% of the total variance. The coefficients of the nine indicators had a range of 0.112 to 0.173. The three indicators that explained a high percentage of the variance of the first component were: the percentage of population that does not know how to read and write; the percentage of population with incomplete primary school; and the percentage of population in households with soil floor.

The Deprivation Index was divided in five groups using the Optimal Stratification Technique. The range of the index was [-2.44, 3.39], and the four cut-off points were: -1.28, -0.69, -0.11 and 1.05. There were 247 municipalities with very low deprivation, 417 with low deprivation, 486 with medium deprivation, 906 with high deprivation, and 386 with very high deprivation. These five groups are used in chapter four to assess municipality deprivation.

3.3.5 Municipality Human Development Index (HDI)

At the international level, the Human Development Index (HDI) aims to measure the health and well-being of a population in a country. The HDI is based on three dimensions: life expectancy at birth (a measure of a long and healthy life); adult literacy rate and combined gross enrolment in primary, secondary and tertiary level of education (a measure of access to knowledge and education); and the gross domestic product (GDP) per capita in Purchasing Power Parity US dollars (PPP US$) (a measure of living standards), (UNDP, 2008).

To calculate the Municipality Human Development Index the indicators that compose the HDI were adapted to the municipality information availability: survival probability during the first year after birth; schooling assistance rate; literacy rate; and yearly average income per capita in dollars (CONAPO, 2001a). With these indicators the health index, the education index, and the income index were generated and then averaged to calculate the index.

The Municipality Human Development Index had a range of 0.362 to 0.930 (CONAPO, 2001a). The lowest municipality HDI was registered in one of the poorest states, Oaxaca; and the highest HDI was registered in one of the delegations of the Distrito Federal, the capital city of Mexico. According to the HDI and the United Nations Development Programme (UNDP) criteria, the municipalities of Mexico were grouped in four strata: low human development, medium-low human development, medium-high human development, and high human development. There were 31 (1.2%) municipalities with low HDI (<0.500); 625 (25.6%) municipalities with medium-low HDI (0.500-0.649); 1584 (64.9%) municipalities with medium-high HDI (0.650-0.799); and 202 (8.3%) municipalities with high HDI (>0.800).

The analysis of this data revealed that the municipalities with high HDI are mainly located in the north region of the country and in more urbanised areas; and that the municipalities with low or medium-low HDI have a high percentage of indigenous population (UNDP, 2000).

3.4 Statistical methods

The main statistical methods across the thesis were: chi-square tests; linear and logistic regression; and Principal Components Analysis. Chi-square tests were used to compare groups across the main outcomes. The chi-square test is based on the null hypothesis that there is no association between the variables (Bewick et al., 2004).

Linear regression was used in chapter four to examine which household assets, materials and facilities were useful to rank households according to their expenditures. Then, the significant indicators were aggregated using Principal Components Analysis. Logistic regression was used in chapters five and six to examine the factors associated with diabetes, working status, employment status, and change in waist circumference. In addition, multilevel logistic regression was used in the analyses of diabetes. The following two subsections explain how these methods were applied.

3.4.1 Ordinary linear regression and logistic regression

Linear regression

In chapter 4, linear regression was used to examine which household assets, materials and facilities were useful to rank households according to their expenditures. The equation for the linear regression can be represented by:

$$\mu_i = \beta_0 + \beta_1 x_{1i} + ... + \beta_p x_{pi} + \varepsilon_i$$

where μ_i is the rank of a household according with its expenditures, and x_{1i} , ... ,x_{pi} represent the household assets, materials and facilities. In the equation, ε indicates an error or deviation and it is a normally distributed random variable with mean zero and constant variance σ^2. In addition, ε_i and ε_j are uncorrelated, where *i* and *j* represent two different households. The parameters of the model, β, can be obtained by the method of least squares. An algebraic and matrix derivation of the values of β can be consulted in Draper and Smith (1998).

The rank μ_i was transformed in order to approximate it to a normal distribution by:

$$\mu_i^* = \Phi^{-1}\left(\frac{\mu_i}{n+1}\right)$$

where $\Phi^{-1}(\cdot)$ is the negative of the cumulative distribution of a N(0,1), and n is the number of observations (n=10,108). Each rank μ_i was divided by (n+1) because $\Phi^{-1}(1) = \infty$.

Two sided z-tests were used to analyze the significance of the coefficients of the model, β. They test the null hypothesis that the coefficient is equal to zero (Draper et al., 1998).

The R^2 was used to assess the increase of the variance explained by the added indicators. The R^2 explains what proportion of the variation was explained by the regression. The residuals were analyzed for outliers and to see if the assumptions hold. The analysis of the residuals was made through qq-plots of residuals; graphs of residuals against fitted values; and the Shapiro-Francia W' test (a test for normality).

The variables included in the model were selected using the stepwise procedure. It consists in adding to the equation the variables one by one according to their significance (forward selection), while checking the rest of the variables and eliminating them if they are not significant (backward elimination), (see Draper, 1998, pgs. 305-313). Because we accounted for the design of the ENIGH in the regression model, the addition or removal of indicators was assessed through the Wald test. This test assesses if a group of parameters is significant. It is based on a z-test and it follows a chi-square distribution. The adjusted Wald test accounts for the strata in the denominator degrees of freedom.

Logistic regression

Logistic models were used in chapters five and six to determine the factors associated with diabetes, working status, employment status, and change in waist circumference. A logistic model is a Generalized Linear Model (GLM) with a binary response variable. GLM's are used in cases where the response variable is not continuous and thus, normality assumptions can not be followed (Agresti, 2002).

The linear probability model is written as:

$$logit(\pi_i) = \beta_0 + \beta_1 x_{1i} + \ldots + \beta_p x_{pi}$$

$$y_i \sim B(n_i, \pi_i)$$

where the $logit(\pi)=log(\pi/(1-\pi))$ is the log odds of the response. The responses in chapter five and six are: having diabetes; not working; being unemployed; and increase/decrease in waist circumference. The parameters of the logistic model are estimated by maximum likelihood (Agresti, 2002). The z-test was used to compare categories across a variable. The likelihood-ratio test was used to assess the addition or removal of a categorical variable.

Multilevel models were used in chapters five and six. The two-level random intercepts logistic model or variance components model allows the probability of having diabetes to vary across municipalities. The binary response y_{ij} equals 1 if the adult i in municipality j has diabetes, and 0 if the adult does not have diabetes. The probability of having diabetes is denoted as $\pi_{ij} = Pr(y_{ij} = 1)$ and the two-level random intercept model is denoted as:

$$logit(\pi_i) = \beta_{0j} + \beta_1 x_{1ij} + ... + \beta_p x_{pij}$$

$$\beta_{0j} = \beta_0 + u_j$$

where the intercept varies randomly across municipalities and consists of two terms: a fixed component β_0 and a municipality-specific component, the random effect u_{0j}. It is assumed that the u_{0j} are independently normally distributed with mean zero and variance σ^2_{u0}. The likelihood ratio test was used to assess the significance of the random intercept, H_0: $\sigma^2_{u0} = 0$ against H_a: $\sigma^2_{u0} > 0$. The logistic multilevel regression was estimated in the software STATA using the command xtmelogit.

3.4.2 Principal Components Analysis

In chapter four we calculated an index of household wealth that discriminates households based on their assets, materials and facilities. In the previous chapter we described that Principal Component Analysis is a widely used technique to develop this measure.

Principal component analysis (PCA) is a method that reduces the dimensionality of the data by creating a new set of uncorrelated variables (principal components), through a linear combination of the original variables (Everitt, 1991). It is expected that the first principal component accounts for the largest variation of information; thus, summarising and representing the original data. The first principal component is expected to be a weighted average of the original variables. According to Everitt and Dunn (1991), the first principal component, as a linear combination of the original variables, can be represented by:

$$z_1 = a_{11}x_1 + a_{12}x_2 + ... + a_{1p}x_p$$

where x_{1i} , ... ,x_{pi} represent the selected household assets, materials and facilities. The mathematical derivation of eigenvalues, eigenvectors and proportion of the variance accounted for each principal component, as well as numerical examples can be consulted in Everitt and Dunn (1991). The software STATA calculates the principal components using the command pca.

3.5 Summary

In this chapter we described the data used in this thesis: three nationally representative surveys and two indices published as official statistics. Additionally, we presented the main statistical methods used in the thesis and how they were applied.

The NHS-2000 is used in this study to explore the relationship between SES and diabetes prevalence. Its main advantage is the inclusion of capillary blood tests to allow the detection of adults with undiagnosed diabetes. Another advantage is that the survey includes information on a large sample and all 32 states are represented. One of its disadvantages is that the survey only includes one adult per household.

The MxFLS-2002 and MxFLS-2005 is used to analyze the incidence of diabetes and to explore employment status and changes in waist circumference. This survey is the first nationally representative longitudinal survey. However, the follow-up is very short and the survey was planned for only three waves; and the third was not available when our analyses started. Although not all the states are represented, the five regions of Mexico are represented as well as primary sampling units (PSU's) representative of three socioeconomic strata. Even though only self-reported diabetes is recorded and the main purpose of the survey is not to gather information on health, the survey includes information on anthropometric measurements and biomedical indicators for all the members in the household. One significant advantage is that adults were followed by the survey even if they moved to another household or moved to reside in the US.

The ENIGH-2000 was used to construct and validate an index of household wealth. This survey includes household assets, materials and facilities as well as income and expenditure information that enable the validation of wealth indices

The Deprivation Index and the Human Development Index are used as measures of municipality SES. The Deprivation Index differentiates municipalities according to the lack of basic needs. The Human Development Index (HDI) at the municipality level is based on indicators of health, education and income.

4 CALCULATION AND VALIDATION OF AN INDEX OF HOUSEHOLD WEALTH IN THE ENIGH-2000

4.1 Introduction

The analysis of diabetes in the NHS-2000 requires a measure of SES at the household level. Income and consumption expenditures per household can be used as SES measures. However, in the NHS-2000, information on expenditure was not included in the survey and income was absent for 8% of the households. Furthermore, income was not measured thoroughly since it was assessed only by two questions: one that inquired about the main income; and another that inquired about the additional incomes (such as transfers). In chapter 2 we mentioned that income presents other problems: underreport; seasonal variability; measurement bias; and it is measured with difficulty in the self-employed and rural areas.

Three main ideas can be recovered from section 2.5. Firstly, that to deal with this type of problems in health surveys, indices of household wealth based on household assets, materials and facilities are commonly calculated. Secondly, that PCA is a popular technique to construct indices of household wealth, however there is not a general consensus in how to select which indicators to include in the index. And thirdly, that consumption expenditure is seen as one of the preferred measures of living standards and consequently, it is expected that these measures have a close association.

Therefore, to construct a measure of SES in the NHS-2000 we propose to build an index of household wealth based on household assets, materials and facilities using PCA. In addition, we use an auxiliary survey, the ENIGH-2000, to select the indicators associated with expenditure, categorize the index and validate it.

The aim of this chapter is to construct and validate an index as a proxy to long-run household wealth in the ENIGH-2000, based on the household assets, materials and facilities included in both the ENIGH-2000 and the NHS-2000.

Section 4.2 presents the data and indicators, the calculation of income and expenditure, and the description of the statistical methods used. Section 4.3 reports the descriptive statistics, the linear regression model for the rank of expenditure, the calculation of the index, its categorization, and the percentiles of income and expenditure by category. Finally, section 4.4 reports the conclusions.

4.2 Methods

The methodology to construct, validate and categorize the index of household wealth is summarized in the following points:

1. Linear regression was used to assess which household assets, materials and facilities (of the 18 indicators available) were useful to rank households according to their expenditures.
2. The indicators selected in the model were aggregated using principal components analysis (PCA). Then, the first component was retained and considered the index of household wealth.
3. The index was validated against different measures of income and expenditure
4. The index was divided in 5 categories according to the income per capita. In addition, percentiles of income and expenditure were calculated by category of the index.

4.2.1 Data source and definition of variables

Data source

Data from the National Survey of Household Income and Expenditure (ENIGH-2000) was used, firstly, because it was collected on the same year as the NHS-2000, although the samples are independent; and secondly, because it has detailed information on income, expenditure and household assets, materials and facilities, to build the index and validate it. The analysis included the 10,108 households of the ENIGH-2000.

Household assets, materials and facilities

There were 18 household assets, materials and facilities that were common in the ENIGH-2000 and in the NHS-2000. The indicators were coded so that a higher category represented households having the facilities and materials or owning the assets:

1. What are the walls of the dwelling primarily made out of? (Residue material, cardboard sheets, asbestos plate, metallic plate or fibreglass, common reed-grass, bamboo, palm tree, or shingle, embarro o bajareque (clays); Other)
2. What are the roofs of the dwelling primarily made out of? (Residue material, cardboard sheets, asbestos plate, metallic plate or fibreglass, palm tree, common reed-grass, bamboo, shingle or wood, linden tree; Other)
3. What are the floors of the dwelling primarily made out of? (Soil; Cement; Other)
4. Does the household have a room for cooking? (No; Yes)
5. How many people are there per room to sleep, not counting kitchen, bathroom, and hallways? (4 or more; 3 to 3.99; 2 to 2.99; 1 to 1.99; 0 to 0.99)
6. Does the house have piped water (No piped water in the house; Piped water in the building or yard; Piped water inside the dwelling)
7. Is there a toilet supplied by piped water? (No;Yes)
8. Does the household have electricity? (No;Yes)
9. What type of fuel does the household use for cooking? (Wood; other)
10. Does the household own a radio/radio tape player? (No;Yes)
11. Does the household own a television of any kind? (No;Yes)
12. Does the household own a VCR? (No;Yes)
13. Does the household own a blender? (No;Yes)
14. Does the household own a refrigerator? (No;Yes)
15. Does the household own a washing machine? (No;Yes)
16. Does the household own a land-line telephone or a cellular telephone? (No;Yes)
17. Does the household own a boiler? (No;Yes)
18. Does the household own an automobile, pick-up, mini-van, cargo truck, etc.? (No;Yes)

Income and expenditure

The total net income per capita and total net expenditure per capita, both per household and per month were calculated in the ENIGH-2000 using the SPSS code published by the Committee for Poverty in Mexico. This SPSS code has two advantages: firstly, it was used to officially measure poverty in 2000 based on the total net income per capita; and secondly, it deflates the monetary values to pesos of the same date, in this case, august 2000. The total net expenditure per capita is calculated in a similar way to that of the total net income per capita (see section 3.3.3). We refer to the total net income per capita, the total net income, and the total current income only as "net income per capita", "net income" and "current income", respectively. The same notation is given to expenditure.

The rank of income and expenditure per capita (μ_i) was calculated. The average of the ranks was used in case that two or more expenditures had equal values. Using a unique rank for each expenditure was not considered because, given that two households have the same expenditure, the decision of which household is ranked first is made arbitrarily by the software.

4.2.2 Statistical analysis

Most statistical analysis was done with STATA version 10.0. Descriptive statistics (percentages, median income and expenditure) were determined for the 18 indicators by urban/rural strata. Chi-square test was used to compare the indicators by stratum. Histograms and Shapiro-Francia, skewness and kurtosis tests were used for the assessment of normality of income and expenditure. The logarithm transformation of income and expenditure was used to compare the means of these measures across categories. Analysis of variance (ANOVA) and t-tests were performed for the mean-comparison of log income and log expenditure across the household assets, materials and facilities. The ANOVA was performed for variables with more than 2 categories, and the t-test for variables with two categories. Both tests were carried out at a 95 confidence level. In order to select the appropriate t-test for the mean comparison, a previous test was performed to compare if the variances of the groups were equal.

Tetrachoric and polychoric correlations were calculated between the indicators in SAS version 9.1. We set up a value of 0.8 as an indication of high correlation.

Linear regression was performed with the transformed rank of expenditure as the dependent variable, and the household assets, materials and facilities as the predictors (see section 3.4.1). The regression was performed in STATA 10.0 accounting partially for the design of the survey (urban/rural stratum, state) and including sampling weights (there was no information in the data that indicates what primary sampling units (PSU's) or secondary sampling units (SSU's) the households belong to). The order of addition of the variables in the model was determined by using the stepwise procedure and the adjusted Wald test values. The significance level considered for addition or removal was 0.05. The stepwise procedure was preferred to the backward elimination because it allows assessing which indicators are most related to the rank of the households by expenditure, in case that fewer indicators need to be used. Additionally, the stepwise procedure enables detecting changes in the values of the coefficients that may be due to multicollinearity. We only included the first of the indicators that were highly correlated. All significant variables were kept in the model since it is recommended that as many variables as possible be retained when building an index of household wealth in order to avoid problems of clumping and truncation (Vyas et al., 2006).

The approximate standardized coefficients were calculated to assess the effect in the transformed rank expenditure that result from a change of one standard deviation in the predictors. They are approximations because after using the survey commands to calculate the standardized coefficients, the sampling weights are treated as analytic weights.

The significant indicators were aggregated using principal components analysis (PCA) from which the first component was retained and considered the index of household wealth. Then, the index was validated against different measures of income and expenditure in its continuous and categorical forms. Pearson and Spearman correlations were calculated between income/expenditure and the continuous index. In addition, the index was classified according to poverty lines. Since about 50% of the households lived in poverty in 2000, we split the non poor in two groups where the partition corresponds to the 80th percentile of income per capita.

Therefore, the categories of income for the index were:

1. Category I. Income lower than 626 pesos in the urban stratum and 463 in the rural stratum);
2. Category II. Income between 626-1255.8 pesos in the urban stratum and 463-842.6 in the rural stratum;
3. Category III. Income between 1255.8-1563.7 pesos in the urban stratum and 842.6-1046.8 in the rural stratum.
4. Categories IV. Income higher than 1563.7 pesos in the urban stratum and 1046.8 in the rural stratum, but lower than the top 20% of income per capita in each stratum.
5. Category V. Top 20% of income per capita in each stratum.

Locally weighted regression of income per capita on the index was used to define the four cut-off points by stratum. The lowess smoothing command in STATA was used, and upper extreme values were not taken into account (1% of the incomes). The cut-off points of the index that correspond to the poverty lines and to the top 80th percentile of income per capita were calculated by interpolation.

The internal coherence of the index was assessed by comparing the index categories to the indicators. In addition, the agreement of the index with income (divided in poverty lines) was calculated. Agreement refers to the percentage of households that are classified in the same category in both the index and the measure of income or expenditure. The kappa value is a measure that takes into account that the agreement is given by chance. If no weights are used, then the kappa considers only exact matches between categories. A very good agreement would occur when kappa is 0.81 or above; good if kappa is between 0.61 and 0.8; moderate if kappa is between 0.41 and 0.6; fair if kappa is between 0.21 and 0.4; and poor if kappa is lower than 0.2 (Altman, 1991). Because the categories are ordered, kappa values with weights reflect the fact that the households may not be classified in exactly the same category, but in a close one. The linear weights are calculated as: wi=1-|i-j|/(k-1), where k=5 is the number of categories, i=1..5, is the category for the index, and j=1..5 is the category for the measure of income or expenditure. Therefore the linear weights are: 1, 0.75, 0.50, 0.25 and 0. Similarly, the quadratic weights are calculated as: wi =1-{(i-j)/(k-1)}^2; and the weights are: 1, 0.937, 0.750, 0.437 and 0. Finally, the percentiles of income and expenditure were calculated by category of the index.

4.3 Results

The ENIGH-2000 covered 10,108 households from which 5,494 (54.4%) were located in the urban stratum and 4,614 (45.6%) in the rural stratum. Table 4.1 shows the characteristics of the households by stratum. Compared to the rural stratum, a higher percentage of the households in the urban stratum had dwellings constructed with more resistant walls and roofs materials, floor coverings, piped water inside the household or land, toilet and electricity; and owned most of the assets. In addition, households in urban areas were less likely to be overcrowded. Having a room to cook was more frequent in rural areas; and there were no differences in having a radio or radio tape player between urban and rural areas.

The indicators that were highly correlated between them were: wall and roof (0.81); fuel and toilet (0.80); boiler and toilet (0.88); blender and electricity (0.84); blender and fridge (0.84); VCR and television (0.80); water and toilet (0.98); water and boiler (0.85); television and electricity (0.85); electricity and fridge (0.84); electricity and phone (1.00); and electricity and boiler (1.00).

Table 4.1 Characteristics of the households in the ENIGH-2000

	Stratum			Total
	Urban	Rural	p-value	
Total (n=100%)	5,494	4,614		10,108
Type of wall (%)				
Residue materials, shingle, clays, etc.	2.8	6.3	p<0.001	4.4
Other	97.2	93.7		95.6
Type of roof (%)				
Residue materials, linden tree, etc.	26.3	58.9	p<0.001	41.2
Other	73.7	41.1		58.8
Type of floor (%)				
Soil	3.6	19.4	p<0.001	10.8
Cement	49.5	65.4		56.8
Other	46.9	15.2		32.4
Have a room for cooking (%)	86.02	88.0	p=0.003	86.9

Table 4.1 Characteristics of the households in the ENIGH-2000 (cont.)

	Stratum			Total
	Urban	Rural	p-value	
Total (n=100%)	5,494	4,614		10,108
Overcrowding (%)				
4 or more	13.8	24.4	p<0.001	18.6
3 or more but less than 4	12.0	16.3		14.0
2 or more but less than 3	33.9	33.1		33.6
1 or more but less than 2	39.2	25.5		32.9
Less than 1 person per room to sleep	1.1	0.7		0.9
Have piped water (%)				
No	5.5	18.4	p<0.001	11.4
Outside the household or land	20.4	47.7		32.8
Inside the household or land	74.1	33.9		55.8
Have a toilet (%)	72.6	30.1	p<0.001	53.2
Have electricity (%)	99.5	94.2	p<0.001	97.1
Type of fuel for cooking (%)				
Wood	1.5	34.0	p<0.001	16.3
Other	98.5	66.0		83.7
Own a radio/radio tape player (%)	66.8	68.2	p=0.130	67.4
Own a television (%)	95.0	78.7	p<0.001	87.5
Own a VCR (%)	41.9	16.9	p<0.001	30.4
Own a blender (%)	88.4	64.9	p<0.001	77.7
Own a fridge (%)	83.2	55.1	p<0.001	70.3
Own a washing machine (%)	61.4	35.2	p<0.001	49.5
Own a phone (%)	48.1	15.3	p<0.001	33.1
Own a boiler (%)	46.9	19.6	p<0.001	34.4
Own a car or truck (%)	36.5	24.6	p<0.001	31.1

The net income per capita had a median of 1087.6 pesos; the maximum value was 97,652.8, and four values were less than or equal to zero. The net expenditure per capita had a median of 1003.9 pesos; the maximum value was 70,698.5 pesos, and two values were zero. There was a significant Pearson correlation of 0.79 between these variables. A scatter plot of income and expenditure for the non negative values lower than 20,000 pesos is shown in Appendix C, Figure 8.2. Table 8.7 and Table 8.8 in appendix C show that the median of the net income per capita and the median of the net expenditure per capita increase by category of each indicator, and are higher in the urban stratum. The positively skewed histograms of income and expenditure (Figure 8.4 in appendix C) and the rejection of normality by the Shapiro-Francia, skewness and kurtosis tests ($p<0.01$) for these variables, suggest that a transformation should be applied to income and expenditure so that the comparison of the means by category of indicator can be performed (a logarithm transformation was applied). The t-tests and ANOVA tests suggest that the mean log income and mean log expenditure are statistically different for each category of the 18 indicators except for the variable "own a radio or a tape player".

4.3.1 Household assets, materials and facilities that best predict net expenditure per capita

The expenditure per capita ranks associated with their corresponding normal distribution are presented in Figure 8.3 (appendix C). The significant variables in the model of the "transformed rank of the net expenditure per capita" are presented in Table 4.2. The second column reports the variables as they were entered in the model. The third column, displays the values of the R^2 achieved by the least squares fit of the models.

"Type of fuel for cooking" was the first variable entered in the model because it had the largest adjusted Wald test value among the 18 indicators. Then, toilet was discarded because it had a high correlation with the variable fuel. Phone was the second variable entered in the model because it had the largest adjusted Wald test value among the 16 indicators once fuel was kept in the model. Then, electricity was discarded because it had a high correlation with phone. The final model included 8 indicators and had an R^2 of 0.58.

Table 4.2 Indicators included in the model of the net expenditure per capita

Order of entry	Variable	R^2
1	Fuel for cooking	0.2409
2	Phone	0.4047
3	Boiler	0.4546
4	Car	0.4854
5	Overcrowding	0.5138
6	Type of floors	0.5698
7	Fridge	0.5746
8	VCR	0.5803

n=10,108

The residuals tests for the final model showed that the assumptions of normality and constant variance seem to hold (appendix C, Figure 8.5). Although the qq-plot showed a slight departure from the normal distribution on the left tail, the Shapiro-Francia W' test showed that the residuals were normally distributed (p>0.05). The two lowest residuals

(-4.1 and -3.6) had both a rank of 1.5 and a net expenditure per capita equal to zero. The lowest residual corresponded to a household without boiler, car, fridge and VCR; but with phone, floors of “other” material, “other” fuel to cook, and almost no overcrowding. The second lowest residual corresponded to a household without boiler, car, phone and VCR; but with fridge, floors of “other” material, “other” fuel to cook, and medium overcrowding. The removal of these points did not change the coefficients, and increased the R^2 just slightly (to 0.5820). Therefore, they were kept in the model.

The coefficients and standardized beta coefficients of the model are presented in Table 4.3. The coefficients of the model represent an increase in the transformed rank of the expenditure, not on expenditure itself or on its rank. The estimated values of the transformed ranked expenditure ranged between -1.57 and 1.95. The lowest of these values represents a household with the reference categories: more than 4 persons per room to sleep, soil floor, where wood is used for cooking, and without: a toilet supplied by piped water, electricity, car, phone, VCR and television. All the coefficients have increasing positive values, as expected from the increasing means of expenditure by category. Holding other variables constant, the transformed ranked expenditure increases with less people per room to sleep, from 0.157 units if there are three persons but less than four per room, to 1.254 if there are more rooms than persons in the household. The transformed ranked expenditure increases with better types of floors, from 0.257 units for cement floor, to 0.512 with “other” type of floor when compared to soil floor. Cooking with other fuel than wood increases the transformed ranked expenditure 0.565 units. Of the assets, owning a phone increases the transformed ranked expenditure 0.332 units, owning a boiler 0.176 units, owning a car 0.301 units, owning a fridge 0.182 units, and owning a VCR 0.201 units.

The coefficients that have a greater effect on the transformed rank expenditure are: having between one and 2 persons per room to sleep, and having floors with materials different to soil or cement. That is, a one standard deviation increase in having floors with materials different to soil or cement, would yield a 0.23 standard deviation increase in the predicted transformed rank of expenditure.

Table 4.3 Coefficients of the model of the transformed rank of the net expenditure per capita

Indicator	Coefficient	Standardized beta coefficient
Type of fuel for cooking		
Wood (reference)		
Other	0.565*** (0.032)	0.1873
Own a phone	0.332*** (0.028)	0.1545
Own a boiler	0.176*** (0.027)	0.0831
Own a car	0.301*** (0.029)	0.1342
Overcrowding		
4 or more (ref.)		
3 or more but <4	0.157*** (0.033)	0.0502
2 or more but <3	0.282*** (0.030)	0.1267
1 or more but <2	0.689*** (0.033)	0.3119
Less than 1	1.254*** (0.083)	0.1257
Type of floors		
Soil (reference)		
Cement	0.257*** (0.034)	0.1216
Other	0.512*** (0.043)	0.2348
Own a fridge	0.182*** (0.027)	0.0758
Own a VCR	0.201*** (0.033)	0.0910
Constant	-1.573*** (0.028)	

**p<0.01, *p<0.05

4.3.2 Index of household wealth and its comparison against income and expenditure

In this section we calculate an index of household wealth by Principal Components Analysis (PCA). Afterwards, the index is categorized and compared with several measures of income and expenditure in both the continuous and categorical forms. Finally, the 2.5th, 50th and 97.5th percentiles of the net income and expenditure per capita are calculated for each index category.

Principal Components Analysis was applied to the indicators that were significant in the final regression model of the transformed ranked expenditure: type of fuel for cooking, own a phone, own a boiler, own a car, overcrowding, type of floors, own a fridge, and own a VCR.

Only the first component had Eigen values higher than one (3.52), and it accounted for 55.44% of the variance. The eigenvectors of the first four components are presented in Table 4.4. The first component was a weighted average of the eight variables, indicating that the presence of these household assets and materials is related to a higher household wealth. Since the PCA is not suitable for discrete data, and PCA intends more to explain the variance than to detect structure in the data, the interpretation of the other components may not be reliable; thus it is not presented.

Table 4.4 Eigenvectors of the first four components of the index of household wealth

	Component 1	Component 2	Component 3	Component 4
Fuel for cooking	0.3188	0.6555	-0.2582	0.0768
Phone	0.3733	-0.2505	0.0301	-0.2115
Boiler	0.3886	-0.2248	0.1536	-0.1216
Car	0.3249	-0.4558	-0.1651	0.7628
Overcrowding	0.2989	0.1558	0.8217	0.1049
Type of floors	0.3962	0.1441	0.1076	-0.1715
Fridge	0.3710	0.3302	-0.3132	0.1918
VCR	0.3442	-0.3087	-0.3109	-0.5249

Only the first principal component was retained, and it was used to calculate the scoring factors that represent the “index of household wealth”. The mean value of the index was zero (because of the PCA technique) and its standard deviation was 1.88. The index ranged from -3.56 to 3.54. Table 4.5 provides descriptive statistics of the indicators and their scoring factors. In binary variables (that were coded as 0 and 1), the scoring factors divided by the standard deviation of the indicators represent the change in the index for the households which have the indicator compared to which do not by f_i/s_i. For example, supposing that two households have the same characteristics except for the “type of fuel for cooking”: more than four persons per room to sleep, soil floor, do not have toilet and electricity, and do not own a car, phone, VCR, fridge, and television; the household that uses wood for cooking would have the lowest index -3.56, and the one that uses other fuel than wood for cooking will have an index of -2.70, 0.86 units higher. Therefore, in variables coded 0 and 1, cooking with other fuel than wood, and owning a boiler or a fridge, result in the largest changes in the index.

Table 4.5 Summary statistics and scoring factors of the index of household wealth

	Mean	Std. dev.	Scoring factors of first component	Scoring factors / Std. Dev.
Fuel for cooking	0.84	0.37	0.32	0.86
Phone	0.33	0.47	0.37	0.79
Boiler	0.34	0.48	0.39	0.81
Car	0.31	0.46	0.32	0.71
Overcrowding	2.84	1.11	0.30	0.27
Type of floors	2.22	0.62	0.40	0.64
Fridge	0.70	0.46	0.37	0.81
VCR	0.30	0.46	0.34	0.75
Index	0.00	1.88		

The histogram of the index is presented in Figure 4.1. There is some clustering at one of the highest values, but there is no evidence of clumping.

Figure 4.1 Histogram of the index by PCA

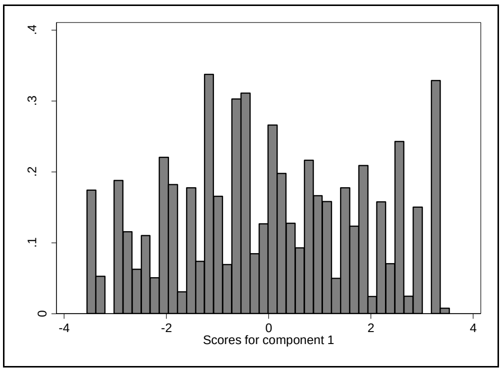


Table 4.6 shows the Pearson correlations between the index and several measures of income and expenditure: current, net and net per capita. For each measure of income and expenditure, the table displays the untransformed variable and its logarithm. The index has a significant positive correlation with all the measures of income and expenditure in the full sample and by strata. In the full sample and in the urban stratum, the index has the highest correlation with the log of all measures. In the rural stratum, the index has the highest correlation with the log of the net income and expenditure per capita.

Table 4.6 Pearson correlations of the index of household wealth against income and expenditure

	Urban	Rural	Total
Income			
Current income	0.4808	0.4714	0.5031
Log current income	0.6637	0.6138	0.6979
Net income	0.4721	0.4622	0.4932
Log net income	0.6548	0.5878	0.6820
Net income per capita	0.3872	0.3829	0.4147
Log net income per capita	0.6443	0.6697	0.7172
Expenditure			
Current expenditure	0.5433	0.4784	0.5560
Log current expenditure	0.6696	0.6252	0.7071
Net expenditure	0.5410	0.4731	0.5523
Log net expenditure	0.6623	0.5935	0.6898
Net expenditure per capita	0.4580	0.3962	0.4774
Log net expenditure per capita	0.6409	0.6774	0.7205

The Spearman’s rank correlations (Table 4.7) show that in the urban stratum, the index has the highest correlations with current and net expenditure per capita. In the rural stratum the index has the highest rank correlation with the net expenditure per capita.

Table 4.7 Spearman’s rank correlations of the index of household wealth against income and expenditure

	Urban	Rural	Total
Income			
Current income	0.6692	0.6030	0.6955
Net income	0.6677	0.5890	0.6909
Net income per capita	0.6464	0.6679	0.7152
Expenditure			
Current expenditure	0.6729	0.6160	0.7031
Net expenditure	0.6762	0.6033	0.7022
Net expenditure per capita	0.6405	0.6803	0.7188

4.3.3 Categorization of the index

The 80th percentile of income per capita corresponds to 3009.3 pesos in the urban stratum and 1500.4 pesos in the rural stratum. The upper 1% of the income per capita that was trimmed corresponded to 16938.2 pesos in the urban stratum and 6677.6 pesos in the rural stratum. The locally weighted regression of income per capita on the index by stratum is presented in Figure 8.6 of appendix C. The cut-off points of the index that correspond to the poverty lines and to the top 80th percentile of income per capita by stratum are shown in Table 4.8. Households located in the rural area were more likely to be in the first two categories ($p<0.000$).

Table 4.8 Cut-off points of the index of household wealth by stratum

	Urban			Rural			Total
Poverty	Net income per capita (pesos)	Cut-off point of index	%[1]	Net income per capita (pesos)	Cut-off point of index	%[1]	%[1]
Food poverty	<626	-2.36	2.2	<463	-2.80	15.5	8.2
Capabilities poverty	626-1255.8	-0.68	21.7	463-842.6	-1.30	27.3	24.2
Patrimony poverty	1255.8-1563.7	0.28	17.9	842.6-1046.8	-0.66	16.2	17.1
Non poor	1563.7-3009.3	2.34	35.5	1046.8- 1542.1	0.73	21.9	29.3
Top 20% non poor	>3009.3	-	22.9	>1542.1	-	19.1	21.2

[1]Percentage of households classified in this category

In order to assess the internal coherence of the index, Table 4.9 shows the percentage of households that have the indicators by category of the index. The percentage of households that own a phone, a boiler, a car, a fridge, and a VCR, increases as the categories of the index increase. Overcrowding decreases with increasing categories of the index. In the first category, few households cook with other fuel than wood and have floor different to soil material.

Table 4.9 Percentage of households that have the household asset, material or facility by category of the index of household wealth

Household asset, material or facility	Category of the index				
	1	2	3	4	5
Fuel for cooking other than wood	7.1	70.5	94.9	98.2	99.5
Own a phone	0.0	2.1	12.4	45.7	80.8
Own a boiler	0.0	1.3	10.8	46.5	88.0
Own a car	0.2	4.0	13.7	35.3	82.3
Overcrowding					
4 or more	68.3	29.9	19.2	7.4	1.4
3 or more (<4)	13.6	23.9	17.5	11.7	3.2
2 or more (<3)	17.1	33.5	35.6	38.8	31.1
1 or more (<2)	1.1	12.7	27.0	41.0	62.2
< 1	0.0	0.1	0.7	1.1	2.2
Type of floors					
Soil	74.0	17.2	1.9	0.8	0.1
Cement	26.0	78.4	80.9	55.8	25.8
Other	0.0	4.4	17.2	43.4	74.1
Own a fridge	0.2	33.2	77.9	95.2	99.6
Own a VCR	0.2	2.1	12.3	39.3	77.0

Table 4.10 shows the percentage of agreement and kappa values between the index and the net income per capita. The index classifies the households in a similar way in both strata and in the full sample. The non-weighted kappa values for the index show a poor agreement in the urban area, and a fair agreement in the rural area and in the full sample. Even though the non weighted agreement is low, the weighted values reflect that both indices are classifying the households closer to the categories where they are expected to be.

Table 4.10 Agreement and kappa values of the index of household wealth with net income per capita, in the full sample and by stratum

	Urban		Rural		Total	
	Agreement (%)	Kappa	Agreement (%)	Kappa	Agreement (%)	Kappa
No weights	38.6	0.20	39.5	0.24	39.0	0.23
Linear weights	78.5	0.40	77.1	0.45	77.9	0.44
Quadratic weights	91.1	0.56	89.4	0.61	90.3	0.60

The correspondence between the categories of household wealth and income/expenditure was calculated by stratum. Table 4.11 and Table 4.12 show an increasing median income and expenditure by household wealth category.

Table 4.11 Percentiles of the income per capita, by household wealth category and by stratum (pesos)

Index of household wealth	Urban			Rural		
	2.5	50	97.5	2.5	50	97.5
1	117.8	459.7	1136.9	87.1	292.7	930.8
2	265.1	817.8	2754.0	148.1	518.3	1935.4
3	384.9	1202.7	3959.5	234.2	768.2	2411.6
4	539.3	1667.0	6798.8	291.9	971.0	4552.3
5	925.5	3148.7	21289.4	400.7	1619.3	9458.2

Table 4.12 Percentiles of the expenditure per capita, by household wealth category and by stratum (pesos)

Index of household wealth	Urban			Rural		
	2.5	50	97.5	2.5	50	97.5
1	173.2	443.1	1227.6	86.4	295.6	880.7
2	264.2	765.3	2515.3	159.6	506.0	1675.7
3	412.1	1105.0	3599.7	232.5	722.7	2253.1
4	539.6	1506.7	5856.8	293.8	918.2	3701.2
5	894.9	2733.4	13708.8	467.2	1426.0	8446.6

4.4 Conclusions

Data from the National Survey of Household Income and Expenditure (ENIGH-2000) was used to construct and validate an index of household wealth. Firstly, the household assets, materials and facilities included in both the ENIGH-2000 and the NHS-2000 were used to predict the rank of expenditure using a linear regression model. Then, the significant indicators included in the regression model were used to build an index by PCA. The first component was retained and considered the index of household wealth.

The index was positively correlated with several measures of income and expenditure. In the full sample and in the urban stratum, the index had a high Pearson correlation with the log of all measures of income and expenditure. In the rural stratum, the index had the highest correlation with the log of the net income and expenditure per capita. In the urban stratum, the Spearman's rank correlations were higher with the current and net expenditure per capita. In the rural stratum the index had the highest rank correlation with the net expenditure per capita.

Once the index was classified in five categories, it had a good internal coherence and it showed a fair agreement with income per capita. To categorize the indices (according to poverty lines) we compared them with the poverty lines and the 80^{th} percentile of income per capita by stratum. This is expected to distinguish households according to the type of poverty that they present, as well as to distinguish the richest 20%. Since the study of diabetes requires that we assess the effect of socioeconomic status, the classification of poverty is relevant.

There was a large variation of income and expenditure within the categories of the index. Although it was expected that the index be closer to expenditure, the index should be seen not as an expenditure measure, but as a measure related to permanent wealth and living standards.

5 RELATIONSHIP BETWEEN SOCIOECONOMIC STATUS AND DIABETES IN THE NHS-2000

5.1 Introduction

The aim of this chapter is to examine the association between socioeconomic status (SES) and type 2 diabetes mellitus among Mexican adults. The specific objectives of the chapter are:

1. To analyze the relationship between total diabetes and SES
2. To determine the association between self-reported diabetes and SES
3. To investigate the relationship between undiagnosed diabetes and SES

For each of these objectives we established two research questions. Firstly, we inquire if there is a relationship between diabetes and SES, and if so, what the nature of this relationship is. Secondly, if a relationship exists, we inquire if the relationship between diabetes and SES varies by urban/rural areas, level of municipality deprivation and sex.

Adults were classified as having diabetes (*total*) if: (1) they had *self-reported diabetes*, that is if previous to the survey they were diagnosed with diabetes by a physician; "or" (2) they had *undiagnosed diabetes*, that is if they found out that they had abnormally higher capillary blood glucose levels during the survey. Therefore, previous to the survey, adults with undiagnosed diabetes did not know that they were likely to have diabetes. SES was measured through educational attainment, household income, household wealth and municipality deprivation.

Cross sectional data was used from two sources: (1) the 2000 National Health Survey (NHS-2000) which includes individual and household level SES measures, self-reported diabetes, biologic and anthropometric measurements, and diabetes risk factors; and (2) the Human Development Index (HDI) and the Deprivation Index (DI) at the municipality level (from official reports derived from the 2000 Mexican Census of population).

Two level logistic models were estimated considering adults nested within municipalities. The study includes 39,780 adults aged 20-69 nested in 321 municipalities across Mexico. The municipality level was selected because it represents the smallest government unit capable of taking actions on political policy (CONAPO, 2001b). The analyses were carried out at the national level, by municipality deprivation, urban/rural stratum, and sex.

This chapter is organized in three main sections: methods, results, and discussion. Section 5.2 illustrates the data source; the adults that were excluded from the study; the definition of the variables; and the statistical methods used in the analysis. Section 5.3 is the results section and it is divided in four subsections. The first subsection presents the descriptive analyses of the data and the other three subsections present the statistical analysis corresponding to: diabetes, self-reported diabetes, and undiagnosed diabetes. Section 5.4 reports the discussion, the limitations of the study and the conclusion. The appendices of the chapter are presented at the end of the thesis.

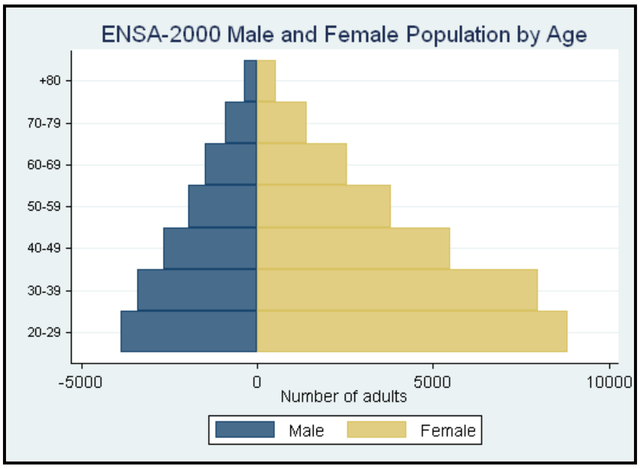
5.2 Methods

5.2.1 Data source

There are two data sources: the National Health Survey 2000 (NHS-2000) and official statistics derived from the 2000 Mexican Census of population: the Human Development Index (HDI) and the Deprivation Index (DI) at the municipality level.

The methodology and objectives of the NHS-2000 were described in section 3.3.1. The NHS-2000 generated information from 45,294 adults. Figure 5.1 shows the age and sex distribution of the adults who provided this information (25 people did not report their age). This distribution represents the individuals interviewed in the survey and do not resemble census population.

Figure 5.1 Distribution of the NHS-2000 population by age and sex



Out of 45294 adults, 2956 (6.5%) had been told by a physician that they had diabetes or high blood sugar, 9 did not know, and 1178 answers were missing (Table 5.1). Adults in the age groups from 50 to 69 represent 53.6% of the people told by a physician that they had diabetes. People aged 70 or more account for 16.1% of the cases of diabetes diagnosed by physician. Of the people diagnosed with diabetes by a physician the majority were women (69.8%).

Table 5.1 Distribution by age and sex of adults with diabetes diagnosed by physician

	Diabetes status[1,2]			Total
	Yes	No	Missing	
Total (n=100%)	2,956	41,151	1,178	45,294
Age groups (%)				
20-29	2.8	29.6	36.3	27.9
30-39	8.5	26.4	22.5	25.1
40-49	18.8	17.9	17.9	18.0
50-59	28.1	11.7	10.5	12.7
60-69	25.5	7.8	6.1	8.9
70-79	13.2	4.6	3.2	5.1
80 or more	2.9	1.9	3.1	2.0
Not known/no answer	0.03	0.05	0.3	0.06
Women (%)	69.8	68.5	30.0	67.6

[1]Answer to the question: Has a physician told you that you have diabetes or high blood sugar?
[2]The column of adults who answered that they did not know if "they were diagnosed with diabetes by a physician" was excluded from the table

All the members of the household were asked about their health status through the question “Could you tell me what your last health problem was during the last two weeks?” To this question, 3 adolescents and 481 adults answered that it was diabetes. Therefore, even though 2956 adults answered that they were previously diagnosed with diabetes or had high blood sugar, it was considered a health problem during the two weeks previous to the survey only by 481 adults, of whom 39.2% considered that it was a serious or very serious health problem.

During the interview, biosensors were used for the measurement of capillary glucose (fasting or random). This measure was recorded for 43,073 adults (95.1%). Of the people who reported to have diabetes or high blood sugar levels, 97.6% also had a recorded measurement of blood glucose levels.

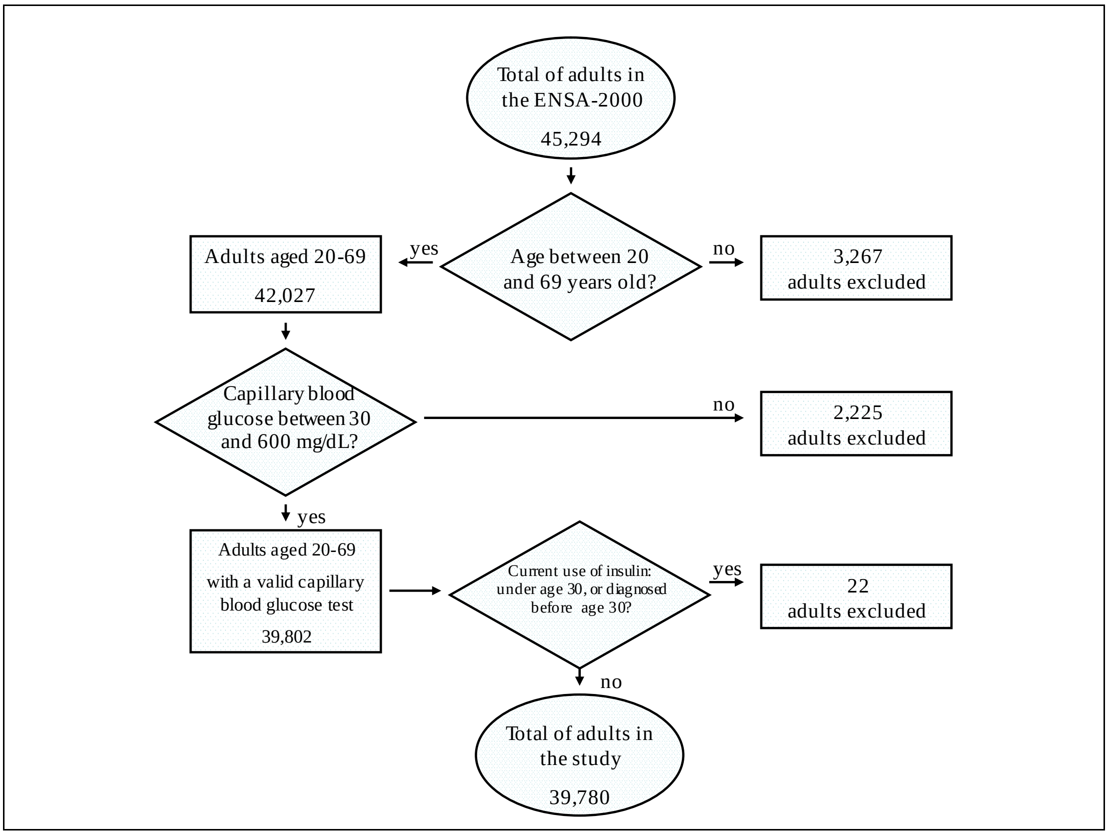
5.2.2 Adults excluded from the study

Adults were excluded from the study if their age was not between 20 and 69 years old; if they did not have valid capillary blood glucose; and if they were likely to have type 1 diabetes. The flow chart in Figure 5.2 summarizes the number of adults that were excluded from the study.

The study was restricted to adults between 20 and 69 years old because it is the age group of occupational activity and because it is in this group that the population presents a higher prevalence of diabetes (3,267 adults out of this age group were excluded (7.2%), leaving 42,027 adults from the original sample of 45,294).

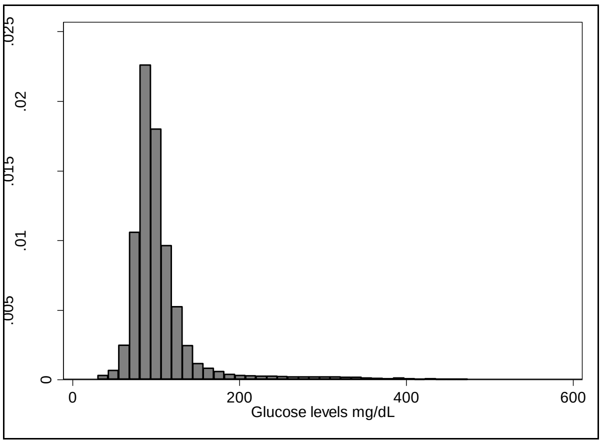
After restricting the sample to adults from 20 to 69 years old, the study was restricted to adults who had a valid capillary blood result with a glucose concentration of 30-600 mg/dL (Aguilar-Salinas et al., 2003). Therefore, an additional 2225 adults were excluded from the analysis. Six adults had zero level of glucose which was the minimum registered and 58 had levels of 1000 mg/dL or more.

Figure 5.2 Flow chart of the number of people excluded from the study



Glucose values out of the 30-600 mg/dL range indicate severe damages to the health. For example, levels of glucose under 40 mg/dL are an indication of severe hypoglycaemia and levels over 600 mg/dL indicate high danger of electrolyte imbalance (Loisa et al., 2007). According to the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC), glucose levels under 45 mg/dL (2.5 mmol/l) are accompanied by neuroglycopenic symptoms, which can range from impairment of cognitive functions to loss of consciousness; and levels over 500mg/dL (27.8 mmol/l) can cause diabetic coma due to insulin deficiency or the development of osmotic diuresis with severe exsiccosis and diabetic ketoacidosis (Lothar, 2006). Therefore, extremely high or low glucose levels may be due to measurement errors since they may not allow a person to be at home and participate in the survey. The histogram of the levels of glycaemia for the valid results shows a positively skewed distribution (Figure 5.3). The glucose values for people aged 20 to 69 had a mean of 108.1 (±54.6) mg/dL, and a median of 95 mg/dL (interquartile range*:* 84 to 111 mg/dL).

Figure 5.3 Histogram of the valid results of glycaemia (between 30 mg/dL and 600 mg/dL)



Adults who may have type 1 diabetes were excluded from the study. Applying similar criteria to other studies, we considered adults that had type 1 diabetes as those who were both currently using insulin and who were diagnosed before age 30 (Ismail et al., 1999). Of the 139 adults who were currently using insulin, we excluded 5 people who were under 30 years old; and 17 aged 30 or more, who were diagnosed with diabetes before the age of 30. There were 5 people aged 30 or more currently using insulin but who did not report the number of years since their diagnosis of diabetes. Keeping them in the study may not bias the results since it is a small number and other studies have found no relationship between socioeconomic status and type 1 diabetes (Evans et al., 2000; Meadows, 1995). Since it is difficult to distinguish between type 1 and type 2 diabetes, there may also be other people in the sample who are misclassified.

In total 12.2% of the adults were excluded from the original sample (see Figure 5.2). Therefore, the final sample for this study included 39,780 adults. We compared the adults included in the sample (39,780) with those that were excluded because of extreme glucose values (2,225). There were no differences in age between included and excluded adults. However, excluded adults were more likely to be men.

5.2.3 Definition of the variables

Diabetes, self-reported diabetes and undiagnosed diabetes

The variables of diabetes (total), self-reported diabetes and undiagnosed diabetes were generated from two sources: the question “Has a physician told you that you have diabetes or high blood sugar?” and the presence of “abnormally higher capillary glucose levels”. These two measures were already used in other studies of diabetes that were based on the same data (Aguilar-Salinas et al., 2003; Vazquez-Martinez et al., 2006). Adults were considered as having “diabetes previously diagnosed by physician”, “diagnosed diabetes”, or as having *self-reported diabetes* if they answered that they were told by a physician to have diabetes or to have high blood sugar. People were considered to have “diabetes diagnosed during the survey” or “abnormally higher capillary glucose levels”, if their capillary result was 110 mg/dl or higher (WHO, 1999), and they did not take any food from 8 to 12 hours before the measurement (fasting). In the absence of fasting, people were considered as having abnormally higher capillary glucose levels if their glucose levels were 200 mg/dl or higher. People who did not self-report diabetes but had abnormally higher capillary glucose levels were considered as adults with “unknown diabetes”, *undiagnosed diabetes* or “newly diagnosed diabetes”. Adults were classified as having *diabetes*, if they had either self-reported diabetes or undiagnosed diabetes. The terms diabetes, self-reported diabetes and undiagnosed diabetes are used in this study.

Genetic, biological and lifestyle factors

Age, sex, ethnicity, and family history of diabetes were considered as genetic and biological factors. Age was divided in five 10-year age groups. As a proxy for ethnicity (being indigenous) we used “Spoken language” through the question: “Do you speak an indigenous language?” Native language is the accepted characteristic in Mexico to identify indigenous people (INEGI, 2000; Rivera et al., 2003a; Rivera et al., 2003b). Spoken language was divided in three categories: speak only Spanish; speak Spanish and an indigenous language; and speak only an indigenous language. Family history of diabetes was categorized as: diabetes present in father; diabetes present in mother;

diabetes present in both father and mother; diabetes not present in any of the parents; and not known or no answer.

Obesity was considered as an indicator of lifestyle because it can be modified through exercise and diet. The body mass index and waist circumference were considered as measures of obesity, since only the data to derive these measures was available in the NHS-2000. The Body Mass Index was calculated as weight in kilograms divided by height in meters squared (kg/m^2) and categorized as: underweight (BMI lower than 18.5), normal (BMI equal or higher than 18.5 and lower than 25), overweight (BMI equal or higher than 25 and lower than 30), and obese (BMI equal or higher than 30), (Pi-Sunyer et al., 1998). As a proxy to *excessive central adiposity* or *abdominal obesity*, a cut-off point of 88 cm. for women and 102 cm. for men independently of age (Pi-Sunyer et al., 1998) was used to categorize subjects in groups of *normal* waist circumference, and waist circumference greater than the recommended (abdominal obesity).

Socioeconomic status

Education and occupation were used as indicators of individual socioeconomic status. Education was defined as the highest educational level attained, except for primary school. We emphasized the partition of primary education as complete or incomplete because before 2000 it was a determinant for employment. Education was classified as follows: none or preschool; incomplete primary; complete primary; secondary; and "high school or above".

Occupation was classified in seven categories: employee (non-agricultural worker or employee); agricultural worker (rural labourer or land peon); self employed or boss (boss, employer, business proprietor, or remunerated self-employed worker); non-remunerated (non-remunerated self-employed worker or worker without remuneration from a business or company owned by the household); homemaker (housemaster/housewife); retired; and other. The "retired" includes people who can not work because they are permanently disabled. The category "other" includes who do not state the type of work; the unemployed; who do not work; and students.

Household income and household wealth were considered as indicators of SES at this level. Household income was calculated as the sum of the individual incomes of all the members of the household. Then, it was divided by the number of household members. The income for each person was calculated in a monthly basis as the sum of their main income and other incomes like pensions; transfers from other family members; government or other institutions; non-monetary transfers (received products); and financial transfers (like interests in bank accounts or derived by rents). Household income was divided in two ways: quintiles and poverty lines (see previous chapter for definitions and ranges of poverty lines).

In chapter 4, a household wealth index was calculated by PCA based on the assets, materials and facilities that best ranked the households according to their expenditure. Then, the index was divided in five categories using Table 4.8, in which the cut-off points were applied by stratum. Finally, the categories from both strata were combined to form a single discrete index. In this chapter we calculated a similar index based on the same indicators and categorization, and using PCA; but based on the NHS-2000 data. A second indicator was calculated in a similar way, but divided in quintiles. We assume that the characteristics of the households have a similar distribution in the ENIGH-2000 and in the NHS-2000.

Potential mediators of the relation between social position and diabetes

Measures of social support and stress, access to health care the social environment were considered as potential mediators of the relation between social position and diabetes (Brown et al., 2004; Evans et al., 2000). Marital status and kinship were considered as measures of social support and stress. Marital status was classified into the following categories: married or cohabiting; single; divorced or separated; and widowed. Kinship was considered because people with more responsibilities may be subject to higher levels of stress, especially in females, and stress is related to the increase of blood sugar levels through the hormone cortisone (Gorn et al., 2005). The variable kinship had three categories: household head, spouse, and other.

In Mexico there is no free health system. However, most of the employees and government workers have access to public health services; or to private ones through a medical insurance paid by their employers. The rest of the population pays for these services directly to private GP's, hospitals, or through a medical insurance. Access to health services may influence an early diabetes diagnosis or an adequate glucose control. Health care access was categorized as: public; private or both (public and private); and none or other.

Since urbanisation plays an important role in the prevalence of obesity and diabetes, this variable was considered as a proxy for the social environment. In this study, level of urbanisation refers to the size of the population in the localities at the time of the survey. Localities with a higher population are considered more urbanised than localities with a lower population. Two variables were used based on this definition: "living in an urban or rural stratum" and "living in a remote area". Urban localities are considered those with 15,000 inhabitants or more; and rural localities are considered those with 14,999 inhabitants or less. The cut-off point of 15,000 inhabitants to divide localities in urban and rural strata was used in the NHS-2000 for the sampling design and is used in the official calculation of poverty; therefore, this classification was used as well. The cut-off point of 2,500 inhabitants was used as an indication of adults "living in remote areas".

Contextual variables

The Deprivation Index (DI) and the Human Development Index (HDI) at the municipality level were considered as contextual variables. Both are reported official statistics based on 2000 Mexican Census data. The indicators used to build this indices and methodology are explained in section 3.3.4 and 3.3.5. In the present chapter, the Deprivation Index was used in five categories as it is officially reported: very low, low, medium, high, and very high. To estimate the models by deprivation, this variable was classified in three categories: low-very low, medium, high-very high. The categories low and very-low were collapsed since there were few observations in the low category. Although the HDI is reported in four categories, we classified it in three categories: low-medium low, medium high, and high.

5.2.4 Statistical analysis

Unweighted results are presented because the aim of the study is to analyze the association between diabetes and SES and not to provide national estimates. Chi square analyses were used for group comparisons. A base model for diabetes was estimated adjusted for genetic, biological and lifestyle factors, and potential mediators of the association between diabetes and SES. Then, unadjusted and adjusted odds ratios were estimated for each of the socioeconomic variables (adjusted by the variables in the base models); and separately for diabetes, self-reported diabetes, and undiagnosed diabetes. Logistic regressions were used to identify the covariates independently associated with: diabetes, self-reported diabetes, and undiagnosed diabetes. Table 5.2 presents the binary dependent variables used in the logistic models, and their corresponding objectives and research questions.

Table 5.2 Objectives, research questions and dependent variables of the logistic models

Research questions	**Objective**	**Binary dependent variable**
Is there a relationship between the prevalence of diabetes and SES? If so, what is the nature of this relationship? Does the relationship between the prevalence of diabetes and SES vary by urban/rural areas, level of municipality deprivation and sex?	1.To analyze the relationship between total diabetes and SES	Diabetes/ No diabetes
	2.To determine the association between self-reported diabetes and SES	Self-reported diabetes/ No diabetes
	3.To investigate the relationship between undiagnosed diabetes and SES	Undiagnosed diabetes / No diabetes

Table 5.3 describes fully the dependent variables of the models. For example, in the variable "diabetes"/ "no diabetes", adults were classified as having diabetes if they either self-reported diabetes, or had undiagnosed diabetes, or both; otherwise they were classified as not having diabetes. To compare adults with "undiagnosed diabetes" with adults with "no diabetes", adults with "self-reported diabetes" were excluded from the analysis.

Table 5.3 Classification of adults according to the diagnosis of diabetes

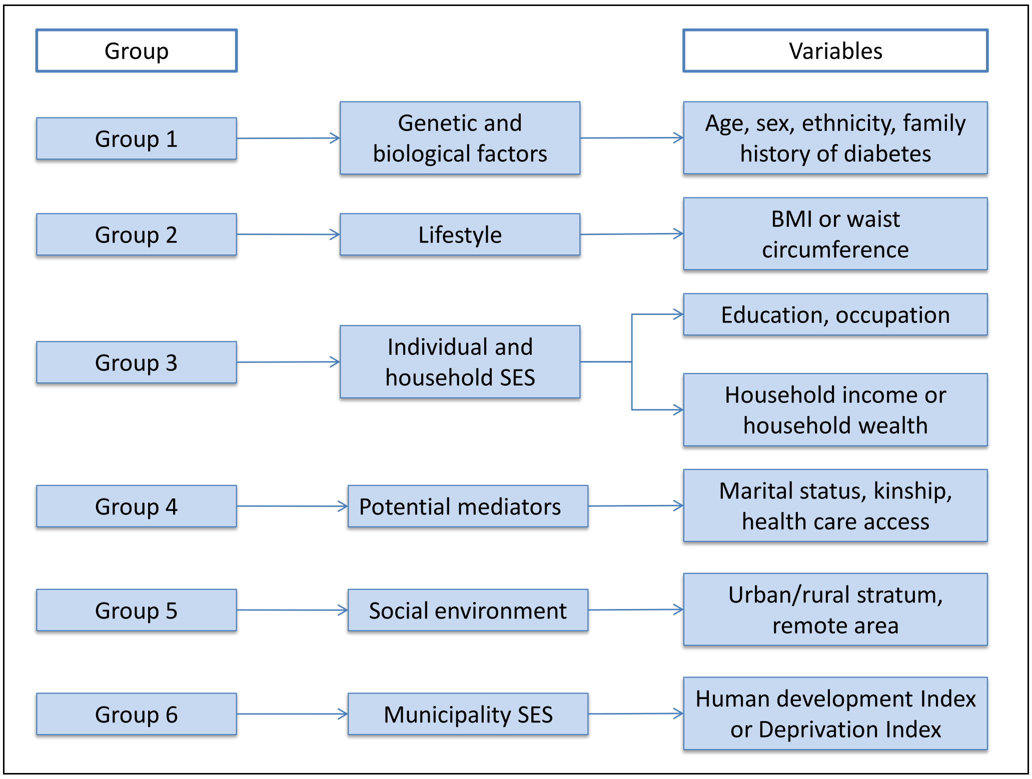
Identification of diabetes		Dependent variable		
Self-reported diabetes	**Abnormally higher capillary blood glucose**	**Diabetes/ No diabetes**	**Self-reported diabetes/ No diabetes**	**Undiagnosed diabetes / no diabetes**
No	No	No diabetes	No diabetes	No diabetes
Yes	No	Diabetes	Self-reported diabetes	Excluded
Yes	Yes			Excluded
No	Yes		No diabetes	Undiagnosed diabetes

A review of 25 publications found that hierarchical regression analysis has become the widely accepted statistical tool for the examination of group level effects on individual health (Pickett et al., 2001). In this study, a two-level random intercept model was used for the final models for two reasons: firstly, to allow for municipality effects on the probability of having diabetes; and secondly, to consider that two randomly selected adults from the same municipality will tend to be more alike than two individuals selected from different municipalities because they share the same damaging and protective exposures in their health. The household was not considered another level because the survey interviewed only one adult within each household (see section 3.3.1). The adults are nested in 321 municipalities across Mexico.

The variables were divided in the following groups: 1) genetic and biological factors; 2) lifestyle; 3) individual and household SES; 4) potential mediators; 5) social environment; and 6) municipality deprivation (Figure 5.4).

The variables were introduced in the models using the stepwise procedure and by stages. In the first stage, the genetic and biological factors variables were added one by one. Once all the variables of this group were significant, the variables of the next group were added, and so on. The likelihood-ratio test (LR) was used to assess the significance for addition or removal of the variables with a significance level of 0.05. Interaction terms were tested for SES and the covariates, and between SES variables. The logistic regression analyses were conducted, first in the whole population and then stratified according to urbanisation, deprivation and sex. The models by stratum, municipality deprivation and sex were estimated with the same variables of the national models. Statistical analyses were conducted using STATA 10.0 for windows (STATA Corporation College Station, TX, USA) and MLwiN 2.0.2.

Figure 5.4 Groups of variables to be included in the logistic models of diabetes



5.3 Results

There were anthropometric measurements that had extreme values. These extreme values can be observed as outliers in the scatter plots of weight against height, and weight against waist circumference in Figure 8.7 and Figure 8.8 (appendix D). The choice of valid anthropometric measurements was based on these graphs and taking into account valid values from other surveys (such as the ones found in the MxFLS). A height between 140 and 250 centimetres, weight between 30 and 250 kilograms, and waist circumference between 45 and 200 centimetres, were considered as valid measurements. The extreme values and the missing values were added in the models as another category. Among adults with valid measurements, BMI and waist circumference (WC) had a significant correlation of 0.70.

There were 411 adults with a zero household income, and 3162 with a missing household income. Of the 36207 persons that had a non-missing and non zero household income, the average monthly household income per person was 1116.8 pesos, with a median of 666.7 pesos and a standard deviation of 1906.7 pesos.

The distribution of the indicators used to calculate the household wealth index is presented in Table 8.9 of the appendix. Chi-square tests showed that the distribution of the characteristics of the households in the NHS-2000 was similar to the distribution of the characteristics of the households in the ENIGH-2000. Principal Component Analysis was applied to the indicators (of the NHS-2000) that were significant in the final regression model for the transformed ranked expenditure of chapter four: type of fuel for cooking, own a phone, own a boiler, own a car, overcrowding, type of floors, own a fridge, and own a VCR. Only the first component had an Eigen value higher than one (3.57), and it accounted for 44.65% of the variance. The first component was a weighted average of the eight variables, indicating that the presence of these household assets and materials is related to a higher household wealth. The first principal component was retained, and it was used to calculate the scoring factors that represent the “index of household wealth”.

The mean value of the index was zero (because of the PCA technique) and its standard deviation was 1.89. The index ranged from -3.48 to 3.46. Table 8.10 in the appendix provides descriptive statistics of the indicators, and scoring factors of the first principal component. In variables coded 0 and 1, cooking with other fuel than wood resulted in the largest changes in the index. The histogram of the index (Figure 8.9 in the appendix) shows that there is some clustering at one of the highest values, but there is no evidence of clumping. Since the indicators in the NHS-2000 and ENIGH-2000 had similar distributions; the scoring factors were similar in both surveys. Moreover, the index of the NHS-2000 had similar standard deviation and range as the index of the ENIGH-2000. Therefore, we used the cut-off points from the index in the ENIGH-2000 to create the categories of the index in the NHS-2000.

Cross tabulations showed that there was a significant association between the socioeconomic variables. The correlation between quintiles of the household index and quintiles of the household income was significant (r=0.55). The correlation between education and household wealth was very low (r=0.33). Adults with high levels of education were more likely to be in the highest categories of household wealth. Adults who speak an indigenous language were more likely to have lower levels of education or to be in the two lowest categories of household wealth. In addition, higher levels of education and household wealth occurred more often in the more affluent municipalities. The correlation between the Deprivation Index and the Human Development Index (continuous) was highly significant (r=0.95).

5.3.1 Characteristics of the adults in the study

The characteristics of the adults in the study are summarised in Table 5.4. Most of the adults in the study were women and spoke only Spanish. It was more common to have a history of diabetes through the mothers, than through the fathers or both parents. A high percentage of the adults were overweight, obese, or presented abdominal obesity. Of the overweight adults, 48.8% also presented abdominal obesity. About half of the adults had levels of education of primary school and below. Only a quarter had higher levels of education. A high percentage of the adults in the study were homemakers, and very small percentages were agricultural workers, retired, or had a non-remunerated job.

About 66% of the adults were classified in the two lowest poverty lines; and 50% of the adults were categorized in the two highest categories of household wealth. According to how the index was calculated; categories 4 and 5 of household wealth correspond approximately to the non poor households. Thus, the household wealth index categorized fewer adults as poor. The majority of the adults were married or cohabiting and about 44% were household heads. The majority of the adults were uninsured and lived in less deprived municipalities, urban localities and non remote areas.

Differences were found for all the covariates by stratum ($p<0.01$) except for sex ($p=0.988$). There was a higher prevalence of risk factors for diabetes in the urban stratum: obesity, abdominal obesity, and family history of diabetes. In addition, in the urban stratum a higher percentage of the adults were employees, single, and divorced or separated. On the other hand, the rural stratum was characterized by a poorer population living in more deprived municipalities. Lower education, household income and household wealth were more frequent in rural than in urban areas. Agricultural workers, uninsured adults, and adults who speak an indigenous language were also more likely to live in rural areas.

Table 5.4 Sociodemographic profile of the 39,780 adults in the study, in the full sample and by stratum

	Stratum		Total
	Urban 21,606 (100%)	Rural 18,174 (100%)	39,780 (100%)
Age groups, n(%)		p=0.004	
20-29	6,601 (30.6)	5,316 (29.2)	11,917 (29.9)
30-39	5,807 (26.9)	5,014 (27.6)	10,821 (27.2)
40-49	4,250 (19.7)	3,467 (19.1)	7,717 (19.4)
50-59	2,901 (13.4)	2,575 (14.2)	5,476 (13.8)
60-69	2,047 (9.5)	1,802 (9.9)	3,849 (9.7)
Sex, n(%)		p=0.988	
Men	6,602 (30.6)	5,552 (30.6)	12,154 (30.6)
Women	15,004 (69.4)	12,622 (69.4)	27,626 (69.4)
Spoken language, n(%)		p<0.001	
Only Spanish	20,992 (97.2)	15,187 (83.6)	36,179 (90.9)
Only an indigenous language	125 (0.6)	431 (2.4)	556 (1.4)
Indigenous language and Spanish	426 (2.0)	2,516 (13.8)	2,942 (7.4)
No answer	63 (0.3)	40 (0.2)	103 (0.3)
Family history of diabetes, n(%)		p<0.001	
None	14,546 (67.3)	13,815 (76.0)	28,361 (71.3)
Only father	2,211 (10.2)	1,124 (6.2)	3,335 (8.4)
Only mother	3,591 (16.6)	2,207 (12.1)	5,798 (14.6)
Both parents	859 (4.0)	376 (2.1)	1,235 (3.1)
Not known / no answer	394 (1.8)	634 (3.5)	1,028 (2.6)
Missing	5 (0.02)	18 (0.1)	23 (0.1)
BMI, n(%)		p<0.001	
Normal	6,328 (29.3)	6,249 (34.4)	12,577 (31.6)
Underweight	314 (1.5)	311 (1.7)	625 (1.6)
Overweight	8,094 (37.5)	6,510 (35.8)	14,604 (36.7)
Obese	6,330 (29.3)	4,396 (24.2)	10,726 (26.9)
Height or weight out of range	377 (1.7)	565 (3.1)	942 (2.4)
Missing height, weight or both	163 (0.8)	143 (0.8)	306 (0.8)
Waist circumference, n(%)		p=0.004	
Normal	10,112 (46.8)	8,724 (48.0)	18,836 (47.4)
Abdominal obesity	10,435 (48.3)	8,490 (46.7)	18,925 (47.6)
Waist measure out of range	41 (0.2)	28 (0.2)	69 (0.2)
Missing	1,018 (4.7)	932 (5.1)	1,950 (4.9)
Level of education, n(%)		p<0.001	
None/preschool	286 (1.3)	510 (2.8)	796 (2.0)
Incomplete primary	3,894 (18.0)	6,431 (35.4)	10,325 (25.9)
Complete primary	5,322 (24.6)	4,712 (25.9)	10,034 (25.2)
Secondary	3,560 (16.5)	2,321 (12.8)	5,881 (14.8)
High school or above	7,473 (34.6)	2,023 (11.1)	9,496 (23.9)
Missing	1,071 (5.0)	2,177 (12.0)	3,248 (8.2)

Chi-square test p-value for stratum across each covariate group

Table 5.4 Sociodemographic profile of the 39,780 adults in the study, in the full sample and by stratum (cont.)

	Stratum		Total
	Urban 21,606 (100%)	Rural 18,174 (100%)	39,780 (100%)
Occupation, n(%)		p<0.001	
Employee	6,776 (31.4)	2,403 (13.2)	9,179 (23.1)
Agricultural worker	222 (1.0)	1,272 (7.0)	1,494 (3.7)
Self employed/boss	4,109 (19.0)	4,108 (22.6)	8,217 (20.6)
Non-remunerated work	208 (1.0)	733 (4.0)	941 (2.4)
Home maker	8, 328 (38.5)	8,608 (47.4)	16,936 (42.6)
Retired	532 (2.5)	171 (0.9)	703 (1.8)
Other	1,381 (6.4)	833 (4.6)	2,214 (5.6)
Missing	50 (0.2)	46 (0.3)	96 (0.2)
Household income quintiles, n(%)		p<0.001	
1 (lowest SES)	1,467 (6.8)	5,959 (32.8)	7,426 (18.7)
2	3,342 (15.5)	4,018 (22.1)	7,360 (18.5)
3	4,314 (20.0)	3,000 (16.5)	7,314 (18.4)
4	5,058 (23.4)	2,168 (11.9)	7,226 (18.2)
5 (highest SES)	5,908 (27.3)	1,384 (7.6)	7,292 (18.3)
Missing	1,517 (7.0)	1,645 (9.0)	3,162 (8.0)
Poverty lines, n(%)		p<0.001	
1 (lowest SES)	6,458 (29.9)	9,115 (50.2)	15,573 (39.2)
2	6,573 (30.4)	3,996 (22.0)	10,569 (26.6)
3	1,653 (7.7)	964 (5.3)	2,617 (6.6)
4 (highest SES)	5,405 (25.0)	2,454 (13.5)	7,859 (19.8)
Missing	1,517 (7.0)	1,645 (9.0)	3,162 (8.0)
Household wealth quintiles, n(%)		p<0.001	
1 (lowest SES)	1,406 (6.5)	7,065 (38.9)	8,471 (21.3)
2	3,381 (15.7)	4,067 (22.4)	7,448 (18.7)
3	4,479 (20.7)	3,335 (18.4)	7,814 (19.6)
4	5,511 (25.5)	2,411 (13.3)	7,922 (19.9)
5 (highest SES)	6,672 (30.9)	1,189 (6.5)	7,861 (19.8)
Missing	157 (0.7)	107 (0.6)	264 (0.6)
Household wealth categories, n(%)		p<0.001	
1 (lowest SES)	364 (1.7)	3,115 (17.1)	3,479 (8.8)
2	4,309 (19.9)	5,294 (29.1)	9,603 (24.1)
3	3,729 (17.3)	2,657 (14.6)	6,386 (16.1)
4	7,628 (35.3)	3,734 (20.6)	11,362 (28.6)
5 (highest SES)	5,419 (25.1)	3,267 (18.0)	8,686 (21.8)
Missing	157 (0.7)	107 (0.6)	264 (0.7)

Chi-square test p-value for stratum across each covariate group

Table 5.4 Sociodemographic profile of the 39,780 adults in the study, in the full sample and by stratum (cont.)

	Stratum		Total
	Urban 21,606 (100%)	Rural 18,174 (100%)	39,780 (100%)
Marital status, n(%)		p<0.001	
Married/Cohabiting	15,415 (71.3)	14,554 (80.1)	29,969 (75.3)
Single	3,466 (16.0)	1,909 (10.5)	5,375 (13.5)
Divorced/Separated	1,532 (7.1)	719 (3.9)	2,251 (5.7)
Widowed	1,180 (5.5)	977 (5.4)	2,157 (5.4)
Not known/no answer	13 (0.1)	15 (0.1)	28 (0.1)
Kinship, n(%)		p<0.001	
Household head	9,570 (44.3)	8,079 (44.5)	17,649 (44.4)
Spouse	8,507 (39.4)	7,784 (42.8)	16,291 (41.0)
Other	3,529 (16.3)	2,311 (12.7)	5,840 (14.6)
Health care access, n(%)		p<0.001	
Public	12,019 (55.6)	4,797 (26.4)	16,816 (42.3)
Private or both	347 (1.6)	59 (0.3)	406 (1.0)
None/other	9,157 (42.4)	13,264 (73.0)	22,421 (56.4)
Missing	83 (0.4)	54 (0.3)	137 (0.3)
Deprivation Index, n(%)		p<0.001	
Very low	17,019 (78.8)	2,848 (15.7)	19,867 (49.9)
Low	3,147 (14.6)	4,552 (25.0)	7,699 (19.4)
Medium	969 (4.5)	5,177 (28.5)	6,146 (15.5)
High	471 (2.2)	4,121 (22.7)	4,592 (11.5)
Very high	0 (0.0)	1,476 (8.1)	1,476 (3.7)
HDI, n(%)		p<0.001	
Low-medium low	0 (0.0)	2,208 (12.1)	2,208 (5.6)
Medium high	5,421 (25.1)	13,515 (74.4)	18,936 (47.6)
High	16,185 (74.9)	2,451 (13.5)	18,636 (46.9)
Stratum, n(%)			
Urban	-	-	21,606 (54.3)
Rural	-	-	18,174 (45.7)
Living in a remote area, n(%)			
Non remote area	21,606 (100.0)	7,319 (40.3)	28,925 (72.7)
Remote area	-	10,855 (59.7)	10,855 (27.3)

Chi-square test p-value for stratum across each covariate group

Table 5.5 shows the prevalence of obesity by socioeconomic status. The second column measures obesity using the Body Mass Index and the third column measures abdominal obesity using Waist Circumference. With either measure of obesity, obesity was more common among adults with primary school and below; and among adults living in less disadvantaged municipalities and in urban areas. The prevalence of obesity was lower among the lowest household income and household wealth categories (except for abdominal obesity by poverty lines). Obesity tended to have an inverse u-shaped association with household income and household wealth (in both categorizations).

Table 5.5 Prevalence of obesity by socioeconomic status

Socioeconomic status	Overweight/obese	Abdominal obesity
N(%)	38,532 (65.7)	18,925 (50.1)
Education (%)	$p<0.001$	$p<0.001$
None/preschool	67.2	60.3
Incomplete primary	70.0	60.4
Complete primary	68.0	51.4
Secondary	62.4	40.2
High school or above	61.4	39.8
Missing	64.0	58.4
Household income quintiles (%)	$p<0.001$	$p<0.001$
1 (lowest SES)	60.0	47.9
2	66.1	52.4
3	67.7	51.5
4	67.9	50.6
5 (highest SES)	66.6	46.5
Missing	66.7	54.1
Poverty lines (%)	$p<0.001$	$p<0.001$
1 (lowest SES)	63.6	50.4
2	67.5	50.8
3	67.9	49.2
4 (highest SES)	66.6	47.3
Missing	66.7	54.1
Household wealth quintiles (%)	$p<0.001$	$p<0.001$
1 (lowest SES)	53.4	42.8
2	64.9	50.7
3	69.1	53.0
4	71.8	53.7
5 (highest SES)	70.0	51.1
Missing	63.0	47.2
Household wealth categories (%)	$p<0.001$	$p<0.001$
1 (lowest SES)	46.7	38.0
2	61.3	48.0
3	66.7	51.6
4	70.9	53.2
5 (highest SES)	70.6	52.2
Missing	63.0	47.2

Percentage over row

Table 5.5 Prevalence of obesity by socioeconomic status (cont.)

Socioeconomic status	Overweight/obese	Abdominal obesity
N(%)	38,532 (65.7)	18,925 (50.1)
Stratum (%)	p<0.001	p=0.005
Urban	68.5	50.8
Rural	62.4	49.3
Live in a remote area (%)	p<0.001	p<0.001
Non remote area	67.9	50.9
Remote	59.8	47.9
Deprivation Index(%)	p<0.001	p<0.001
Very low	68.1	50.7
Low	68.3	52.7
Medium	65.6	51.8
High	59.4	47.5
Very high	38.9	30.0
HDI (%)	p<0.001	p<0.001
Low	38.8	22.1
Medium low	44.5	35.1
Medium high	65.9	51.0
High	68.0	51.0

5.3.2 Characteristics of the adults with diabetes, self-reported diabetes and undiagnosed diabetes

Overall, there were 3,123 adults with diabetes (7.8% of 39,780): 2,396 (6%) adults who "self-reported diabetes" plus 727 (1.8%) who had abnormally higher blood glucose levels (Table 5.6).

Table 5.6 Distribution of adults by self-reported diabetes and abnormally higher blood glucose levels

Self-reported diabetes	Abnormally higher blood glucose levels		
	Yes	No	Total
Yes	1,350	1,046	2,396
No	726	36,624	37,350
No answer	0	7	7
Missing	1	26	27
Total	2,077	37,703	39,780

Only 2233 persons were measured fasting. Of the 2135 adults that fasted and did not self-reported diabetes, 8% were found to have diabetes during the survey (170 adults, Table 5.7). Besides, 158 adults had fasting glucose values between 100 and 110 mg/dl locating them in a stage of Impaired Fasting Glycaemia (IFG), a high risk of developing diabetes. IFG is a clinical stage that classifies individuals who have fasting glucose values above the normal range but still below a diagnosis of diabetes (WHO, 1999).

Table 5.7 Distribution of the adults that fasted

Self-reported diabetes	Abnormally higher blood glucose levels					
	Yes	%	No	%	Total	%
Yes	79	80.6	19	19.4	98	100.0
No	170	8.0	1,965	92.0	2,135	100.0
Total	249		1,984		2,233	

Of the adults with diabetes, 33.5% only self-reported diabetes; their capillary test did not result in an abnormally higher blood glucose level (Table 5.8). Therefore, they seem to have a good glycaemic control. On the other hand, 43.2% both self-reported diabetes and had abnormally higher blood glucose levels (indicating a poor glycaemic control). Hence, 23.3% of the adults with diabetes did not know that they had this condition before the survey.

Table 5.8 Distribution of adults with diabetes by type of diagnosis

Diabetes	Frequency	%
Self-reported and abnormally higher blood glucose levels	1,350	43.2
Only self-reported	1,046	33.5
Undiagnosed	727	23.3
Total	3,123	100.0

The glucose average of the adults that had both “self-reported diabetes” and “abnormally higher blood glucose levels” was higher (313.82±89.46 mg/dL) than the glucose average of those who “only self-reported diabetes” (128.89±37.34 mg/dL) and those who had “undiagnosed diabetes” (267.17±106.83 mg/dL).

It has been suggested that a diagnosis of diabetes should not be made by a single abnormal blood glucose value, but it should be confirmed with a subsequent test and the presence of symptoms or risk factors (WHO, 1999). Of the 727 people with undiagnosed diabetes, 23.4% were measured in fasting. Of the 555 who were not measured in fasting, 58.6% presented at least one of the diabetes symptoms (excessive thirst or hunger, frequent urination, weight loss or/and blurred vision). Of the 230 people (about 32%) who were neither measured in fasting nor presented symptoms, 86% were overweight or obese, 47% were over age 50, and 29% had at least one parent with diabetes.

Table 5.9 in this section, and Table 8.11 in the appendix, give an overview of the characteristics of the adults with diabetes, self-reported diabetes, and undiagnosed diabetes. Having diabetes and self-reported diabetes was more common in adults over 40 years old, adults who only speak Spanish, adults who have a family history of diabetes, and adults who are overweight or obese. There were no significant differences in having diabetes by sex (p=0.328). Women were more likely than their male counterparts to self-report diabetes. A higher percentage of adults with diabetes (or self-reported diabetes) were divorced, separated or widowed; were considered the household head; or had access only to public health services.

Regarding SES, having diabetes and self-reported diabetes was more frequent in adults with lower levels of education; higher levels of household income and household wealth; and in the self-employed, home makers and the retired. As in the association between obesity and household SES, diabetes tended to have an inverse u-shaped association with income and wealth. Adults with diabetes or self-reported diabetes tended to live in the most advantaged municipalities, independently of the deprivation measure used. In relation to social environment, a higher proportion of adults with diabetes (or self-reported diabetes) were living in urban and non remote areas.

There was no association between “undiagnosed diabetes” and sex, spoken language, household income, occupation, health care access, living in a remote area, stratum and the HDI. Undiagnosed diabetes was more common among adults 40 years or older, with a family history of diabetes, with obesity, and lower levels of education. It was also common in adults who were widowed, separated or divorced; those who were considered the household head; adults in the middle quintiles of household wealth; and adults living in municipalities with medium and high deprivation. However, if only adults with diabetes are taken into account, table 5.9 shows that the ratio of undiagnosed to total diabetes increases with decreasing household and municipality SES. For instance, among adults with diabetes, while only one fifth in the richest quintile of income were undiagnosed, a third of the adults in the poorest quintile of income were undiagnosed.

Table 5.9 Characteristics of adults with diabetes, self-reported diabetes, and undiagnosed diabetes

	Diabetes	Self-reported diabetes	Undiagnosed diabetes
N	3,123	2,396	727
Age groups (%)	p<0.001	p<0.001	p<0.001
20-29	1.1	0.7	0.5
30-39	3.4	2.2	1.2
40-49	9.7	7.0	3.0
50-59	18.4	14.7	4.4
60-69	22.5	19.2	4.1
Sex (%)	p=0.328	p=0.031	p=0.074
Men	7.7	5.6	2.1
Women	7.9	6.2	1.9
Language (%)	p<0.001	p<0.001	p=0.230
Only Spanish	8.0	6.2	1.9
Only an indigenous language	4.3	3.4	0.9
Indigenous language and Spanish	6.3	4.2	2.2
No answer	4.9	3.9	1.0
Family history of diabetes (%)	p<0.001	p<0.001	p<0.001
None	6.2	4.5	1.7
Only father	9.8	7.8	2.2
Only mother	12.2	9.8	2.6
Both parents	19.5	17.1	2.9
Not known/no answer/missing	9.3	7.0	2.5
BMI (%)	p<0.001	p<0.001	p<0.001
Normal	4.6	3.8	0.9
Underweight	3.0	2.1	1.0
Overweight	8.2	6.4	1.9
Obese	11.5	8.5	3.3
Height or weight out of range/missing	7.3	5.8	1.6
Waist circumference (%)	p<0.001	p<0.001	p<0.001
Normal	4.3	3.3	1.0
Abdominal obesity	11.6	9.0	3.0
Missing	5.5	4.0	1.6
Education (%)	p<0.001	p<0.001	p<0.001
None/preschool	13.2	10.7	2.8
Incomplete primary	11.5	9.0	2.8
Complete primary	7.3	5.6	1.8
Secondary	4.2	3.2	1.1
High school or above	4.6	3.4	1.2
Missing	12.8	9.7	3.4

Percentage across each category of the variable (row). Chi-square test p-value compares diabetes against no diabetes (refer to Table 5.3 to identify categories of diabetes). Diabetes= self-reported diabetes + undiagnosed diabetes.

Table 5.9 Characteristics of adults with diabetes, self-reported diabetes, and undiagnosed diabetes (cont.)

	Diabetes	Self-reported diabetes	Undiagnosed diabetes
N	3,123	2,396	727
Household income quintiles (%)	p<0.001	p<0.001	p=0.194
1 (lowest SES)	6.1	4.2	2.0
2	7.4	5.5	2.0
3	8.2	6.4	1.9
4	8.7	6.7	2.2
5 (highest SES)	8.0	6.6	1.6
Missing	10.0	8.0	2.1
Poverty lines (%)	p<0.001	p<0.001	p=0.527
1 (lowest SES)	6.9	5.0	1.9
2	8.4	6.4	2.1
3	8.4	6.7	1.9
4 (highest SES)	8.1	6.5	1.7
Missing	10.0	8.0	2.1
Household wealth quintiles (%)	p<0.001	p<0.001	p=0.047
1 (lowest SES)	4.7	3.0	1.7
2	7.7	5.6	2.2
3	8.8	6.8	2.1
4	9.7	7.9	2.0
5 (highest SES)	8.6	7.1	1.6
Missing	6.4	3.8	2.8
Household wealth categories (%)	p<0.001	p<0.001	p=0.082
1 (lowest SES)	3.4	2.0	1.4
2	6.6	4.6	2.1
3	8.0	6.0	2.1
4	9.3	7.6	1.9
5 (highest SES)	9.0	7.3	1.9
Missing	6.4	3.8	2.8

Percentage across each category of the variable (row). Chi-square test p-value compares diabetes against no diabetes (refer to Table 5.3 to identify categories of diabetes). Diabetes= self-reported diabetes + undiagnosed diabetes.

Table 5.9 Characteristics of adults with diabetes, self-reported diabetes, and undiagnosed diabetes (cont.)

	Diabetes	Self-reported diabetes	Undiagnosed diabetes
N	3,123	2,396	727
Occupation (%)	p<0.001	p<0.001	p=0.202
Employee	5.5	3.8	1.7
Agricultural worker	4.1	2.5	1.7
Self employed/boss	8.8	6.9	2.1
Non-remunerated work	5.1	3.5	1.7
Home maker	8.3	6.5	2.0
Retired	21.9	19.4	3.2
Other	9.6	7.7	2.1
Marital status (%)	p<0.001	p<0.001	p<0.001
Married/Cohabiting	7.5	5.8	1.9
Single	3.7	2.5	1.3
Divorced/Separated	11.2	8.9	2.4
Widowed	19.0	15.4	4.3
Not known/no answer	7.1	3.6	3.7
Kinship (%)	p<0.001	p<0.001	p<0.001
Household head	9.6	7.4	2.4
Spouse	7.4	5.8	1.8
Other	3.9	2.6	1.3
Health care access (%)	p<0.001	p<0.001	p=0.224
Public	9.6	7.8	2.0
Private or both	6.2	5.2	1.0
None/other	6.6	4.7	1.9
Missing	5.1	5.1	0.0
Live in a remote area (%)	p<0.001	p<0.001	p=0.175
Non remote area	8.4	6.5	2.0
Remote	6.4	4.7	1.8
Stratum (%)	p<0.001	p<0.001	p=0.199
Urban	8.4	6.7	1.9
Rural	7.2	5.2	2.0
Deprivation Index(%)	p<0.001	p<0.001	p=0.008
Very low	8.5	6.8	1.8
Low	8.2	6.4	1.9
Medium	7.5	5.2	2.4
High	6.6	4.4	2.3
Very high	3.1	1.8	1.3
HDI (%)	p<0.001	p<0.001	p=0.285
Low	0.0	0.0	0.0
Medium low	4.0	2.4	1.6
Medium high	7.6	5.7	2.0
High	8.6	6.8	1.9

Percentage across each category of the variable (row). Chi-square test p-value compares diabetes against no diabetes (refer to Table 5.3 to identify categories of diabetes). Diabetes= self-reported diabetes + undiagnosed diabetes.

5.3.3 Socioeconomic status and diabetes

In this part of the chapter we explore if there is a relationship between diabetes and SES, and if so, what the nature of this relationship is. Secondly, if a relationship exists, we inquire if the relationship between diabetes and SES varies by urban/rural areas, level of municipality deprivation and sex. Adults were classified as having diabetes if they had an abnormally higher capillary blood glucose level or if they self-reported diabetes, otherwise they were considered as not having diabetes.

Table 8.12 in the appendix presents the base model for the whole sample. This model shows that the likelihood of diabetes increases with age, family history of diabetes and abdominal obesity. Adults who speak an indigenous language were less likely to have diabetes than adults who speak only Spanish. Adults with no access to public health care services were less likely to have diabetes than adults with access to public or private health services. Single adults were less likely to have diabetes than married adults; and the divorced, separated or widowed adults were more likely to have diabetes than the married ones. There was a significant interaction between sex and waist circumference. Among adults with obesity, the probability of having diabetes was similar among men and women. However, among adults with normal waist circumference, women were less likely to have diabetes than men.

Table 8.13 in the appendix presents the unadjusted and adjusted odds ratios for the SES variables. The odds of having diabetes increased gradually with lower levels of education; even after adjustment for genetic, biological, and lifestyle factors and potential mediators (base model). Adults in the lowest categories of household income and household wealth were less likely to have diabetes than adults in the highest category of these variables. However, after adjustment for the base model, an inverse u-shaped association between diabetes and household SES seemed more evident. There was a positive relationship between diabetes and municipality SES. Nevertheless, after adjustment for other factors, the odds ratios of diabetes were significantly lower only among the poorest municipalities when compared with municipalities with medium SES. Adults living in rural and remote areas were less likely to have diabetes than adults living in urban or non remote areas. Nonetheless, no association was found between diabetes and urban/rural stratum after controlling for the base model.

Table 5.10 presents a multiple logistic regression model to assess the association between diabetes and all SES measures simultaneously. At the national level, a step model was estimated introducing the groups of variables sequentially: model 1 was adjusted for genetic and biological factors; model 2 was additionally adjusted for lifestyle determinants; model 3 was additionally adjusted for individual and household SES; model 4 was additionally adjusted for potential mediators and moderators of the relationship between diabetes and SES; model 5 was additionally adjusted for social environment; model 6 was additionally adjusted for interactions; model 7 was additionally adjusted for municipality deprivation; and model 8 was additionally adjusted for random effects at the municipality level. In addition, Table 8.14 in the appendix reports the likelihood ratio statistics of these models.

During the stepwise addition, waist circumference was preferred over BMI because it had a higher significance in the models. Similarly, the two measures of household wealth were more significant than the measures of household income. We selected the index of household wealth, in the categories that we specified, to interpret the results according to approximate poverty lines. Among deprivation measures, only the index of human development was associated with diabetes. The final model was assessed for multicollinearity and changes in the direction of the coefficients of the variables sex, stratum, and education-household wealth. In addition, categories with few observations were dropped from the model (not known/no answer of marital status); others were collapsed; and interactions were tested. Categories were collapsed if no statistical difference was found between them when predicting diabetes. The categories that were collapsed were: "only father" with "only mother" in the variable family history of diabetes; "none/preschool" to "secondary" as "secondary or below" in the variable education; categories "2" with "3" and "4" with "5" of household wealth; "public" with "private or both" in the variable health care access; and "divorced/separated" with "widowed" in the variable marital status.

A further analysis was performed on the variables education and household wealth because they showed contrary results; as well as on sex because it changed of direction after adjustment for waist circumference. An analysis of the variables sex and waist circumference showed that, among adults with normal waist circumference the percentage of men with diabetes (6.0%) was statistically significantly higher than the percentage of women with diabetes (2.8%); but there was no difference among adults with obesity (12.6% and 11.5% respectively). Across all the household wealth categories, the percentage of adults with diabetes was higher among adults with secondary school than with high school. However, the gap between these two groups increased with increasing categories of household wealth.

The effects of age, family history of diabetes and waist circumference were significant and consistent across the eight models and after adjustment for several factors (Table 5.10). In the first two models, adults who speak an indigenous language were less likely to have diabetes when compared with adults who speak only Spanish; but this association disappeared after adjustment for household wealth. Spoken language and kinship were not significant in the final model. The odds ratios of occupation were almost unchanged across the models 3 to 8. The odds ratios of education and household wealth changed when the interaction between these variables was introduced in the model. The conclusions regarding the effects of the risk factors and SES on diabetes were almost unchanged after allowing for municipality-level variation. There were no significant random slopes or cross-level interactions between the HDI and the risk factors; or between the HDI and individual SES variables. The introduction of waist circumference in the model produced a significant large reduction in the likelihood ratio statistic (Table 8.14).

Table 5.10 Odds ratios for diabetes adjusting by genetic, biological and lifestyle factors, SES and potential mediators

	Model							
	1	2	3	4	5	6	7	8
Age								
40-49 (ref.)								
20-29	0.11***	0.13***	0.13***	0.14***	0.14***	0.14***	0.14***	0.14***
30-39	0.32***	0.34***	0.35***	0.36***	0.36***	0.36***	0.36***	0.36***
50-59	2.30***	2.22***	2.13***	2.08***	2.09***	2.08***	2.08***	2.09***
60-69	3.24***	3.11***	2.81***	2.67***	2.68***	2.66***	2.66***	2.68***
Family history of diabetes								
None (ref.)								
Only father or mother	2.26***	2.20***	2.23***	2.22***	2.20***	2.21***	2.20***	2.19***
Both parents	4.78***	4.55***	4.74***	4.71***	4.65***	4.68***	4.67***	4.68***
Not known/no answer/missing	1.18	1.19	1.17	1.17	1.18	1.18	1.19	1.20
Language								
Only Spanish (ref.)								
Only indigenous language	0.49***	0.54**	-	-	-	-	-	-
Indigenous language and Spanish	0.80**	0.85	-	-	-	-	-	-
No answer	0.62	0.64	-	-	-	-	-	-
Sex								
Men (ref.)								
Woman	1.19***	0.93	0.88*	0.85**	0.85**	0.69***	0.69***	0.69***
Waist circumference								
Normal (ref.)								
Abdominal obesity	-	1.78***	1.71***	1.69***	1.69***	1.35***	1.35***	1.34***
Missing	-	1.56***	1.53***	1.53***	1.53***	1.69**	1.68**	1.73**
Household wealth								
4-5 (highest SES, ref.)								
1 (lowest SES)	-	-	0.55***	0.59***	0.62***	0.98	1.03	1.01
2-3	-	-	0.96	0.98	1.00	1.48**	1.49**	1.47**
Missing			0.71	0.72	0.72	0.44	0.44	0.43
Education								
High school or above (ref.)								
Secondary or below	-	-	1.56***	1.58***	1.61***	1.72***	1.71***	1.71***
Missing	-	-	1.65***	1.69***	1.74***	1.90***	1.90***	1.88***

Dependent variable “diabetes in adult” no(0), yes(1). – not included. *p<0.05 **p<0.01 ***p<0.001
Model 1: diabetes adjusted by genetic and biological factors. Model 2: includes also lifestyle determinants. Model 3: includes also SES (the variable “language” was not significant after controlling for household wealth, therefore, it was removed). Model 4: includes also potential mediators/moderators. Model 5: includes also environmental factors. Model 6: includes interactions. Model 7: includes contextual variables at the municipality level. Model 8: includes random effects at the municipality level.

Table 5.10 Odds ratios for diabetes adjusting by genetic, biological and lifestyle factors, SES and potential mediators (cont.)

	Model							
	1	2	3	4	5	6	7	8
Occupation								
Employee (ref.)								
Agricultural worker	-	-	0.56***	0.60***	0.62**	0.61***	0.61***	0.61***
Self employed/boss	-	-	0.98	1.03	1.04	1.04	1.04	1.04
Non-remunerated	-	-	0.61**	0.66*	0.69*	0.68*	0.71*	0.71*
Home maker	-	-	1.06	1.11	1.12	1.11	1.12	1.11
Retired	-	-	1.28*	1.27*	1.27*	1.28*	1.29*	1.28*
Other	-	-	1.26*	1.33**	1.33**	1.34**	1.33**	1.34**
Health care access								
Public and/or private (ref.)								
None/other	-	-	-	0.85***	0.87**	0.87**	0.88**	0.88**
Missing	-	-	-	0.80	0.81	0.85	0.84	0.84
Marital status								
Married/Cohabiting (ref.)								
Single	-	-	-	0.82*	0.82*	0.82*	0.81*	0.81*
Divorced/Separated/Widowed	-	-	-	1.14*	1.12*	1.12*	1.12*	1.11*
Live in a remote area								
Non remote area (ref.)								
Remote	-	-	-	-	0.84***	0.84***	0.85**	0.83***
Sex*waist circumference								
Woman*abdominal obesity	-	-	-	-	-	1.48***	1.47***	1.47***
Woman*missing	-	-	-	-	-	0.96	0.95	0.94
Household wealth*education								
1*secondary	-	-	-	-	-	0.72	0.72	0.72
2-3*secondary	-	-	-	-	-	0.64**	0.64**	0.64**
Missing*secondary	-	-	-	-	-	2.36	2.37	2.40
1*missing	-	-	-	-	-	0.47	0.49	0.50
2-3*missing	-	-	-	-	-	0.67*	0.69*	0.69*
Missing*missing	-	-	-	-	-	0.42	0.44	0.46
Index of human development								
Medium high-high (ref.)								
Low-medium low	-	-	-	-	-	-	0.72**	0.72*
Municipality								
SD	-	-	-	-	-	-	-	0.20***

Dependent variable "diabetes in adult" no(0), yes(1). – not included. *p<0.05 **p<0.01 ***p<0.001
Model 1: diabetes adjusted by genetic and biological factors. Model 2: includes also lifestyle determinants. Model 3: includes also SES. Model 4: includes also potential mediators/moderators. Model 5: includes also environmental factors. Model 6: includes interactions. Model 7: includes contextual variables at the municipality level. Model 8: includes random effects at the municipality level.

The final model for diabetes at the national level is displayed on the first column of Table 5.11. The odds ratios of diabetes for the genetic, biological and lifestyle factors and potential mediators are in the same direction and have approximately the same magnitude as those of the base model (Table 8.12). Figure 5.5 shows the interaction between sex and waist circumference.

Figure 5.6 shows the interaction between education and household wealth. Adults with an education below secondary school were more likely to have diabetes than adults with high school or above. However, among adults with secondary schooling, there was a positive association between diabetes and household wealth; and among adults with high school education, there was a negative u-shaped association between diabetes and household wealth. The non-remunerated and agricultural workers were less likely to have diabetes than employees; and the retired and "other occupations" were more likely to have diabetes than employees. Higher urbanisation and municipality SES were associated with an increased prevalence of diabetes. Adults living in a non remote area were at increased risk of having diabetes compared with their counterparts living in a remote area. Adults living in municipalities with a low to medium-low Human Development Index were less likely to have diabetes than adults living in municipalities with a medium_high-high HDI.

The standard deviation for the municipality effect u_{0j} was 0.20. Since the between-municipality standard deviation decreased from 0.30 to 0.20 from a model with no covariates to the fully adjusted model, some of the variation in having diabetes between municipalities was explained by individual characteristics, risk and environmental factors, and SES. However, the municipality level variation was still significant. The Human Development Index did not significantly decrease the variation in having diabetes between municipalities. A model estimated without the HDI index had a standard deviation of 0.21.

Ten more models were fitted by stratum, HDI, Deprivation Index and sex controlling by the same variables of the model at the national level (Table 5.11 and Table 5.12). Some variables were not included in the models because of collinearity or because of lack of cases of diabetes. Others were excluded because they had few observations that were causing large estimates and confidence intervals. Most of the models had similar odds ratios compared to those of the model at the national level. Therefore, only relevant differences are described. In the model for low HDI no significant differences were shown in the age groups 50-59 and 60-69 compared to 40-49. The probability of having diabetes was not different between men and women living in the rural stratum, municipalities with medium_low-low human development, and municipalities with medium and high-very_high deprivation. There was no association between diabetes and obesity in municipalities with low HDI and municipalities with medium DI.

In the most deprived municipalities there were no differences between diabetes and occupation (independently of the municipality deprivation measure used). Agricultural workers tended to be less likely to have diabetes than employees in most of the models. Home makers were more likely to have diabetes than employees only in the urban area. Health care access was not associated with diabetes in men, rural areas, municipalities with medium_high and medium_low HDI, and municipalities with medium and high DI. In municipalities with medium_high HDI and very_low-low deprivation, single adults were less likely to have diabetes than married adults.

The interaction between education and household wealth was significant in rural areas and municipalities with medium_high HDI (Figure 5.7 and Figure 5.8). The interaction showed that there was a positive association between diabetes and education in households with lower wealth; and a negative association between diabetes and education in wealthier households. The interaction was not significant in all the models or it could not be fitted in all the models because the number of observations in each cell was small. Lower levels of education were associated with a higher probability of diabetes across all the models except for the most deprived municipalities. There was no association between household wealth and diabetes in urban areas and municipalities with low HDI. Among municipalities with high HDI, and across all models of the Deprivation Index, adults in the lowest category of household wealth were less likely to have diabetes than adults in the highest category of household wealth.

In municipalities with high HDI, low HDI, medium deprivation and women, there were no differences in the probability of having diabetes between people living in remote areas and people living in non remote areas. In men there was no association between diabetes and HDI.

A random-effects model for the adults living in low HDI municipalities and high deprivation could not be fitted. The standard deviation for the municipality effect in the urban area and least deprived municipalities was lower than in the rural area and more deprived municipalities. The standard deviation for the municipality effect in men was higher than in women.

Table 5.11 Odds ratios for diabetes at the national level, by stratum and HDI

	Total	Stratum		HDI		
		Urban	Rural	High	Medium high	Medium low-low
N	39,752	21,593	18,159	18,626	18,919	2,105
Age group						
20-29	0.14***	0.14***	0.13***	0.14***	0.14***	0.12***
30-39	0.36***	0.37***	0.34***	0.36***	0.35***	0.39**
40-49	1.00	1.00	1.00	1.00	1.00	1.00
50-59	2.09***	2.15***	2.02***	2.11***	2.14***	1.30
60-69	2.68***	2.94***	2.40***	2.87***	2.63***	1.54
Family history of diabetes						
None	1.00	1.00	1.00	1.00	1.00	1.00
Only father or mother	2.19***	2.06***	2.45***	2.12***	2.25***	3.77***
Both parents	4.68***	4.77***	4.49***	4.93***	4.22***	7.55*
Missing	1.20	1.18	1.27	1.18	1.16	1.80
Sex						
Men	1.00	1.00	1.00	1.00	1.00	1.00
Women	0.69***	0.58***	0.92	0.68**	0.75*	0.53
Waist circumference						
Normal	1.00	1.00	1.00	1.00	1.00	1.00
Abdominal obesity	1.34***	1.33**	1.29*	1.40**	1.31*	0.38
Missing	1.73**	1.41	2.26**	1.37	1.92*	7.19*
Household wealth						
1 (lowest SES)	1.01	0.64	1.39	0.45*	1.61	0.57
2 and 3	1.47**	1.06	1.98*	1.12	1.62*	0.62
4 and 5 (highest SES)	1.00	1.00	1.00	1.00	1.00	1.00
Missing	0.43	0.73	1.18	0.53	0.64	-[a]
Education						
High school/above	1.00	1.00	1.00	1.00	1.00	1.00
Secondary/below	1.71***	1.55***	1.83***	1.57***	1.81***	1.70
Missing	1.88***	1.86***	2.04***	1.94***	1.78**	1.15

Z-test significance for individual coefficients: *p<0.05, **p<0.01, ***p<0.001; - not included in the models.

Table 5.11 Odds ratios for diabetes at the national level, by stratum and HDI (cont.)

	Total	Stratum		HDI		
		Urban	Rural	High	Medium high	Medium low-low
N	39,752	21,593	18,159	18,626	18,919	2,105
Occupation						
Employee	1.00	1.00	1.00	1.00	1.00	1.00
Agricultural worker	0.61***	0.56	0.57**	0.44*	0.57**	1.30
Self employed/boss	1.04	1.19*	0.82	1.20*	0.89	0.93
Non-remunerated	0.71*	0.94	0.56**	1.10	0.52**	0.84
Home maker	1.11	1.24*	0.86	1.14	1.05	0.81
Retired	1.28*	1.29*	1.14	1.27	1.20	3.07
Other	1.34**	1.41**	1.15	1.45**	1.18	1.95
Health care access						
Public and/or private	1.00	1.00	1.00	1.00	1.00	1.00
None/other	0.88**	0.83**	0.96	0.80***	0.98	0.95
Missing	0.84	0.53	1.41	0.57	1.22	-
Marital status (%)						
Married/Cohabiting	1.00	1.00	1.00	1.00	1.00	1.00
Single	0.81*	0.84	0.79	0.83	0.77*	1.50
Divorced/Separated/Widowed	1.11*	1.13	1.08	1.12	1.10	1.32
Live in a remote area						
Non remote area	1.00	-	1.00	1.00	1.00	1.00
Remote	0.83***	-	0.80***	0.91	0.85*	0.65
Sex*waist circumference						
Woman*abdominal obesity	1.47***	1.46**	1.53**	1.34*	1.49**	9.16**
Woman*missing	0.94	1.26	0.61	1.15	0.84	-
Household wealth*education						
1*secondary	0.72	-	0.48	-	0.37	-
2-3*secondary	0.64**	-	0.45**	-	0.52**	-
Missing*secondary	2.40	-	0.65	-	2.28	-
1*missing	0.50	-	0.37	-	0.45	-
2-3*missing	0.69*	-	0.41**	-	0.62	-
Missing*missing	0.46	-	0.30	-	0.59	-
Index of human development						
Low-medium low	0.72*	-	0.73*	-	-	-
Medium high-high	1.00	-	1.00	-	-	-
Municipality						
SD	0.20***	0.13***	0.27***	0.18***	0.21***	-

Z-test significance for individual coefficients: *p<0.05, **p<0.01, ***p<0.001; - not included in the models. National model has 321 municipalities, min=17 adults, max=873 adults, average=123.9. Model for urban stratum has 151 municipalities, min=18 adults, max=710, average=143. Model for rural stratum has 204 municipalities, min=17 adults, max=274, average=89. Model for high HDI: 99 municipalities, min=18 adults, max=873, average=188. Model for medium HDI: 196 municipalities, min=17 adults, max=274, average=96.5.

Figure 5.5 Interaction between sex and waist circumference at the national level

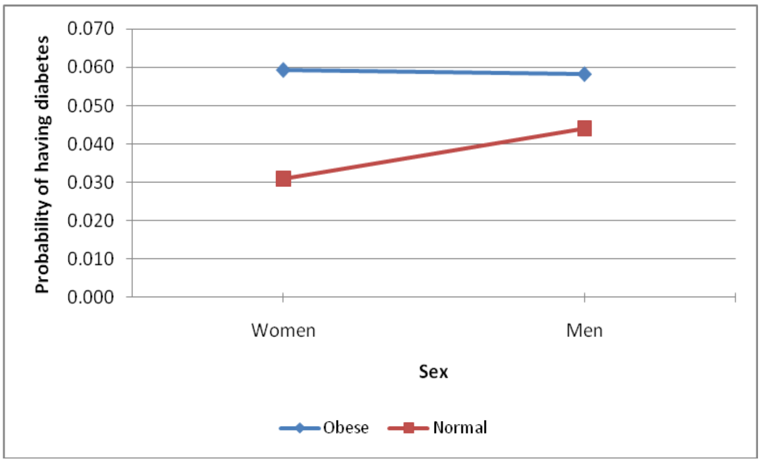


Figure 5.6 Interaction between education and household wealth index at the national level

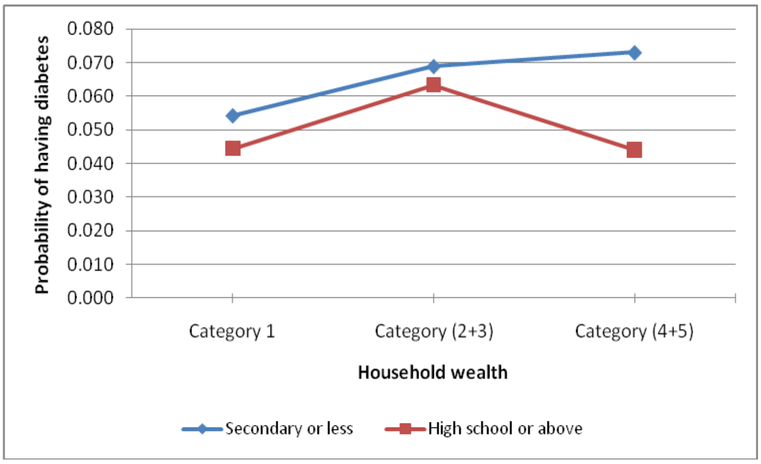


Figure 5.7 Interaction between education and household wealth index in the rural stratum

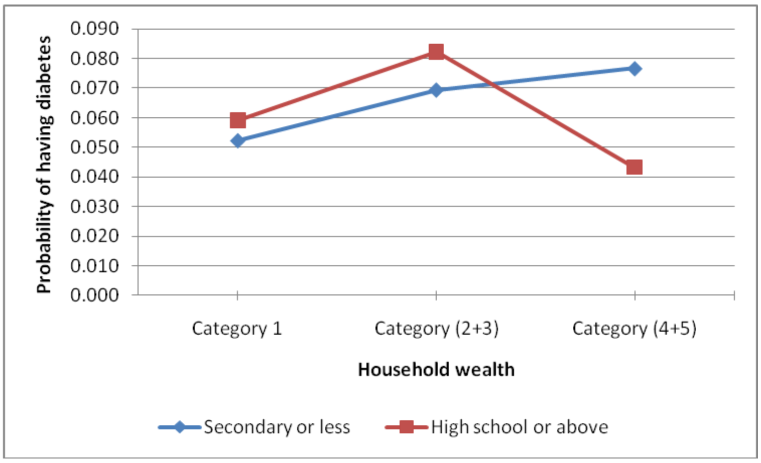


Figure 5.8 Interaction between education and household wealth index in the medium high HDI

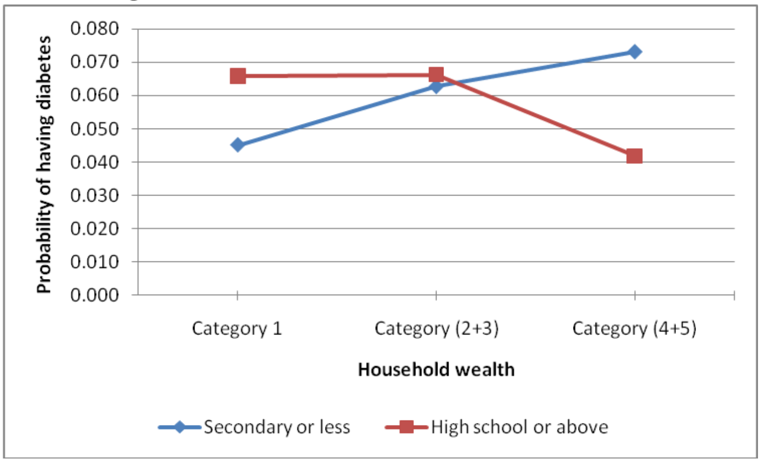


Table 5.12 Odds ratios for diabetes by sex and Deprivation Index

	Sex		Deprivation Index		
	Men	Women	Very low-low	Medium	High-very high
N	12,147	27,605	27,551	6,141	6,021
Age group					
20-29	0.12***	0.15***	0.14***	0.14***	0.15***
30-39	0.34***	0.37***	0.36***	0.32***	0.40***
40-49	1.00	1.00	1.00	1.00	1.00
50-59	1.79***	2.24***	2.03***	2.34***	2.12***
60-69	2.35***	2.88***	2.74***	2.72***	2.41***
Family history of diabetes					
None	1.00	1.00	1.00	1.00	1.00
Only father or mother	1.88***	2.35***	2.14***	2.30***	2.62***
Both parents	4.02***	5.20***	4.78***	3.26***	5.83***
Not known	1.01	1.29	1.10	1.19	1.46
Sex					
Men	-	-	1.00	1.00	1.00
Women	-	-	0.63***	1.04	0.95
Waist circumference					
Normal	1.00	1.00	1.00	1.00	1.00
Abdominal obesity	1.34***	1.94***	1.33***	1.33	1.96***
Missing	1.74**	1.59**	1.42	1.47	2.15**
Household wealth					
1 (lowest SES)	0.68	2.19	0.52**	0.64*	0.65*
2 and 3	0.84*	1.44*	1.08	0.76*	0.88
4 and 5 (highest SES)	1.00	1.00	1.00	1.00	1.00
Missing	0.75	0.37	0.95	0.26	-[a]
Education					
High school/above	1.00	1.00	1.00	1.00	1.00
Secondary/below	1.45***	1.82***	1.59***	1.56*	1.23
Missing	1.08	2.14***	1.72***	1.94**	1.23

Z-test significance for individual coefficients: *p<0.05, **p<0.01, ***p<0.001; - not included in the models.

Table 5.12 Odds ratios for diabetes by sex and Deprivation Index (cont.)

	Sex		Deprivation Index		
	Men	Women	Very low-low	Medium	High-very high
N	12,147	27,605	27,551	6,141	6,021
Occupation					
Employee	1.00	1.00	1.00	1.00	1.00
Agricultural worker	0.65*	0.68	0.61*	0.41*	0.93
Self employed/boss	0.96	1.19	1.13	0.79	0.93
Non-remunerated	0.56	0.88	1.03	0.37*	0.52
Home maker	0.70	1.19	1.16	0.81	1.18
Retired	1.33	1.30	1.24	1.59	1.78
Other	1.46**	1.30	1.37**	1.03	1.60
Health care access					
Public and/or private	1.00	1.00	1.00	1.00	1.00
None/other	0.90	0.87**	0.86**	0.88	0.99
Missing	1.62	0.37	0.58	0.76	2.07
Marital status (%)					
Married/Cohabiting	1.00	1.00	1.00	1.00	1.00
Single	0.76	0.85	0.79*	0.94	0.85
Divorced/Separated/Widowed	1.10	1.11	1.13	0.98	1.30
Live in a remote area					
Non remote area	1.00	1.00	1.00	1.00	1.00
Remote	0.68***	0.90	0.83*	0.94	0.75*
Sex*waist circumference					
Woman*abdominal obesity	-	-	1.48**	1.23	-
Woman*missing	-	-	1.25	0.45	-
Household wealth*education					
1*secondary	-	0.31	-	-	-
2-3*secondary	-	0.70	-	-	-
Missing*secondary	-	2.87	-	-	-
1*missing	-	0.28	-	-	-
2-3*missing	-	0.81	-	-	-
Missing*missing	-	0.78	-	-	-
Index of human development					
Low-medium low	0.95	0.63**	-	-	0.74*
Medium high-high	1.00	1.00	-	-	1.00
Municipality					
SD	0.33***	0.21***	0.17***	0.21***	-

Z-test significance for individual coefficients: *p<0.05, **p<0.01, ***p<0.001; - not included in the models. Model for men has 321 municipalities, min=4 adults, max=255, average=37.8. Model for women has 321 municipalities, min=10 adults, max=618, average=86. Model for low deprivation has 187 municipalities, min=17 adults, max=873, average=147.3. Model for medium deprivation has 68 municipalities, min=17 adults, max=274, average=90.3.

5.3.4 Socioeconomic status and self-reported diabetes

The aim of this section is to examine if there is a relationship between self-reported diabetes and SES and in case that there is, what the nature of this relationship is. Secondly, if a relationship exists, we inquire if the relationship between self-reported diabetes and SES varies by urban/rural areas, sex, and level of municipality deprivation. Logistic regression models were estimated where the dependent variable classified as adults having diabetes only to those with “self-reported diabetes” (2,396 adults), otherwise they were classified as not having diabetes.

Unadjusted and adjusted odds ratios for self-reported diabetes by socioeconomic status are given in Table 8.15 in the appendix. The odds ratios of most of the variables had a similar direction and significance as those of the total diabetes model. In contrast with the adjusted odds ratios of total diabetes, a significant negative graded association was observed between diabetes and the Deprivation Index.

Table 5.13 and Table 5.14 report the odds ratios of the multiple regression models for self-reported diabetes. The models were estimated as in the previous section. The final model for self-reported diabetes at the national level is displayed in the first column of Table 5.13. Sex, spoken language and kinship were not significant in the final model. The odds ratios of the rest of the risk factors, potential mediators and occupation had a similar direction and magnitude as those of the diabetes model. In this subsection self-reported diabetes is just mentioned as diabetes.

Adults in the first category of household wealth were less likely to have diabetes compared to adults in the highest category of household wealth. The odds of having diabetes increased with decreasing levels of education. Adults living in a remote area were less likely to have diabetes than adults living in a non remote area. HDI had a higher significance than the Deprivation Index. There were no differences in the odds between adults living in municipalities with a high HDI when compared to adults living in municipalities with a medium_high HDI; thus, these categories were collapsed. Adults living in municipalities with a low to medium-low Human Development Index were less likely to have diabetes than adults living in municipalities with a medium_high-high HDI. There were no significant interactions, random slopes or cross-level interactions. The standard deviation for the municipality effect was 0.18.

Education had a similar association with diabetes in the stratified models as in the national level (Table 5.13), except for the most deprived municipalities (using both deprivation measures). In the rural stratum, men and municipalities with medium HDI, medium deprivation, and high deprivation, there was a positive association between diabetes and household wealth. Among women and municipalities with high HDI and low deprivation, adults in the lowest category of household wealth were less likely to have diabetes than adults in the highest categories (4 and 5). There was no association between diabetes and household wealth in urban areas and municipalities with low HDI.

There were no differences in the probability of having diabetes between people living in remote areas and people living in non remote areas among women and municipalities with high HDI, medium HDI, and low to medium Deprivation Index. In men, there was no association between diabetes and HDI. A random-effects model could not be fitted for low HDI and medium/high Deprivation Index.

Home makers were more likely to have diabetes than employees only in the urban area, women and municipalities with a high/low Deprivation Index. There were no differences in the probability of having diabetes by health care access among men and among the most disadvantaged municipalities. There was no difference in the probability of having diabetes in adults by marital status in municipalities with low HDI and with a medium to high Deprivation Index.

Table 5.13 Odds ratios for self-reported diabetes at the national level, by stratum and HDI

		Stratum		HDI		
	Total	Urban	Rural	High	Medium	Low
N	39,752	21,593	18,159	18,626	18,919	2,183
Age group						
20-29	0.12***	0.12***	0.11***	0.12***	0.11***	0.12**
30-39	0.33***	0.35***	0.30***	0.34***	0.32***	0.21**
40-49	1.00	1.00	1.00	1.00	1.00	1.00
50-59	2.33***	2.44***	2.19***	2.53***	2.15***	2.01
60-69	3.24***	3.50***	2.95***	3.64***	2.89***	2.89*
Family history of diabetes						
None	1.00	1.00	1.00	1.00	1.00	1.00
Only father or mother	2.43***	2.21***	2.83***	2.27***	2.58***	4.58***
Both parents	5.81***	5.69***	5.97***	6.09***	5.26***	9.29*
Missing	1.22	1.29	1.2	1.26	1.08	2.28
Waist circumference						
Normal	1.00	1.00	1.00	1.00	1.00	1.00
Abdominal obesity	1.44***	1.39***	1.48***	1.43***	1.44***	1.32
Missing	1.35*	1.21	1.55*	1.08	1.71**	1.19
Household wealth						
1 (lowest SES)	0.56***	0.56	0.54***	0.38*	0.52***	0.97
2 and 3	0.91	0.98	0.85*	1.07	0.79**	1.07
4 and 5 (highest SES)	1.00	1.00	1.00	1.00	1.00	1.00
Missing	0.51*	0.41	0.62	0.26*	0.85	-[a]
Education						
High school/above	1.00	1.00	1.00	1.00	1.00	1.00
Secondary/below	1.70***	1.63***	1.77***	1.64***	1.75***	0.73
Missing	1.83***	1.97***	1.73**	2.02***	1.83***	0.43

Z-test significance for individual coefficients: *p<0.05, **p<0.01, ***p<0.001; - not included in the models.

Table 5.13 Odds ratios for self-reported diabetes at the national level, by stratum and HDI (cont.)

		Stratum		HDI		
	Total	Urban	Rural	High	Medium	Low
N	39,752	21,593	18,159	18,626	18,919	2,183
Occupation						
Employee	1.00	1.00	1.00	1.00	1.00	1.00
Agricultural worker	0.58**	0.38*	0.57*	0.38*	0.54**	3.59
Self employed/boss	1.18*	1.31**	0.97	1.31**	1.05	1.65
Non-remunerated	0.72	0.83	0.63	0.87	0.63	1.44
Home maker	1.19*	1.21*	1.09	1.17	1.19	1.70
Retired	1.48***	1.50**	1.32	1.48**	1.39	3.60
Other	1.50***	1.54**	1.34	1.55**	1.43*	1.83
Health care access						
Public and/or private	1.00	1.00	1.00	1.00	1.00	1.00
None/other	0.82***	0.81**	0.85*	0.78***	0.88	0.94
Missing	1.11	0.74	1.92	0.8	1.7	-
Marital status (%)						
Married/Cohabiting	1.00	1.00	1.00	1.00	1.00	1.00
Single	0.72***	0.73**	0.69*	0.72**	0.72*	0.35
Divorced/Separated/Widowed	1.09	1.06	1.13	1.04	1.15	1.25
Live in a remote area						
Non remote area	1.00	-	1.00	1.00	1.00	1.00
Remote	0.85**		0.85*	0.95	0.89	0.45*
Index of human development						
Low-medium low	0.60**	-	0.64**	-	-	-
Medium high-high	1.00		1.00			
Municipality						
SD	0.18***	0.14***	0.22***	0.19***	0.15***	-

Z-test significance for individual coefficients: *p<0.05, **p<0.01, ***p<0.001; - not included in the models. National model has 321 municipalities, min=17 adults, max=873 adults, average=123.8. Model for urban stratum has 151 municipalities, min=18 adults, max=710, average=143. Model for rural stratum has 204 municipalities, min=17 adults, max=274, average=89. Model for high HDI: 99 municipalities, min=18 adults, max=873, average=188.1. Model for medium HDI: 196 municipalities, min=17 adults, max=274, average=96.5.

Table 5.14 Odds ratios for self-reported diabetes by sex and Deprivation Index

	Sex		Deprivation Index		
	Men	Women	Low	Medium	High
N	12,147	27,605	27,551	6,105	6,021
Age group					
20-29	0.12***	0.12***	0.12***	0.11***	0.10***
30-39	0.32***	0.34***	0.33***	0.29***	0.33***
40-49	1.00	1.00	1.00	1.00	1.00
50-59	2.00***	2.47***	2.30***	2.40***	2.43***
60-69	2.95***	3.38***	3.37***	2.80***	3.06***
Family history of diabetes					
None	1.00	1.00	1.00	1.00	1.00
Only father or mother	2.09***	2.60***	2.31***	2.88***	2.83***
Both parents	5.02***	6.39***	5.76***	4.78***	7.35***
Missing	0.88	1.39*	1.17	1.35	1.32
Waist circumference					
Normal	1.00	1.00	1.00	1.00	1.00
Abdominal obesity	1.14	1.66***	1.43***	1.31	1.55*
Missing	1.49	1.40*	1.24	1.26	2.21*
Household wealth					
1 (lowest SES)	0.51**	0.58***	0.52*	0.45**	0.52**
2 and 3	0.71***	1.00	1.01	0.71**	0.69*
4 and 5 (highest SES)	1.00	1.00	1.00	1.00	1.00
Missing	0.47	0.56	0.67	-	-
Education					
High school/above	1.00	1.00	1.00	1.00	1.00
Secondary/below	1.53***	1.81***	1.65***	2.06**	1.85
Missing	1.17	2.17***	1.74***	2.43**	2.04

Z-test significance for individual coefficients: *p<0.05, **p<0.01, ***p<0.001; - not included in the models.

Table 5.14 Odds ratios for self-reported diabetes by sex and Deprivation Index (cont.)

	Sex		Deprivation Index		
	Men	Women	Low	Medium	High
N	12,147	27,605	27,551	6,105	6,021
Occupation					
Employee	1.00	1.00	1.00	1.00	1.00
Agricultural worker	0.60*	0.76	0.59*	0.21**	1.83
Self employed/boss	1.13	1.26*	1.24*	0.9	1.65
Non-remunerated	0.54	0.87	0.87	0.45	1.05
Home maker	0.49	1.22*	1.17*	0.96	2.34*
Retired	1.64**	1.37	1.40**	1.97	3.65*
Other	1.63**	1.43*	1.52***	1.19	2.09
Health care access					
Public and/or private	1.00	1.00	1.00	1.00	1.00
None/other	0.89	0.79***	0.83***	0.84	0.75
Missing	2.45	0.45	0.8	1.07	3.18
Marital status (%)					
Married/Cohabiting	1.00	1.00	1.00	1.00	1.00
Single	0.70*	0.73**	0.71**	0.86	0.32
Divorced/Separated/Widowed	1.03	1.1	1.07	1.12	1.27
Live in a remote area					
Non remote area	1.00	1.00	1.00	1.00	1.00
Remote	0.70**	0.91	0.89	1.02	0.74*
Index of human development					
Low-medium low	0.91	0.51***	-	-	0.67*
Medium high-high	1.00	1.00			1.00
Municipality					
SD	0.26***	0.19***	0.16***	-	-

Z-test significance for individual coefficients: *p<0.05, **p<0.01, ***p<0.001; - not included in the models. Model for men has 321 municipalities, min=4 adults, max=255, average=37.8. Model for women has 321 municipalities, min=10 adults, max=618, average=86. Model for low deprivation has 187 municipalities, min=17 adults, max=873, average=147.4.

Wide confidence intervals were detected for some categories in the models for higher deprivation. This was mainly due to small cases of diabetes, especially with the HDI measure. For instance, there were very few cases of adults with diabetes among high levels of education. A cross-tabulation and chi-square test showed no association between education and total/ self-reported diabetes among adults living in municipalities with the lowest HDI. For the highest deprivation strata, models were repeated after excluding categories with wide CIs. The results were similar.

5.3.5 Socioeconomic status and undiagnosed diabetes

The aim of the section is to investigate if there is a relationship between undiagnosed diabetes and SES, and if so, what the nature of this relationship is. Secondly, if a relationship exists, we inquire if the relationship between undiagnosed diabetes and SES varies by urban/rural areas and sex. As we explored in previous sections, of the 39780 adults of the study, 2396 self-reported diabetes and 727 did not know that had high blood sugar before the survey. In this section we only considered adults who did not self-reported diabetes and compared the undiagnosed (N=727) to adults without diabetes (N=37384).

The unadjusted and adjusted odds ratios for undiagnosed diabetes by socioeconomic status are reported on Table 8.16 in the appendix. There was a negative graded association between education and undiagnosed diabetes. However, after further adjustment for the covariates in the base model (Table 8.12), only adults with incomplete primary were more likely to be undiagnosed than adults with high school or above.

Adults in the fourth quintile of household income (and in the 2/3 quintile of household wealth) were more likely to be undiagnosed than adults in the fifth quintile. After further adjustment for risk factors, adults in quintiles 1 to 4 of household income and wealth were more likely to be undiagnosed than adults in quintile five. There was no association between poverty lines and undiagnosed diabetes. However, adjustment for the base model showed that adults in the second category of poverty had an increased risk of being undiagnosed when compared with adults in category four. Only adults in the first category of household wealth were less likely to be undiagnosed than adults in the fifth category. After controlling for the variables in the base model, there was an inverse u-shaped association between undiagnosed diabetes and household wealth.

There was an inverse u-shaped relationship between the Deprivation Index and undiagnosed diabetes. However, after further adjustment for risk factors, only adults living in the most advantaged municipalities were less likely to be undiagnosed than adults living in municipalities with medium DI. Unadjusted and adjusted analysis showed no association between undiagnosed diabetes and stratum, living in a remote area, and HDI.

A step logistic model was built at the national level for undiagnosed diabetes (as in the previous sections). Then, separate models were built by stratum and sex using the same variables included in the final model at the national level. Table 5.15 shows the odds ratios for these models. BMI was more strongly and significantly associated with a higher risk of undiagnosed diabetes than waist circumference. Overall, by stratum and sex, the probability of undiagnosed diabetes increased with age, family history of diabetes and body mass index.

At the national level, urban areas and in women, there was an inverse u-shaped association between undiagnosed diabetes and household wealth. Adults with household wealth categories 2/3 had a higher risk of undiagnosed diabetes than adults with household wealth categories 4/5. In the same models, there was no difference in the probability of having diabetes between adults in the category 1 of household wealth and adults in the categories 4/5. In the rural area and men, household wealth was not significantly associated with undiagnosed diabetes.

In the rural area and women, adults living in municipalities with medium to very high deprivation were more likely to be undiagnosed than adults living in municipalities with very low and low deprivation. There was not a significant association between the Deprivation Index and undiagnosed diabetes in the urban area and in men. There were no significant interactions between the risk factors and individual SES variables.

Table 5.15 Odds ratios for undiagnosed diabetes at the national level, by stratum and sex

	Total	Stratum		Sex	
		Urban	Rural	Men	Women
N	37384	20162	17222	11469	25915
Age group					
20-29	0.18***	0.18***	0.18***	0.14***	0.21***
30-39	0.41***	0.39***	0.43***	0.40***	0.42***
40-49	1.00	1.00	1.00	1.00	1.00
50-59	1.56***	1.52**	1.59**	1.34	1.69***
60-69	1.56***	1.87***	1.27	1.14	1.85***
Family history of diabetes					
None	1.00	1.00	1.00	1.00	1.00
Only father or mother	1.54***	1.53***	1.58***	1.44*	1.60***
Both parents	1.88**	2.10**	1.50	1.96*	1.81*
Not known/missing	1.16	0.94	1.31	1.28	1.07
BMI					
Normal	1.00	1.00	1.00	1.00	1.00
Overweight/Obese	2.04***	1.80***	2.23***	1.58**	2.41***
Out of range/missing	1.19	0.7	1.62	1.88	1.03
Household wealth					
1 (lowest SES)	0.93	1.05	0.82	0.92	0.95
2 and 3	1.34***	1.53***	1.16	1.22	1.41***
4 and 5 (highest SES)	1.00	1.00	1.00	1.00	1.00
Missing	1.56	2.06	0.95	1.7	1.45
Deprivation Index					
Low-very low	1.00	1.00	1.00	1.00	1.00
Medium-high-very high	1.28**	1.11	1.36**	0.95	1.49***

Z-test significance for individual coefficients: *p<0.05, **p<0.01, ***p<0.001

All results were similar when BMI was replaced by waist-to-hip ratio. In addition, similar results were obtained when household wealth divided according to poverty lines was replaced by the quintiles of household wealth.

5.4 Discussion

These data confirm an association between socioeconomic status and the prevalence of type 2 diabetes among Mexican adults aged 20-69. However, the nature of the association between diabetes and SES depends on the measure used and it differs by sex and strata.

Prevalence of total and self-reported diabetes

Findings at the national level

We hypothesized that the association between diabetes and SES would be negative at the national level across all our SES measures. A negative association was confirmed only for the variable education. The association between household wealth and diabetes was non-linear or positive; and the association between municipality SES and diabetes was positive.

Education

There was a negative association between diabetes and education at the national level in the full sample, in men and in women. This association has also been reported in studies from developed countries (as was seen in our literature review); and it is consistent with findings in Mexico. Two studies were based on the Mexican NHS-2000. However, one study was confined to the insured population of the IMSS (Vazquez-Martinez et al., 2006); and in the other study the association between education and diabetes was only borderline significant in women (Olaiz-Fernandez et al., 2007). Moreover, both studies included people aged 70 years or more, and the diagnosis of diabetes was based on the ADA criteria. In the latter study, the lack of association between education and diabetes in men, and the marginal significance in women, may be due to the fact that their adjustment for co morbidities may have further attenuated the association between these variables. For instance, hypertension occurs more often in people with lower levels of education (Fernald et al., 2008; Hazuda, 1996). The direction of the associations found in our study also agrees with the direction found in our data between obesity and SES.

Since obesity was the most important determinant of diabetes, education may be related to diabetes through obesity.

Moreover, our results showed that SES differentials in the prevalence of diabetes by education were larger among women than among men. Evidence from other studies corroborates these findings (Connolly et al., 2000; Dalstra et al., 2005; Espelt et al., 2008; Gnavi et al., 2008; Larranaga et al., 2005; Regidor et al., 2002; Stern et al., 1984; Tang et al., 2003). The most common explanation for these inequalities is that, among the lowest SES groups, women are more likely than men to have a higher prevalence of obesity (Rathmann et al., 2005); lower physical activity (Cubbin et al., 2001); and higher psychosocial risks (Agardh et al., 2004). These behaviours and biological-psychological markers have been identified as strong risk factors for type 2 diabetes.

According to Geyer et al. (2006), education may determine the ability to turn information into practical measures and behaviours. It has been suggested that students who reach and complete a degree tend to be more persistent, despite the obstacles, than those who abandon their studies (Cabrera et al., 2006). In addition, they have more ability to overcome difficulties, fix goals and achieve them, to be constant in their daily work, and to integrate better in the social, economic, cultural and organizational environment. Hence, the more educated may be more persistent and have better control over their lives to, for instance, successfully engage in healthy behaviours (e.g. to do the recommended levels of physical activity and follow dietary guidelines).

Household wealth

There was an inverse u-shaped association between diabetes and household wealth. The association between household income and diabetes was also similar. However, household wealth had a greater significance than household income in the fully adjusted model; thus, only the first was further investigated. The direction of this association seems a mixture of the negative associations found in developed countries (Beckles et al., 2002; Smith, 2007; Tang et al., 2003); and the positive associations found in developing countries (Ramachandran et al., 2001; Ramachandran et al., 2002; Xu et al., 2006).

The lower prevalence of diabetes in the poorest households may be partly explained by undernutrition in adults and having a more traditional lifestyle. A study showed that the prevalence of anaemia in Mexican women aged 12-49 years was higher in the low and medium SES tertiles compared with the highest tertile (Rivera et al., 2003a). The study was based on the National Nutrition Survey 1999 and SES was calculated as an index of household wealth (see section 2.5). The study also showed that undernutrition is more prevalent in the lowest socioeconomic groups, in rural areas, and in the Indigenous population. In our sample, about 90% of the households in the lowest household wealth category were located in the rural area. Moreover, a higher percentage of the adults that speak dialect lived in rural areas (78-87%). Of them, about half belonged to the lowest category of household wealth. We have previously mentioned that the prevalence of diabetes is low among the indigenous population, mainly due to keeping a more traditional diet (Cerqueira et al., 1979).

Moreover, we observed a significant interaction between education and household wealth for total diabetes. Although people with low levels of education had a higher prevalence of diabetes across all the household wealth categories than adults with high school or above, the gap among adults with higher wealth was more evident. Hence, education may be more important than wealth in the development of diabetes.

Municipality socioeconomic status

The risk of diabetes increased with higher municipality SES. However, only the Human Development Index was significant, not the Deprivation Index. Our results contrasted with most of those in developed countries where an increased risk of diabetes has been observed among the most deprived areas (Andersen et al., 2008; Connolly et al., 2000; Gnavi et al., 2008; Ismail et al., 1999; Larranaga et al., 2005; Middelkoop et al., 1999). Nevertheless, most of them were computed at the ward level or within census sections. It could be argued that municipalities are large and very heterogeneous within themselves. However, we explored the association between diabetes and locality deprivation and we observed the same pattern as at the municipality level (these analyses are not shown).

Although the correlation between DI and HDI was high; only the HDI was significant to identify differences in the prevalence of diabetes. Both indices include measures of education and income. However, the DI seems more an indicator of urbanisation and modernisation since it additionally includes indicators of the availability of public services, overcrowding and locality size. In contrast, the HDI additionally includes the “survival probability during the first year after birth”, which is mainly related to infections and malnutrition (SINAIS, 2010). Therefore, the Human Development Index can be seen as an indicator of the prevalence of infectious diseases and obesity for two reasons. Firstly, neonatal and post-neonatal mortality are associated with low birth weight (Osorno-Covarrubias et al., 2002). One of the causes of low birth weight is undernutrition in the mothers (Kuh et al., 2004), or low maternal weight (Torres-Arreola et al., 2005). Thus, women living in municipalities with a lower human development index may be less likely to be obese, and hence, at lower risk of having diabetes. And secondly, infections are also associated with the survival probability during the first year after birth. A study showed that a decrease in the post-neonatal mortality rates in Mexico have partly been due to a reduction in infections (Vandale et al., 1997).

Consequently, the Human Development Index may reveal the nutritional and epidemiological profile of the municipalities. Hence, municipalities with a low Human Development Index may reflect a population with low risk of diabetes and high risk of malnutrition and infection. However, after inclusion of individual characteristics, risk and environmental factors; the municipality deprivation explained a very small amount of the variation in having diabetes between municipalities. This implies that there are other characteristics of the municipalities that contribute to the prevalence of diabetes.

The positive association between diabetes and the municipality Human Development Index can also be explained by the close association between urbanisation and the municipality SES. As we mention below, the prevalence of diabetes increases with urbanisation. In our study, all of the urban areas had a medium_high-high HDI which did not permit a differentiation between rich and poor areas within the urban stratum.

Urbanisation

We hypothesized that there was a positive association between urbanisation and diabetes. Urban-rural stratum was not associated with diabetes in fully adjusted models. However, there was a positive association between diabetes and living in a remote area. The difference between these variables is the cut-off point of the population: 15,000 inhabitants for the first; and 2,500 inhabitants for the latter. Thus, we encountered a problem of multicollinearity when we controlled for both variables concurrently.

Other studies in developing countries have also shown an increased risk of diabetes by urbanisation (AbuSayeed et al., 1997; Al-Moosa et al., 2006; Herman et al., 1995). Moreover, a higher prevalence of diabetes in urban areas has been previously documented in the Mexican population (Olaiz-Fernandez et al., 2007); however, they used a cut-off point of 15,000 inhabitants. Because we built a model at the national level, and then used the same variables in the stratified analyses; we did not identify whether any of the variables that were not included were significant in the analyses by stratum and sex.

In Mexico, urbanisation has been accompanied by changes in diet and physical activity. In urban areas diets are high in daily total energy; refined carbohydrates; animal products; sugars; low in fibre; and high in saturates (Barquera et al., 2003a). Thus, obesity, a risk factor of diabetes, is more prevalent in urban than in rural areas (Gomez et al., 2009). In addition, diet composition and physical activity may change when migrating from rural to urban areas (Gonzalez-Barranco et al., 2001). Migration from rural to urban areas has increased in 352% from 1980 to 2002 (INEGI, 2010). Since it is expected that Mexico has a high urban population growth rate, rises in the prevalence of obesity and chronic diseases may be expected as well (Lopez et al., 2001).

<u>Diabetes and SES (education and household SES) by municipality SES and urbanisation</u>

We expected to find a negative relationship between diabetes and SES in urban areas and in municipalities with lower deprivation; and a positive relationship in rural areas and municipalities with higher deprivation. However, most of the associations by stratum mirrored those at the national level independently of the level of urbanisation and municipality SES: a negative association with education; and an inverse u-shaped association with household wealth.

The negative association between diabetes and education was significant in all stratified analyses, except in the most deprived municipalities (using both measures of deprivation). Household wealth had an inverse u-shaped association with diabetes except among the most disadvantaged municipalities, where the association seemed positive (although it was not significant in municipalities with low HDI). The positive association between diabetes and SES among the most deprived municipalities is close to influences of household SES on obesity and Coronary Heart Disease factors in Mexico (Fernald, 2007; Fernald et al., 2008).

Different directions in the association between diabetes and SES, and the lack of significance between diabetes and SES in less urbanised areas is consistent with studies in developing countries (Ramachandran et al., 2008; Reddy et al., 2007; Xu et al., 2006); and within Mexico. A study restricted to a poor urban area in Mexico found no association between diabetes and education and household SES (Avila-Curiel et al., 2007). The household socioeconomic level was measured as an index integrated by household characteristics, overcrowding, income and expenditure.

The interaction between education and household wealth was only significant in the rural setting and in the medium high HDI. While among adults with the highest wealth, there was a negative association between diabetes and education; among the lowest two household wealth groups, there was a positive association between diabetes and education. So far, we did not find other studies who reported this kind of interaction. However, one study of blood pressure in poor rural areas of Mexico found an interaction between education and household income per capita (Fernald et al., 2008). It showed that there were no differences by education among women with lower income; but at higher levels of income, women without formal education were at higher risk of hypertension than women with secondary school or higher education.

This supports that, when families are exposed to more westernized lifestyles, family resources are more important in determining changes in habits (such as diet, (McLaren, 2007)), that lead gradually to obesity and diabetes. Then, among the more affluent families, the better educated acquire healthier behaviours more rapidly, hence, preventing the onset of diabetes; and translating the burden of diabetes rapidly from the higher to the lower educational groups, and more slowly from the higher to the lower income groups. Gradually, the prevalence of obesity and diabetes becomes higher among the lower socioeconomic groups. This may explain the majority of negative associations seen between diabetes and SES among developed countries (which are at an advanced stage of the nutritional and epidemiological transition).

Most of the households in the categories 1 and 2/3 of wealth (between 63% and 76%) were located in remote areas (localities with population below 2,500 inhabitants). Previous studies have shown that education and diabetes have a positive association in the poorest rural areas (Fernald et al., 2007). In this context, the higher prevalence of diabetes among the highest education groups (within the lowest wealth households) may be explained by changes in lifestyle derived from possibly working or studying in the cities. On one hand, a higher prevalence of diabetes in an indigenous group was partly explained because of changes in diet derived from migration to the cities to work (Alvarado-Osuna et al., 2001). On the other, adolescents may need to move to bigger localities to study high school. Besides, of the adults in the lowest wealth category (in the rural area), very few adults had an education of high school or above (about 2%).

Undiagnosed diabetes and SES

We hypothesized that adults in the lowest SES groups or living in rural areas are more likely to have undiagnosed diabetes compared with adults in higher SES groups or living in urban areas. There were only two SES measures associated with undiagnosed diabetes: household wealth and the Deprivation Index.

There was a negative u-shaped association between household wealth and undiagnosed diabetes. However, this was only significant in the full sample, in urban areas and in women. In urban areas, adults in the lowest category of household wealth may have a low prevalence of diabetes because, with a low budget, they may only have the resources to access basic foods. In addition, they may have jobs that involve more physical activity. In contrast, adults in the categories 2 and 3 of household wealth may have more resources to access mediators of risk, but they may also be uninsured (78.7%

of the adults in categories 2 and 3 were uninsured). Although it has been suggested that access to health care is not effective on the prevention of diabetes (Robbins et al., 2001); diabetes could be diagnosed while using preventive services, curative services, and hospitalization. Therefore, an early detection of diabetes depends on access and quality of health care. However, only a small percentage of people with a health problem seek professional or traditional medical attention, particularly those with lower education and income (Valdespino et al., 2003).

We confirmed a higher prevalence of undiagnosed diabetes among adults living in the most deprived municipalities. The significant association in rural areas may indicate that people living in the most deprived municipalities in rural areas may be less likely to use these services because they may be more likely to be uninsured and live farther from health care facilities. A study showed that uninsured adults were less likely to use preventive screening for diabetes (Pagan et al., 2007). Moreover, the NHS-2000 reported that the use of preventive and curative services was lower in localities with less than 15,000 inhabitants (Valdespino et al., 2003). In addition, lower rates of hospitalization have been associated with being uninsured, living in rural areas, illiteracy, and low income.

The lack of association between education and undiagnosed diabetes is consistent with findings from our literature review in developed countries and in Mexico. Only one study in Mexico described an association between the prevalence of undiagnosed diabetes and education (Vazquez-Martinez et al., 2006). However, the association was not further adjusted for risk factors.

Comparison with the theoretical framework

As proposed in the theoretical framework, genetic, biological and lifestyle factors were associated with diabetes. In the model of the prevalence of diabetes, the largest likelihood ratio decrease was observed when the model was adjusted for obesity. This confirms that obesity is one of the most important risk factors for diabetes. Of the two measures of obesity, waist circumference was more strongly associated with diabetes than BMI. Sex was associated with diabetes only when it interacted with abdominal obesity.

Belonging to an indigenous group was associated with a lower prevalence of diabetes in the base model. However, this association disappeared after controlling for household wealth. This was due to the strong association between household wealth and spoken language. A low prevalence of diabetes among indigenous groups has been reported in previous studies (Castro-Sanchez et al., 1997; GuerreroRomero et al., 1997). Indigenous populations keep a more traditional diet and lifestyle (Alvarado-Osuna et al., 2001; Cerqueira et al., 1979; Ravussin et al., 1994) that protects them from developing diabetes.

Among psychosocial factors, only marital status was associated with diabetes. The divorced, separated or widowed had a higher risk of diabetes than the married, even after adjustment for age. We found that having no access to public and/or private health services was associated with a lower prevalence of diabetes. This may be attributable to that the uninsured population tend to have SES characteristics associated with a low prevalence of diabetes such as living in a rural area, low income, and being a farmer (Olaiz et al., 2003).

Because in our data obesity was associated with SES in a similar way as diabetes and SES; it is possible that SES is associated with diabetes through obesity. However, obesity did not explain this association completely. SES was associated with diabetes independently of genetic, biological, lifestyle factors, and other factors.

Strengths and limitations of the study

Our study has several strengths. Firstly, the study was based on a nationally representative sample that provided sufficient cases of diabetes to perform stratified analysis. Secondly, the data included capillary blood samples and risk factors for diabetes. The inclusion of a capillary blood test in the survey was very valuable because about 20% of the population was unaware of having this condition (Olaiz et al., 2003). However, the results were not confirmed by subsequent tests, as suggested by WHO (WHO, 1999). In the absence of test verification, we confirmed that people with abnormal glycaemic levels presented symptoms or risk factors. In addition, it has been suggested that plasma glucose measurements may be better tests to identify diabetes.

However, studies have shown that there is a good correlation (higher than r=0.91) between capillary and plasma glucose measurements (Ramachandran et al., 2008; Ramachandran et al., 2001); and it is recommended for epidemiological studies (WHO, 2002). And thirdly, the analyses were simultaneously adjusted for individual, family and municipality socioeconomic status. The availability of data at different levels allowed us to examine whether the characteristics of the municipalities were related to diabetes independently of individual characteristics and risk factors. Furthermore, the contextual variables and the information to validate the index of household wealth were collected on the same year as the health survey. Although we introduced contextual variables at the municipality level, further studies should be carried out to replicate and extend these analyses at lower area levels such as locality and neighbourhood.

Nevertheless, a series of limitations of this study should be noted. First, it was not possible to assess if there is a causal relationship between diabetes and SES due to the cross-sectional nature of the data. The theoretical framework suggested that SES interacts with other variables during the life-course in the development of diabetes. However, it is possible that SES at early stages of adulthood is more important in the development of diabetes than childhood and adolescence SES (Agardh et al., 2007; Andersen et al., 2008). On the other hand, diabetes may lead to a lower socioeconomic status by affecting the employment and income of adults with diabetes. The association between diabetes and SES needs to be further investigated in longitudinal studies.

Second, random misclassification may have occurred in the study. Although some considerations were taken into account to distinguish between type 1 and type 2 diabetes; it is possible that the study included some adults with type 1 diabetes. However, this may not affect the results since other studies have reported that there is little or no relationship between type 1 diabetes and SES (Connolly et al., 2000; Ismail et al., 1999). In addition, it is estimated that only a small percentage of people with diabetes have type 1 (ADA, 2004).

Third, a random error could have occurred in the estimates of the models for the low deprivation strata. However, the analyses were repeated after excluding the categories with small sample sizes which resulted in similar results. Fourth, recall bias may have occurred in the ENIGH-2000 when people were asked about their incomes and expenditures; and in the NHS-2000 when people were asked about their education and income. However, it is possible that there is less recall bias about household wealth, since the characteristics of the household could be corroborated by direct observation of the interviewer. And fifth, there was response bias since women were overrepresented in the sample. Because no weights were used in the calculation of prevalences, they should be taken with caution. However, response bias may not affect the probabilities of having diabetes (Jagers, 1986).

Conclusion

In this chapter we have confirmed that there are important socioeconomic gradients in diabetes. The direction of the association between SES and diabetes agrees with that of economies in health transition. Studies from developed countries have shown that the higher prevalence of diabetes shifts gradually towards the most disadvantaged populations. Knowledge of SES differentials in diabetes should be taken into account to monitor these shifts and to design health policies to protect the most vulnerable.

6 RELATIONSHIP BETWEEN SOCIOECONOMIC STATUS AND DIABETES IN THE MXFLS-2002 AND MXFLS-2005

6.1 Introduction

This chapter explores three topics. Firstly, it examines the association between socioeconomic status (SES) and the incidence of diagnosed diabetes. Incidence refers to the number of newly diagnosed cases during a specific time period, in this study we refer to the period 2002-2005. Secondly, it explores the effects of diabetes on working status and employment status. And thirdly, it explores the association between diabetes and waist circumference change. The research questions to be dealt with are:

1. Is there a relationship between the incidence of diabetes and SES? If so, what is the nature of this relationship? Does the relationship between the incidence of diabetes and SES vary by urban/rural areas, level of municipality deprivation and sex?
2. What is the relationship between diabetes and employment status?
3. Is there a relationship between diabetes and waist circumference change? If so, is change in waist circumference related to SES?

The chapter begins with an introduction to the data and statistical methods used, and how the variables were defined. Section 6.3 examines the association between SES and the incidence of diagnosed diabetes. Section 6.4 explores the association between diabetes and employment status. Section 6.5 explores the relationship between diabetes and waist circumference change. Last of all, section 6.6 provides the discussion and conclusions of the chapter.

6.2 Data source, definition of variables and statistical analysis

The analyses are based on the Mexican Family Life Surveys 2002 and 2005 (MxFLS-2002 and MxFLS-2005). In both years self-reported diabetes was identified through the question: have you ever been diagnosed with diabetes? Of the 35,677 participants in 2002 only 18,529 were in the 20-69 age range (51.9%). The distribution of adults by diabetes status and tracking status in 2002 and 2005 is presented in Table 6.1. As the table shows, 85.5% of the 18,529 adults who were 20-69 years in 2002 were successfully tracked. However, a high percentage did not report their diabetes status (14.5%). About 13.2% were not tracked and 1.3% died by 2005.

The table also shows that 4.7% of the adults reported to have diabetes in 2002, while the corresponding percentage in 2005 was 6.2%. Hence, newly reported diabetes was 1.5% and about 23% of those who self-reported diabetes in 2002 did not report it in 2005. Of those free of diabetes in 2002 and who reported their diabetes status in both years, 294 adults were diagnosed by 2005. Hence, the incidence of self-reported diabetes between 2002 and 2005 was 2.9%.

Table 6.1 Distribution of adults aged 20-69 in 2002 by diabetes status and tracking status in 2005

	Tracking status in 2005					Total	
	Diabetes in 2005 (tracked)			Died	Not tracked		
	No	Yes	Missing				
Diabetes in 2002							
No	9,787	294	1,256	137	1,488	12,962	70.0%
Yes	201	500	71	34	62	868	4.7%
Missing	2,568	194	966	73	898	4,699	25.3%
Total	12,554	988	2,293	244	2,448	18,529	100.0%

Note: number of adults, unless stated otherwise

The variable “Diabetes status in 2002-2005” was generated from table 6.1. This variable was used for the analyses in the sections of employment status and weight change. The categories of this variable were: “no-no” for adults who reported not having diabetes in 2002 and 2005; “no-yes” for adults who reported not having diabetes in 2002, but then they reported having diabetes in 2005; “yes-no” for adults who reported having diabetes in 2002, but then they reported not having diabetes in 2005; and “yes-yes” for adults who reported having diabetes in both years.

Age, sex, family history of diabetes (FHD), and ethnicity were considered as genetic and biological factors. They were classified as in chapter 5 except for ethnicity. In the questionnaire of the MXFLS-2002, ethnicity was identified through the question: Do you recognize yourself as part of an indigenous ethnic group? Ethnicity was classified as non indigenous or indigenous.

As in the previous chapter, obesity was considered as an indicator of lifestyle. The Body Mass Index (BMI), waist circumference (WC) and waist-to-hip ratio (WHR) were considered as proxies to obesity. The first two variables were classified as previously. A WHR cut-off point of 0.85 for women and 0.95 for men were used to define obesity.

Education, occupation, working status, and employment status were used as indicators of individual socioeconomic status. Education and occupation were categorized as in chapter 5. Adults who “work” were defined as: adults whose main activity during the previous week to the survey was to work or carry out an activity that helped household expenditures; adults who during the previous week to the survey, worked or developed any activity that helped the household expenditure for at least one hour; adults who worked in a family business (agricultural or non agricultural) either being paid or not, during the previous week to the survey; and adults that had a job or developed any activity that helped the household expenditure, but didn't attend it the previous week to the survey. Employed adults were defined as those who “work” but excluding adults whose main activity during the previous week to the survey was to be student, home maker, or retired. Unemployed adults were defined as those who were looking for a job during the previous week to the survey.

Household income and household wealth were considered as SES measures at this level. Income was identified through the question: In the last 12 months approximately, how much did you earn or receive from this job, or activity, to help household expenditure? Household income was calculated as the sum of the individual monthly incomes within each household and divided over the number of members of the household. A household wealth index was calculated by principal components analysis based on most of the variables of the regression model of chapter four: type of fuel for cooking, have a toilet, own a phone, own a car, overcrowding, type of floors, own a fridge, and own a VCR. Toilet was used instead of boiler since this variable was not available. The first Eigen value accounted for 37.8% of the variance. Household income and the index were divided in quintiles.

The Deprivation Index and the Human Development Index were considered as measures of SES at the municipality level. In addition, marital status, kinship, health care access, living in an urban or rural stratum, and living in a remote area were used as potential mediators of the relationship between SES and diabetes. All these variables were categorized as in the previous chapter.

The Pearson chi-squared test was used to compare categorical data. Multiple logistic regressions with step-wise addition were used to identify the covariates independently associated with the incidence of diabetes, working status, employment status and increase/decrease in waist circumference (section 3.4.1). The variables were introduced in the models using the stepwise procedure and by stages (as in the previous chapter). The likelihood-ratio test (LR) was used to assess the significance for addition or removal of the variables with a significance level of 0.05. Statistical analyses were conducted using STATA 10.0 for windows (STATA Corporation College Station, TX, USA).

For the incidence of diabetes, firstly, a base model was estimated adjusted for genetic, biological and lifestyle factors. Secondly, unadjusted and adjusted odds ratios were estimated for each of the socioeconomic variables (adjusted by the variables in the base models). And thirdly, two-level random intercepts logistic models were estimated separately by stratum and sex. As in the previous chapter, the control variables were divided in four groups: genetic and biological factors, lifestyle characteristics, social and economic factors, and potential mediators. These models were re-estimated with all the variables that were significant in the separate models.

6.3 Incidence of diagnosed diabetes

Of the 18,529 adults that participated in the 2002 survey, we excluded those who reported having diabetes (n=868, 4.7%) or whose diabetes status was unknown (n=4,699, 25.3%). We also excluded adults who died by 2005 (n=137), who were not tracked in 2005 (n=1,488), and who had missing data on their diabetes status in 2005 (n=1,256). The final sample included 10,081 adults aged 20-69 that were free of diagnosed diabetes in 2002 and who reported their diabetes status in 2005 (Table 6.1). Among adults who were free of diabetes in 2002, excluded adults were younger, were more likely to be men, to be single, to not belong to an indigenous group, and to not have obesity (data not shown). In addition, the excluded had higher levels of education and income, and lived in urban strata and less deprived areas.

Table 8.17 in appendix E summarizes the characteristics of the adults included in the study of the incidence of diabetes. Adults with lower levels of education and income were more likely to reside in rural areas than in urban areas. Adults living in the urban area were more likely to have a family history of diabetes and higher BMI than adults living in the rural area. However, adults living in the rural area presented a higher frequency of abdominal obesity and waist-to-hip ratio. Women were more likely to present obesity and a family history of diabetes than men. In addition, they were more likely to be in the lowest categories of household income.

Table 6.2 describes the characteristics of the adults who were diagnosed with diabetes between 2002 and 2005. In the full sample and both strata, a higher incidence of diabetes was observed among the highest age groups and among adults with obesity (whether using BMI, WC or WHR). Moreover, the incidence of diabetes was higher among those whose mother had diabetes. Only in the rural stratum, women had a higher incidence of self-reported diabetes than men.

Table 6.2 also shows that the incidence of diabetes increased with decreasing education levels. In the full sample and in the urban strata, the incidence of diabetes was higher among the retired, home makers and the self employed/boss. Only in the urban area, the incidence of diabetes was higher among adults living in municipalities with a higher Deprivation Index. The incidence of diabetes was higher among the divorced, separated or widowed. Household heads or their spouses also showed a high incidence of diabetes.

There was no association between the incidence of diabetes and ethnicity, household income, household wealth, the Human Development Index, health care access, living in a remote area, and stratum.

Table 6.2 Characteristics of adults diagnosed with diabetes between 2002 and 2005 by stratum

	Urban		Rural		Total	
	Cases	% (Total)	Cases	% (Total)	Cases	% (Total)
	135	3.3 (4,114)	159	2.7 (5,967)	294	2.9 (10,081)
Age group		p<0.001		p<0.001		p<0.001
20-29	12	1.0 (1,227)	11	0.7 (1,544)	23	0.8 (2,771)
30-39	20	1.7 (1,187)	28	1.7 (1,646)	48	1.7 (2,833)
40-49	46	5.3 (872)	52	4.1 (1,275)	98	4.6 (2,147)
50-59	33	6.4 (516)	40	4.6 (865)	73	5.3 (1,381)
60-69	24	7.7 (312)	28	4.4 (637)	52	5.5 (949)
Family history of diabetes		p=0.003		p<0.001		p<0.001
None	31	2.7 (1,172)	50	2.9 (1,705)	81	2.8 (2,877)
Only father	6	2.3 (259)	8	3.6 (220)	14	2.9 (479)
Only mother	26	6.5 (398)	24	5.8 (413)	50	6.2 (811)
Both parents	3	4.1 (74)	1	1.9 (53)	4	3.2 (127)
Not known/ missing	69	3.1 (2,211)	76	2.1 (3,576)	145	2.5 (5,787)
Sex		p=0.755		p=0.026		p=0.143
Men	55	3.4 (1,623)	52	2.1 (2,462)	107	2.6 (4,085)
Women	80	3.2 (2,491)	107	3.1 (3,505)	187	3.1 (5,996)
Ethnicity		p=0.292		p=0.375		p=0.224
Non indigenous	121	3.2 (3,789)	133	2.8 (4,743)	254	3.0 (8,532)
Indigenous	10	3.8 (265)	26	2.2 (1,211)	36	2.4 (1,476)
Missing	4	6.7 (60)	0	0 (13)	4	5.5 (73)
BMI		p<0.001		p<0.001		p<0.001
Normal	13	1.3 (1,041)	18	1.0 (1,757)	31	1.1 (2,798)
Overweight	25	1.7 (1,453)	48	2.3 (2,079)	73	2.1 (3,532)
Obese	74	7.2 (1,027)	81	5.5 (1,483)	155	6.2 (2,510)
Missing	23	3.9 (593)	12	1.9 (648)	35	2.8 (1,241)
Waist circumference		p<0.001		p<0.001		p<0.001
Normal	48	1.9 (2,590)	63	1.7 (3,794)	111	1.7 (6,384)
Abdominal obesity	63	7.1 (884)	81	5.7 (1,431)	144	6.2 (2,315)
Missing	24	3.8 (640)	15	2.0 (742)	39	2.8 (1,382)
Waist-to-hip ratio		p<0.001		p<0.001		p<0.001
Normal	45	1.9 (2,392)	42	1.4 (3,023)	87	1.6 (5,415)
Obesity	65	6.1 (1,072)	102	4.7 (2,193)	167	5.1 (3,265)
Missing	25	3.9 (650)	15	2.0 (751)	40	2.9 (1,401)

Table 6.2 Characteristics of adults diagnosed with diabetes between 2002 and 2005 by stratum (cont.)

	Urban		Rural		Total	
	Cases	% (Total)	Cases	% (Total)	Cases	% (Total)
	135	3.3 (4,114)	159	2.7 (5,967)	294	2.9 (10,081)
Education		p<0.001		p=0.032		p<0.001
None/preschool	15	6.5 (230)	32	3.8 (842)	47	4.4 (1,072)
Incomplete primary	34	6.0 (568)	60	3.1 (1,954)	94	3.7 (2,522)
Complete primary	41	4.3 (956)	40	2.6 (1,534)	81	3.3 (2,490)
Secondary	27	2.7 (1,013)	16	1.6 (988)	43	2.2 (2,001)
High school or above	18	1.3 (1,342)	11	1.8 (629)	29	1.5 (1,971)
Missing	0	0.0 (5)	0	0.0 (20)	0	0.0 (25)
Occupation		p=0.028		p=0.134		p=0.012
Employee	43	2.5 (1,750)	21	1.7 (1,268)	64	2.1 (3,018)
Agricultural worker	3	7.7 (39)	24	2.3 (1,058)	27	2.5 (1,097)
Self employed/boss	27	4.1 (664)	25	3.4 (738)	52	3.7 (1,402)
Non-remunerated	2	2.3 (89)	5	2.6 (196)	7	2.5 (285)
Home maker	48	3.9 (1,241)	71	3.0 (2,357)	119	3.3 (3 ,598)
Retired	5	8.2 (61)	2	3.2 (63)	7	5.7 (124)
Other	7	2.6 (270)	11	3.8 (287)	18	3.2 (557)
Household Income*		p=0.452		p=0.569		p=0.627
1 (lowest SES)	10	3.6 (281)	37	2.7 (1,375)	47	2.8 (1,656)
2	21	3.9 (546)	27	2.1 (1,301)	48	2.6 (1,847)
3	15	2.1 (709)	27	2.9 (918)	42	2.6 (1,627)
4	34	3.5 (972)	23	3.5 (664)	57	3.5 (1,636)
5 (highest SES)	33	3.1 (1,053)	11	2.4 (469)	44	2.9 (1,522)
Missing	22	4.0 (553)	34	2.7 (1,240)	56	3.1 (1,793)
Household wealth*		p=0.378		p=0.570		p=0.396
1 (lowest SES)	10	5.5 (183)	45	2.2 (2,038)	55	2.5 (2,221)
2	10	2.2 (446)	42	2.8 (1,480)	52	2.7 (1,926)
3	24	2.9 (820)	27	2.5 (1,069)	51	2.7 (1,889)
4	43	3.6 (1,182)	28	3.2 (870)	71	3.5 (2,052)
5 (highest SES)	47	3.3 (1,433)	15	3.3 (458)	62	3.3 (1,891)
Missing	1	2.0 (50)	2	3.9 (52)	3	2.9 (102)
Deprivation Index		p=0.002		p=0.236		p=0.092
Very low	103	3.3 (3,143)	30	3.3 (905)	133	3.3 (4,048)
Low	12	1.8 (658)	46	2.5 (1,813)	58	2.4 (2,471)
Medium	16	6.1 (263)	47	2.7 (1,765)	63	3.1 (2,028)
High	4	8.0 (50)	21	1.9 (1,082)	25	2.2 (1,132)
Very high	-	-	15	3.7 (402)	15	3.7 (402)
HDI		p=0.807		p=0.069		p=0.115
Medium low	-	-	22	3.1 (722)	22	3.1 (722)
Medium high	43	3.4 (1,271)	101	2.4 (4,253)	144	2.6 (5,524)
High	92	3.2 (2,843)	36	3.6 (992)	128	3.3 (3,835)

*Quintiles

Table 6.2 Characteristics of adults diagnosed with diabetes between 2002 and 2005 by stratum (cont.)

	Urban		Rural		Total	
	Cases	% (Total)	Cases	% (Total)	Cases	% (Total)
	135	3.3 (4,114)	159	2.7 (5,967)	294	2.9 (10,081)
Marital status		p=0.012		p=0.001		p<0.001
Married/Cohabiting	105	3.6 (2,946)	136	3.0 (4,584)	241	3.2 (7,530)
Single	12	1.5 (788)	9	0.9 (962)	21	1.2 (1,750)
Divorced/Separated/Widowed	18	4.8 (379)	14	11.2 (421)	32	4.0 (800)
Not known/no answer	0	0.0 (1)	0	0.0 (0)	0	0.0 (1)
Kinship		p=0.006		p<0.001		p<0.001
Household head	66	4.2 (1,591)	64	2.7 (2,337)	130	3.3 (3,928)
Spouse	51	3.3 (1,548)	77	3.5 (2,220)	128	3.4 (3,768)
Other	18	1.9 (975)	18	1.3 (1,410)	36	1.5 (2,385)
Health care access		p=0.377		p=0.442		p=0.136
Public	82	3.6 (2,304)	55	3.1 (1,761)	137	3.4 (4,065)
Private or both	2	2.3 (87)	0	0.0 (9)	2	2.1 (96)
None/other	49	2.9 (1,696)	104	2.5 (4,178)	153	2.6 (5,874)
Missing	2	7.4 (27)	0	0.0 (19)	2	4.4 (46)
Live in a remote area				p=0.370		p=0.367
Non remote area	-	-	27	2.3 (1,180)	162	3.1 (5,294)
Remote	-	-	132	2.8 (4,787)	132	2.8 (4,787)
Stratum						p=0.070
Urban	-	-	-	-	135	3.3 (4,114)
Rural	-	-	-	-	159	2.7 (5,967)

Table 6.3 shows that, for both sexes, the incidence of diabetes was higher among the highest age groups, among adults with obesity, and among those whose mother had diabetes (as in the analyses for the full sample and by stratum). An increased incidence of diabetes was observed among the less educated. However, this association was borderline significant in men. Only among men, the incidence of diabetes was higher among the self employed, the retired, and among adults in the two highest quintiles of household wealth.

The incidence of diabetes was also higher among the married, cohabiting, divorced, widowed or separated; among the household head or their spouse; and among men living in urban areas. There was no association between the incidence of diabetes and household income, municipality SES, ethnicity, health care access and living in a remote area.

Table 6.3 Characteristics of adults diagnosed with diabetes between 2002 and 2005 by sex

	Men		Women	
	Cases	% (Total)	Cases	% (Total)
	107	2.6 (4,085)	187	3.1 (5,996)
Family history of diabetes		p=0.066		p<0.001
None	30	2.7 (1,117)	51	2.9 (1,760)
Only father	4	2.3 (176)	10	3.3 (303)
Only mother	15	5.1 (294)	35	6.8 (517)
Both parents	2	4.4 (46)	2	2.5 (81)
Not known/missing	56	2.3 (2,452)	89	2.7 (3,335)
Age group		p<0.001		p<0.001
20-29	5	0.5 (1,040)	18	1.0 (1,731)
30-39	17	1.6 (1,062)	31	1.8 (1,771)
40-49	40	4.5 (895)	58	4.6 (1,252)
50-59	29	4.6 (634)	44	5.9 (747)
60-69	16	3.5 (454)	36	7.3 (495)
Ethnicity		p=0.059		p=0.911
Non indigenous	95	2.8 (3,435)	159	3.1 (5,097)
Indigenous	10	1.6 (625)	26	3.1 (851)
Not known/ missing	2	8.0 (25)	2	4.2 (48)
BMI		p<0.001		p<0.001
Normal	10	0.9 (1,170)	21	1.3 (1,628)
Overweight	27	1.8 (1,546)	46	2.3 (1,986)
Obese	53	7.0 (760)	102	5.8 (1,750)
Missing	17	2.8 (609)	18	2.9 (632)
Waist circumference		p<0.001		p<0.001
Normal	51	1.7 (2,983)	60	1.8 (3,401)
Abdominal obesity	38	7.8 (487)	106	5.8 (1,828)
Missing	18	2.9 (615)	21	2.7 (767)
Waist-to-hip ratio		p<0.001		p<0.001
Normal	32	1.4 (2,242)	55	1.7 (3,173)
Obesity	57	4.7 (1,222)	110	5.4 (2,043)
Missing	18	2.9 (621)	22	2.8 (780)

Table 6.3 Characteristics of adults diagnosed with diabetes between 2002 and 2005 by sex (cont.)

	Men		Women	
	Cases	% (Total)	Cases	% (Total)
	107	2.6 (4,085)	187	3.1(5,996)
Education		p=0.055		p<0.001
None/preschool	12	3.1 (392)	35	5.2 (680)
Incomplete primary	34	3.2 (1,050)	60	4.1 (1,472)
Complete primary	33	3.4 (973)	48	3.2 (1,517)
Secondary	15	2.1 (730)	28	2.2 (1,271)
High school or above	13	1.4 (924)	16	1.5 (1,047)
Missing	0	0.0 (16)	0	0.0 (9)
Occupation		p=0.014		p=0.105
Employee	38	2.1 (1,822)	26	2.2 (1,196)
Agricultural worker	20	2.0 (983)	7	6.1 (114)
Self employed/boss	27	3.6 (756)	25	3.9 (646)
Non-remunerated work	3	2.9 (104)	4	2.2 (181)
Home maker	0	0.0 (30)	119	3.3 (3,568)
Retired	7	6.4 (110)	0	0.0 (14)
Other	12	4.3 (280)	6	2.2 (277)
Household income quintiles		p=0.514		p=0.772
1 (lowest SES)	18	2.8 (642)	29	2.9 (1,014)
2	12	1.6 (743)	36	3.3 (1,104)
3	17	2.5 (678)	25	2.6 (949)
4	22	3.1 (718)	35	3.8 (918)
5 (highest SES)	18	2.7 (661)	26	3.0 (861)
Missing	20	3.1 (643)	36	3.1 (1,150)
Household wealth quintiles		p=0.041		p=0.998
1 (lowest SES)	16	1.8 (912)	39	3.0 (1,309)
2	15	1.9 (781)	37	3.2 (1,145)
3	17	2.3 (756)	34	3.0 (1,133)
4	32	3.9 (815)	39	3.2 (1,237)
5 (highest SES)	26	3.3 (780)	36	3.2 (1,111)
Missing	1	2.4 (41)	2	3.3 (61)
Deprivation Index		p=0.473		p=0.187
Very low	49	3.1 (1,603)	84	3.4 (2,445)
Low	24	2.3 (1,059)	34	2.4 (1,412)
Medium	19	2.3 (830)	44	3.7 (1,198)
High	9	2.1 (437)	16	2.3 (695)
Very high	6	3.9 (156)	9	3.7 (246)
HDI		p=0.181		p=0.493
Low	0	0.0 (0)	0	0.0 (0)
Medium low	8	3.0 (266)	14	3.1 (456)
Medium high	51	2.2 (2,303)	93	2.9 (3,221)
High	48	3.2 (1,516)	80	3.5 (2,319)

Table 6.3 Characteristics of adults diagnosed with diabetes between 2002 and 2005 by sex (cont.)

	Men		Women	
	Cases	% (Total)	Cases	% (Total)
	107	2.6 (4,085)	187	3.1 (5,996)
Marital status		p=0.050		p<0.001
Married/Cohabiting	94	3.0 (3,158)	147	3.4 (4,372)
Single	9	1.2 (763)	12	1.2 (987)
Divorced/Separated/Widowed	4	2.5 (163)	28	4.4 (637)
Not known/no answer	0	0.0 (1)	0	0.0 (0)
Kinship		p=0.004		p=0.002
Household head	95	3.1 (3,089)	35	4.2 (839)
Spouse	1	3.1 (32)	127	3.4 (3,736)
Other	11	1.1 (964)	25	1.8 (1,421)
Health care access		p=0.258		p=0.522
Public	53	3.2 (1,673)	84	3.5 (2,392)
Private or both	1	2.3 (44)	1	1.9 (52)
None/other	52	2.2 (2,349)	101	2.9 (3,525)
Missing	1	5.3 (19)	1	3.7 (27)
Live in a remote area		p=0.230		p=0.855
Non remote area	61	2.9 (2,095)	101	3.2 (3,199)
Remote	46	2.3 (1,990)	86	3.1 (2,797)
Stratum		p=0.012		p=0.727
Urban	55	3.4 (1,623)	80	3.2 (2,491)
Rural	52	2.1 (2,462)	107	3.1 (3,505)

Due to the small number of incident cases in some variables, some categories were collapsed with others, and some were excluded. Family history of diabetes was collapsed into three categories: none; family history of diabetes; and not known or missing. In the variable ‘occupation’, the category “non-remunerated” was collapsed with “other”. In the variable health care access the category “private or both” was collapsed with “public”. The category not known/no answer/missing was excluded from the variables ethnicity, education, household wealth, marital status and access to health care.

A base model was estimated after adjusting for genetic and biological factors, lifestyle characteristics, and potential mediators (Table 8.18, appendix E). WC and BMI were highly correlated (corr=0.8678, p<0.001); but WC and WHR, and WHR and BMI were not (corr=0.4888, p<0.001 and corr=0.2357, p<0.001 respectively). Only the most significant measure of obesity was included in the model (BMI). This model shows that the incidence of diabetes increased with age, family history of diabetes and obesity. The proposed potential mediators were not associated with the incidence of diabetes.

Table 8.19 presents the unadjusted and adjusted odds ratios for the incidence of diabetes for the socioeconomic status variables (adjusted for the variables in the base model). Unadjusted and adjusted odds ratios show that only education and HDI were associated with the incidence of diabetes. Adults with complete primary and secondary were more likely to be diagnosed with diabetes than adults with high school or above. Additionally, adults living in municipalities with high HDI were more likely to be diagnosed with diabetes than adults living in municipalities with medium high HDI.

Multiple logistic regression models were estimated separately for the full sample, by stratum and sex (data not shown). The models for the full sample and women included three variables: family history of diabetes, age and BMI. These variables decreased the municipality standard deviation from 0.32 to 0.28 in the full sample. In women, there was little variation between municipalities in the model without covariates.

In the urban area the model included five variables: family history of diabetes, age, BMI education, and municipality deprivation. The individual level variables (family history of diabetes, age, BMI and education) decreased the municipality random effects from 0.29 to 0.22. Then, the municipality deprivation explained the rest of the variance. The model was simplified by reducing the number of categories for education and deprivation, and an interaction between these variables was investigated but it was not significant.

In the rural area the model included four variables: family history of diabetes, age, BMI, and HDI. The individual level variables explained the variance at the municipality level. There were three variables included in the final model for men: age, BMI, and stratum. These variables hardly explained the variance at the municipality level (reduction in standard deviation from 0.25 to 0.22).

Table 6.4 presents the odds ratios of the models after including all the variables that were significant in the stratified analyses. HDI was preferred over DI because the latter had few cases in some categories. Across all the models, the incidence of diabetes increased with age, obesity and family history of diabetes. Lower education was associated with higher incidence of diabetes; however, it was not significant in the rural areas and women. Adults living in rural areas were less likely to self-report diabetes than adults living in urban areas. However, this was only significant in men. Adults living in municipalities with a high Human Development Index were more likely to self-report diabetes than adults living in municipalities with a medium Human Development Index. Nonetheless, this was only significant in rural areas. Since there were very few incident cases in the rural area, the analyses were repeated after excluding the category medium-low. The results were similar.

Table 6.4 Odds ratios for the incidence of diabetes for the full sample, by stratum and sex

	Full sample	Urban	Rural	Men	Women
Family history of diabetes					
None	1.00	1.00	1.00	1.00	1.00
Family history of diabetes	1.81***	2.04**	1.71*	1.44	2.05***
Not known/missing	1.14	1.50	0.90	1.15	1.13
Age groups					
20-29	0.25***	0.26***	0.23***	0.14***	0.31***
30-39	0.40***	0.37***	0.43***	0.39**	0.41***
40-49	1.00	1.00	1.00	1.00	1.00
50-59	1.23	1.32	1.21	1.09	1.36
60-69	1.37	1.41	1.33	0.83	1.82**
BMI					
Normal	1.00	1.00	1.00	1.00	1.00
Overweight	1.57*	1.01	2.04*	1.82	1.42
Obese	4.26***	3.70***	4.42***	6.84***	3.16***
Missing	2.22**	2.52*	1.6	3.00**	1.81
Education					
Secondary or less	1.79**	2.29**	1.07	2.13*	1.61
High school or above	1.00	1.00	1.00	1.00	1.00
HDI					
Medium low	1.33	-	1.56	1.78	1.11
Medium high	1.00	1.00	1.00	1.00	1.00
High	1.22	1.03	1.55*	1.18	1.26
Stratum					
Urban	1.00	-	-	1.00	1.00
Rural	0.78			0.54*	1.01
Municipality					
Sd	0.27**	0.22	-	0.20	-

*p<0.05, **p<0.01, ***p<0.001

6.4 Effects of diabetes on employment and working status

Effects of diabetes on working status

As it was mentioned in the previous section, there were 15835 adults whose diabetes status was available in 2002 and 2005. Of them, 50.8% (8039) were working in 2002, 28.9% were home makers; 14.7% did not specify their activity; and the rest were looking for a job, attending school, or they had another activity. Table 6.5 shows the distribution of the 8039 adults who were working in 2002 according to the type of activity that they carried out in 2005. Of the adults that worked in 2002, 69.9% also worked in 2005, 1.6% looked for a job, 11.1% were home makers, the activity of 13.4% adults was missing, and the rest carried out another activity. Thus, the sample for the analysis of diabetes status and working status included 6959 adults: 5623 that worked in 2002 and 2005, and 1336 who worked in 2002 but not in 2005. Adults whose working status was missing were excluded.

Table 6.5 Distribution of adults aged 20-69 by type of activity in 2005

Activity in 2005	Total, n(%)
Worked	5,623(69.9)
Looked for a job	130(1.6)
Attended school	40(0.5)
Home maker	893(11.1)
Retired	118(1.5)
Other	155(1.9)
Missing	1,080(13.4)
Total	8,039(100.0)

Adults who were less likely to work in 2005 were more likely to be at baseline (in 2002): in the extreme categories of age; in the lowest quintiles of household income; women; self-employed, boss, or non-remunerated; divorced, widowed or separated; the spouse of the household head; not to have access to public health care; and to live in municipalities with medium human development and in rural areas (data not shown). Table 6.6 shows the distribution of the adults that were working in 2002 but not in 2005, according to their diabetes status in 2002 and 2005. There was a significant association between diabetes status and working status ($p<0.001$). Adults who reported to have diabetes in any of the years were more likely to not work in 2005 than adults who did not self-report diabetes in any of the years. Among adults with diabetes, the percentage of adults who did not work in 2005 was slightly higher among those recently diagnosed (No-Yes category).

Table 6.6 Distribution of adults by diabetes status 2002-2005 and working status

	Not working in 2005, n (%)	Total n=100%
Diabetes status in 2002-2005		
No-No	1039 (18.4)	5,651
No-Yes	42 (28.0)	150
Yes-No	23 (24.0)	96
Yes-Yes	57 (25.6)	223
Missing	175 (20.9)	839
Total	1,336 (19.2)	6,959

Table 6.7 presents the odds ratios for the probability of not working in 2005. The models in this table were estimated to examine if the association presented in the previous table is independent of other variables. The unadjusted odds ratios (model 1) showed that adults with recently diagnosed diabetes and who reported diabetes in both years were more likely to be not working in 2005 than adults without diabetes. After adjusting for SES, potential mediators and municipality deprivation, only the association between working status and recently diagnosed diabetes was borderline significant (model 2). The final model shows that adults who were diagnosed with diabetes between 2002 and 2005 were 1.52 times more likely to be not working in 2005 than adults without diabetes.

Table 6.7 Odds ratios for the probability of not working in 2005 (method 1)

	Model	
	1	2§
Diabetes status in 2002-2005		
No-no	1.00	1.00
No-Yes	1.73**	1.52*
Yes-No	1.40	1.34
Yes-yes	1.52**	1.13
Missing	1.17	1.27*
Occupation in 2002		
Employee	-	1.00
Agricultural worker	-	1.26
Self employed/boss	-	1.27**
Non-remunerated	-	1.56**

§Odds ratios adjusted for age, sex, education, kinship, health care access, living in a remote area, and Human Development Index. *p<0.05, **p<0.01, ***p<0.001

An additional model was estimated using an interaction between diabetes in 2002 and diabetes in 2005. Table 6.8 presents the odds ratios for this model. The first model shows the unadjusted odds ratios for not working in 2005. Adults who self-reported diabetes in 2005 were significantly more likely to not work in 2005 than adults without diabetes. A similar result was found for adults who self-reported diabetes in 2002; however, the association was not significant. The interaction between diabetes in both years was also not significant. After adjusting for genetic and biological factors, SES, potential mediators, and municipality deprivation the odds ratios were only slightly attenuated (model 2). The final model shows that adults who self-reported diabetes in 2005 were more likely to be not working in 2005 than adults without diabetes.

Table 6.8 Odds ratios for the probability of not working in 2005 (method 2)

	Model	
	1	2
Diabetes status in 2002 and 2005		
No diabetes	1.00	1.00
Diabetes in 2002	1.40	1.32
Diabetes in 2005	1.73**	1.53*
Diabetes in 2002 and 2005	0.63	0.56
Occupation in 2002		
Employee	-	1.00
Agricultural worker	-	1.35*
Self-employed/boss	-	1.33**
Non-remunerated	-	1.58**

Model 1 presents unadjusted odds ratios. Model 2 odds ratios adjusted for age, sex, education, kinship, remote area and municipality deprivation. *p<0.05, **p<0.01, ***p<0.001

A second analysis was carried out to test the separate effects of diabetes in 2002 and diabetes in 2005; as well as the interaction between diabetes in 2002 and SES variables measured at baseline (education, living in a remote area, and municipality deprivation). All analyses were adjusted for the same variables of model 2 in Table 6.8. When the separate effects of diabetes in each year were assessed, no association was found between diabetes and working status. The interaction between diabetes in 2002 and education was not significant. A significant interaction was found between diabetes and the Human Development Index (Figure 6.1), and between diabetes and living in a remote area (Figure 6.2). Among municipalities with medium high and high human development, the probability of not working was higher among people without diabetes. On the contrary, among municipalities with medium low human development, the probability of not working was higher among people who reported diabetes in 2002. Figure 6.2 shows that in non remote areas, adults without diabetes were more likely to not work when compared with adults who reported diabetes in 2002. In remote areas, adults who reported to have diabetes in 2002 were more likely to not work than adults without diabetes.

Figure 6.1 Interaction between diabetes in 2002 and the Human Development Index for the probability of not working in 2005

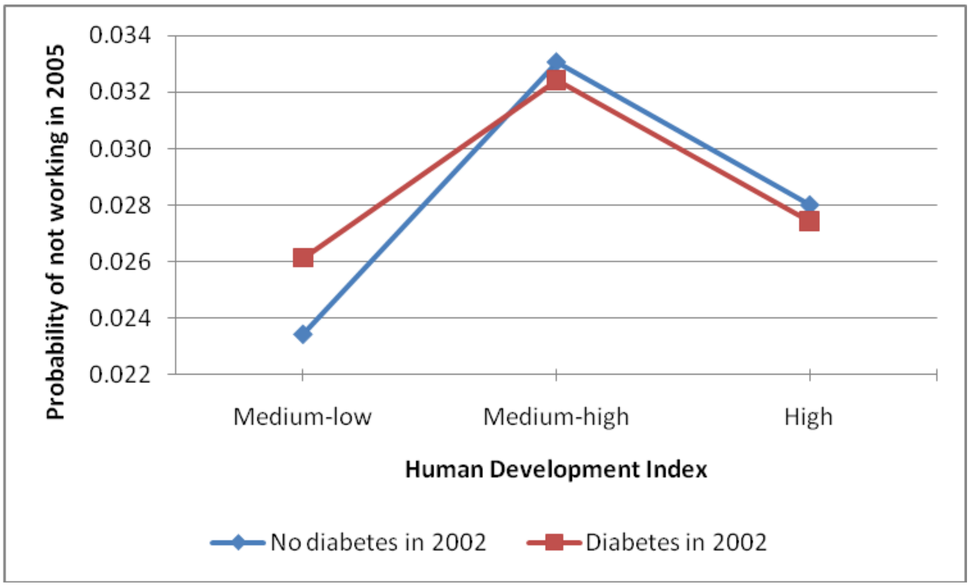
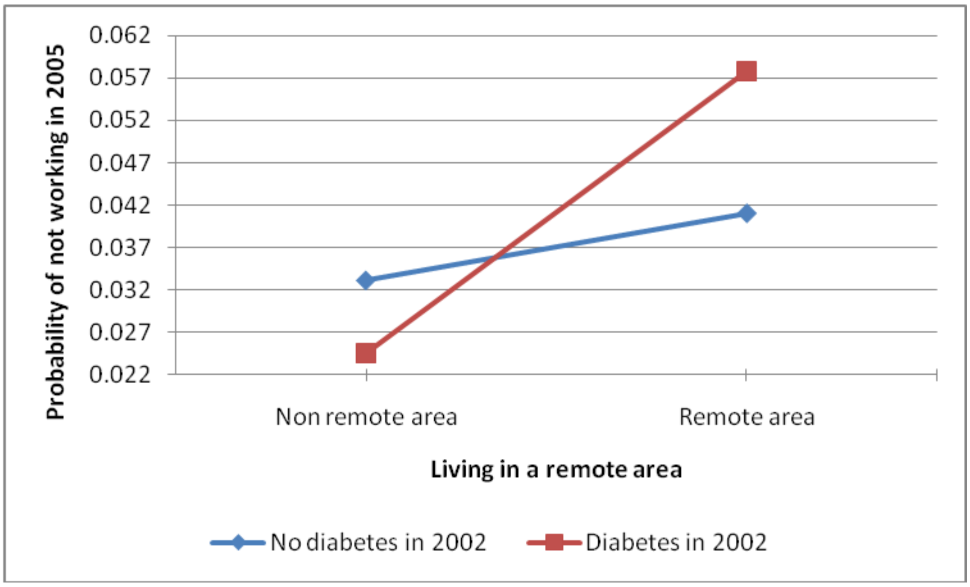


Figure 6.2 Interaction between diabetes in 2002 and living in a remote area for the probability of not working in 2005



We explored the reasons why adults were not working in 2005 and the activities that they were carrying out in 2005 in order to find out if some of them were related to having diabetes. Table 6.9 shows the distribution of the adults that were working in 2002 but not in 2005, according to their type of activity in 2005 and their diabetes status in 2002 and 2005. There was no association between diabetes status and type of activity (p=0.208).

Table 6.9 Distribution of adults that worked in 2002 by diabetes status 2002-2005 and type of activity during the week previous to the 2005 survey

	Diabetes status in 2002-2005 (%)					Total
	No-no	No-Yes	Yes-No	Yes-Yes	Missing	n=100%
Type of activity in 2005						
Looked for a job	82.3	3.1	0.8	0.8	13.1	130
Attended school	77.5	0.0	0.0	5.0	17.5	40
Housemaster/housewife	76.6	2.9	1.9	4.6	14.0	893
Were sick (didn't work)	78.9	3.3	0.0	5.6	12.2	90
Retired	80.5	5.1	2.5	5.1	6.8	118
Didn´t work/Nothing	86.2	6.9	0.0	6.9	0.0	29
Vacations	64.0	4.0	8.0	0.0	24.0	25
Other (specify)	90.9	0.0	0.0	0.0	9.1	11
Total	77.7	3.1	1.7	4.3	13.1	1,336

Table 6.10 shows the distribution of adults who were working in 2002 according to the main reason why they did not go back to work or to develop an activity that helped the household expenditure since the last job reported. Only 465 adults reported the main reason why they did not go back to work. Of the 85 adults that retired between 2002 and 2005, 3 (4%) were diagnosed with diabetes between 2002 and 2005, and 8 (9.4%) had diabetes in 2002. Of the 68 adults that did not go back to work because of a prolonged sickness, 4 (5.9%) were diagnosed with diabetes between 2002 and 2005, and 5 (7.4%) had diabetes in both years. And of the 16 adults that did not go back to work because of incapacity for the rest of their lives, only one adult had diabetes in both years. The reason why the adults did not go back to work was not significantly associated with diabetes status (p=0.965).

Table 6.10 Main reason why adults did not go back to work or to develop an activity that helped the household expenditure since last job

	Diabetes status in 2002-2005 (n)					Total	
	No-no	No-Yes	Yes-No	Yes-Yes	Missing		
Reason							
01. Retired	63	3	1	7	11	85	18.3%
02. Prolonged sickness	54	4	1	5	4	68	14.6%
03. Incapacitated for the rest of your life	13	0	0	1	2	16	3.4%
04. Marriage/concubinage	22	2	0	2	2	28	6.0%
05. Had a child	28	1	1	0	2	32	6.8%
06. Was fired	22	1	0	0	5	28	6.0%
07. Hasn't found a job	48	3	1	1	4	57	12.3%
08. Home maker	35	0	0	1	5	41	8.8%
09. Student	5	0	0	0	0	5	1.1%
10. Changed residence	2	0	0	1	1	4	0.9%
11. Take care of someone	15	1	0	0	0	16	3.4%
12. Because of old age	3	0	0	0	0	3	0.7%
13. Other	67	4	0	2	9	82	17.7%
Total	377	19	4	20	45	465	100.0%

Effects of diabetes on employment status

After excluding adults whose main activity in the week previous to the 2002 survey was student, home maker, or retired; the study of the analysis of diabetes and employment status included 5580 adults: 5453 employed and 127 unemployed. Table 6.11 shows the distribution of adults according to their diabetes status in 2002 and 2005, and their employment status in 2005. There was no association between employments status and diabetes status (p=0.269). Among adults with diabetes, those diagnosed between 2002 and 2005 were more likely to be looking for a job than those who were diagnosed in 2002 (p=0.049). Further analyses were not carried out because the number of people with diabetes that were unemployed was very small.

Table 6.11 Distribution of adults by diabetes status 2002-2005 and employment status

	Employed in 2005, n (%)		Total
	Yes	No	n=100%
Diabetes status in 2002-2005			
No-No	4,483 (97.7)	105 (2.3)	4,588
No-Yes	102 (96.2)	4 (3.8)	106
Yes-No	71 (98.6)	1 (1.4)	72
Yes-Yes	154 (100.0)	0 (0.0)	154
Missing	643 (97.4)	17 (2.6)	660
Total	5,453 (97.7)	127 (2.3)	5,580

6.5 Diabetes and changes in waist circumference

In this section we explored if adults with abdominal obesity in the highest SES groups were more likely to achieve a normal waist circumference after being diagnosed with diabetes than adults with abdominal obesity in the lowest SES groups. We also explored the association between SES and diabetes among adults with normal waist circumference at baseline.

The analysis included adults whose waist circumference was available in 2002 and 2005. Waist circumference was preferred over BMI because it is a better indicator for the risk of diabetes. There were 10,043 transitions for waist circumference (Table 6.12). Of the adults with normal waist circumference in 2002, 21.6% had an increased waist circumference in 2005 (abdominal obesity). Of the adults who had abdominal obesity in 2002, only 14.1% achieved a reduction of waist circumference in 2005.

Table 6.12 Transitions of Waist Circumference 2002-2005 of adults aged 20-69

	WC 2005, n (%)			Total
	Normal	Obesity	Missing	n=100%
WC 2002				
Normal	5,231 (57.5)	1,965 (21.6)	1,907 (20.9)	9,103
Obesity	478 (14.1)	2,369 (69.9)	543 (16.0)	3,390
Missing	1,304 (39.0)	735 (22.0)	1,303 (47.2)	2,758
Total	7,013 (44.3)	5,069 (32.0)	3,753 (23.7)	15,835

Table 6.13 shows the distribution of adults who had normal waist circumference in 2002 and then abdominal obesity in 2005. Adults who reported diabetes in 2005 were more likely to have abdominal obesity in 2005 than adults without diabetes in 2005. Reporting diabetes in 2002 was not associated with abdominal obesity. When diabetes status was analyzed combining both years, adults who reported diabetes in any of the years were more likely to have abdominal obesity than adults without diabetes. However, adults who were recently diagnosed (No-Yes category) were slightly more likely to report abdominal obesity. In addition, adults who had abdominal obesity were less likely to be in the youngest age group, and more likely to be women, non indigenous, and to have low education levels.

Being homemakers, non-remunerated, or retired was associated with having abdominal obesity. In addition, participants who had abdominal obesity were more likely to be in the highest categories of household wealth and the Human Development Index; and to live in municipalities with medium and very low deprivation.

Abdominal obesity was less common among single adults and household heads. Adults with access to public health care were more likely to have abdominal obesity. No association was found between waist circumference change and household income, and urbanisation.

Table 6.13 Characteristics of the adults without abdominal obesity in 2002 that had abdominal obesity in 2005

	Abdominal obesity in 2005, n (%)	Total[1], n=100%
Total	1,965 (27.31)	7,196
Diabetes in 2002	p=0.065	
No	1,607 (27.6)	5,829
Yes	101 (32.4)	312
Missing	257 (24.4)	1,055
Diabetes in 2005	p<0.001	
No	1,766 (27.3)	6,469
Yes	130 (36.0)	361
Missing	69 (18.9)	366
Diabetes status in 2002-2005	p=0.032	
No-No	1,519 (27.8)	5,463
No-Yes	39 (37.9)	103
Yes-No	26 (30.2)	86
Yes-Yes	72 (34.0)	212
Missing	309 (23.2)	1,332
Age groups	p<0.001	
20-29	441 (21.0)	2,100
30-39	564 (28.4)	1,983
40-49	472 (31.6)	1,492
50-59	301 (31.2)	965
60-69	187 (28.5)	656
Sex	p<0.001	
Men	517 (14.9)	3,480
Women	1,448 (39.0)	3,716
Ethnicity	p<0.001	
Non indigenous	1,629 (28.5)	5,720
Indigenous	239 (23.2)	1,032
Missing	97 (21.9)	444

[1]Adults without abdominal obesity in 2002. Percentage across row. Chi-square test p-value compares adults with and without abdominal obesity in 2005 and excludes missing values.

Table 6.13 Characteristics of the adults without abdominal obesity in 2002 that had abdominal obesity in 2005 (cont.)

	Abdominal obesity in 2005, n(%)	Total[1], n=100%
Total	1,965 (27.31)	7,196
Level of education	p<0.001	
None/preschool	205 (28.6)	717
Incomplete primary	504 (29.3)	1,719
Complete primary	516 (29.5)	1,748
Secondary	404 (26.9)	1,504
High school or above	332 (22.3)	1,491
Missing	4 (23.5)	17
Occupation	p<0.001	
Employee	497 (21.9)	2,271
Agricultural worker	117 (14.4)	815
Self employed/boss	257 (26.7)	964
Non-remunerated work	55 (29.1)	189
Home maker	853 (40.7)	2,094
Retired	22 (27.9)	79
Other	164 (20.9)	784
Household income quintiles	p=0.901	
1 (lowest SES)	310 (27.2)	1,137
2	293 (25.6)	1,144
3	281 (27.0)	1,040
4	260 (26.9)	968
5 (highest SES)	242 (27.2)	889
Missing	579 (28.7)	2,018
Household wealth quintiles	p<0.001	
1 (lowest SES)	321 (22.8)	1,404
2	338 (27.1)	1,246
3	334 (28.5)	1,173
4	390 (31.4)	1,244
5 (highest SES)	330 (28.4)	1,161
Missing	14 (31.1)	45

[1]Adults without abdominal obesity in 2002. Percentage across row. Chi-square test p-value compares adults with and without abdominal obesity in 2005 and excludes missing values.

Table 6.13 Characteristics of the adults without abdominal obesity in 2002 that had abdominal obesity in 2005 (cont.)

	Abdominal obesity in 2005, n(%)	Total[1], n=100%
Total	1,965 (27.31)	7,196
Deprivation Index	p<0.001	
Very low	890 (28.4)	3,134
Low	444 (26.9)	1,650
Medium	398 (30.2)	1,319
High	181 (21.5)	843
Very high	52 (20.8)	250
HDI	p=0.002	
Medium low	109 (22.1)	493
Medium high	1,026 (27.3)	3,757
High	830 (28.2)	2,946
Marital status	p<0.001	
Married/Cohabiting	1,520 (28.9)	5,257
Single	268 (19.1)	1,403
Divorced/Separated/Widowed	177 (33.1)	535
Not known/no answer	0 (0.0)	1
Kinship	p<0.001	
Household head	625 (19.9)	3,145
Spouse	941 (42.4)	2,219
Other	399 (21.8)	1,832
Health care access	p=0.044	
Public	814 (29.3)	2,780
Private or both	17 (25.4)	67
None/other	1,028 (26.5)	3,873
Missing	106 (22.3)	476
Live in a remote area	p=0.670	
Non remote area	1,097(27.5)	3,988
Remote	868(27.1)	3,208
Stratum	p=0.371	
Urban	866 (27.9)	3,110
Rural	1,099 (26.9)	4,086

[1]Adults without abdominal obesity in 2002. Percentage across row. Chi-square test p-value compares adults with and without abdominal obesity in 2005 and excludes missing values.

Table 6.14 shows the distribution of adults who had abdominal obesity in 2002 and then had a normal waist circumference in 2005. No association was found between waist circumference change and diabetes status. Among adults with obesity, men and the youngest and oldest age groups were more likely to have a normal waist circumference.

Among all the occupations, only home makers were less likely to have normal waist circumference. Agricultural workers and the retired were more likely to have normal waist circumference. Adults living in municipalities with higher human development and those living in municipalities with low and high Deprivation Index were more likely to have normal waist circumference. Waist circumference decrease was associated with being a household head and living in urban areas.

Waist circumference change was not associated with indigenous background, education, household income or wealth, access to health care and marital status.

Table 6.14 Characteristics of the adults with abdominal obesity in 2002 that had normal waist circumference in 2005

	Normal waist circumference in 2005, n (%)	Total[1], n=100%
Total	478 (16.8)	2,847
Diabetes in 2002	p=0.567	
No	337 (15.9)	2,116
Yes	48 (17.3)	278
Missing	93 (20.5)	453
Diabetes in 2005	p=0.529	
No	390 (16.4)	2,376
Yes	69 (17.7)	390
Missing	19 (23.5)	81
Diabetes status in 2002-2005	p=0.861	
No-No	303 (15.6)	1,939
No-Yes	22 (17.5)	126
Yes-No	13 (18.3)	71
Yes-Yes	33 (16.8)	197
Missing	107 (20.8)	514
Age groups	p=0.024	
20-29	65 (19.5)	334
30-39	109 (15.1)	720
40-49	110 (14.4)	766
50-59	102 (17.6)	580
60-69	92 (20.6)	447
Sex	p<0.001	
Men	195 (31.3)	623
Women	283 (12.7)	2,224
Ethnicity	p=0.507	
Non indigenous	405 (16.6)	2,439
Indigenous	39 (15.0)	260
Missing	34 (23.0)	148

[1]Adults with abdominal obesity in 2002. Percentage across row. Chi-square test p-value compares adults with and without abdominal obesity in 2005 and excludes missing values.

Table 6.14 Characteristics of the adults with abdominal obesity in 2002 that had normal waist circumference in 2005 (cont.)

	Normal waist circumference in 2005, n (%)	Total[1], n=100%
Total	478 (16.8)	2,847
Level of education	p=0.287	
None/preschool	64 (20.7)	310
Incomplete primary	65 (16.7)	390
Complete primary	138 (15.4)	898
Secondary	130 (16.4)	791
High school or above	81 (17.8)	455
Missing	0 (0.0)	3
Occupation	p<0.001	
Employee	100 (19.2)	523
Agricultural worker	41 (25.2)	163
Self employed/boss	79 (19.2)	411
Non-remunerated work	17 (19.1)	89
Home maker	174 (12.7)	1,376
Retired	11 (25.0)	44
Other	56 (23.2)	241
Household income	p=0.574	
1 (lowest SES)	56 (16.6)	338
2	66 (15.1)	438
3	73 (18.9)	386
4	78 (18.6)	420
5 (highest SES)	51 (16.7)	306
Missing	154 (16.1)	959
Household wealth	p=0.880	
1 (lowest SES)	70 (16.4)	428
2	73 (15.7)	464
3	86 (18.0)	477
4	85 (16.0)	533
5 (highest SES)	75 (17.0)	441
Missing	6 (21.4)	28

[1]Adults with abdominal obesity in 2002. Percentage across row. Chi-square test p-value compares adults with and without abdominal obesity in 2005 and excludes missing values.

Table 6.14 Characteristics of the adults with abdominal obesity in 2002 that had normal waist circumference in 2005 (cont.)

	Normal waist circumference in 2005, n (%)	Total[1], n=100%
Total	478 (16.8)	2,847
Deprivation Index	p=0.025	
Very low	216 (16.7)	1,296
Low	122 (17.1)	712
Medium	85 (15.0)	567
High	52 (23.0)	226
Very high	3 (6.5)	46
HDI	p=0.021	
Medium low	6 (6.3)	95
Medium high	267 (17.3)	1,545
High	205 (17.0)	1,207
Marital status	p=0.285	
Married/Cohabiting	378 (16.5)	2,289
Single	49 (20.4)	240
Divorced/Separated/Widowed	51 (16.0)	318
Kinship	p<0.001	
Household head	214 (23.8)	900
Spouse	195 (12.4)	1,572
Other	69 (18.4)	375
Health care access	p=0.425	
Public	195 (15.6)	1,249
Private or both	2 (11.8)	17
None/other	246 (17.3)	1,419
Missing	35 (21.6)	162
Live in a remote area	p=0.001	
Non remote area	289 (19.1)	1,515
Remote	189 (14.2)	1,332
Stratum	p=0.036	
Urban	226 (18.5)	1,223
Rural	252 (15.5)	1,624

[1]Adults with abdominal obesity in 2002. Percentage across row. Chi-square test p-value compares adults with and without abdominal obesity in 2005 and excludes missing values.

Table 6.15 presents unadjusted and adjusted odds ratios for increased and decreased waist circumference among adults with and without diabetes. Among adults without obesity in 2002, only adults with a recent diagnosis of diabetes had increased waist circumference when compared to adults without diabetes. However, this association disappeared after adjustment for other variables. In the fully adjusted model, increased waist circumference was associated with increased age, lower levels of education, and living in the least deprived municipalities. Women were more likely to have increased waist circumference than men. There was a negative u-shaped association between increased waist circumference and household wealth. Single adults and those widowed, divorced or separated were less likely to have increased waist circumference than the married.

Among adults with obesity in 2002, unadjusted and adjusted odds ratios showed no association between decreased waist circumference and diabetes status. Women were less likely than men to have decreased waist circumference. Adults in the extreme categories of age were more likely to have decreased waist circumference than adults aged 40-49 years. Adults living in remote areas were less likely to have decreased waist circumference than adults not living in remote areas. There was a non-linear association between municipality deprivation and waist circumference decrease.

Table 6.15 Odds ratios for the probability of increased/decreased waist circumference

	Increased waist circumference		Decreased waist circumference	
	Unadjusted	Adjusted	Unadjusted	Adjusted
Diabetes status in 2002-2005				
No-no	1.00	1.00	1.00	1.00
No-Yes	1.58**	1.42	1.14	1.13
Yes-No	1.13	0.90	1.21	1.13
Yes-yes	1.34	0.98	1.09	1.11
Missing	0.78***	0.93	1.42**	1.24
Women				
Men	-	1.00	-	1.00
Women	-	4.00***	-	0.32***
Age groups				
20-29	-	0.61***	-	1.60**
30-39	-	0.82*	-	1.14
40-49	-	1.00	-	1.00
50-59	-	1.08	-	1.26
60-69	-	0.97	-	1.46*
Education				
High school or above	-	1.00	-	-
None/preschool	-	1.29	-	-
Incomplete primary	-	1.40**	-	-
Complete primary	-	1.26*	-	-
Secondary	-	1.23*	-	-
Live in a remote area				
Non remote area	-	-	-	1.00
Remote	-	-	-	0.58***
Household wealth				
1 (lowest SES)	-	1.00	-	-
2	-	1.21	-	-
3	-	1.30*	-	-
4	-	1.44***	-	-
5 (highest SES)	-	1.25	-	-
Deprivation Index				
Very low	-	1.00	-	1.00
Low	-	0.88	-	1.38*
Medium	-	1.10	-	1.31
High	-	0.62***	-	2.48***
Very high	-	0.60**	-	0.67
Marital status				
Married/Cohabiting	-	1.00	-	-
Single	-	0.65***	-	-
Divorced/Separated/Widowed	-	0.80*	-	-

*p<0.05, **p<0.01, ***p<0.001

6.6 Discussion

In this chapter we investigated the association between the incidence of diabetes and socioeconomic status. Then, we explored if diabetes had an effect on working and employment status. Finally, we explored if there was an association between diabetes and changes in waist circumference.

Incidence of diabetes

We examined whether socioeconomic status was associated with diabetes incidence; the nature of this relationship; and if this relationship varied by urban-rural stratum, level of municipality deprivation and sex. Only education and the municipality SES were associated with the incidence of diabetes. There was no association between household SES and diabetes incidence.

Lower education was associated with an increased incidence of diabetes. However, this association was only significant in the full sample, in the urban area and in men. A higher incidence of diabetes in the lowest education groups concurs with the higher prevalence of diabetes among lower education groups found in the previous chapter. Moreover, studies in U.S. have found a negative association between education and the incidence of diabetes (Lipton et al., 1993; Resnick et al., 1998; Robbins et al., 2005). Among Mexican Americans and non-Hispanic whites, the San Antonio Heart Study revealed a negative association between education and the incidence of diabetes in men and women combined (Haffner et al., 1991). Nonetheless, because of how diabetes was identified, all these findings examined the incidence of total diabetes (diagnosed and undiagnosed); while we only had self-reported diabetes.

There was a u-shaped association between the incidence of diabetes and the Human Development Index. However, the association between the incidence of diabetes and the HDI was significant only in the rural area. The incidence of diabetes was higher in municipalities with high HDI than in municipalities with medium-high HDI; and there was no difference between municipalities with medium-low and medium-high HDI. Hence, a positive association between HDI and the incidence of diabetes was revealed in rural areas. Men living in rural areas were significantly less likely to be diagnosed with diabetes between 2002 and 2005 than their counterparts living in urban areas. These associations concur with findings from the previous chapter.

In urban areas, the combination of risk factors, education and municipality deprivation explained the variation between municipalities (when separate models were fitted for each strata and sex). The incidence of diabetes was higher among the most deprived municipalities. One explanation is that, because our data relies on self-reports, adults living in the most disadvantaged municipalities may have benefited more from detection campaigns. During the last decade, several health policies and campaigns were launched in Mexico to prevent diabetes (SSA, 2002) or to ensure an early detection of this condition (SSA, 2001b). Another explanation is that the characteristics of the municipalities may be responsible for a further increase in the cases of diabetes. For instance, illiteracy, low levels of education and income, and worse housing conditions are more prevalent in more disadvantaged municipalities since they are indicators included in the Deprivation Index. Hence, in urban areas the Deprivation Index captures some characteristics of the environment that account for the development of diabetes.

There was an increased incidence of diabetes with age, body mass index and family history of diabetes. These results agree with findings from the previous chapter and with the theoretical framework. Analyses stratified by municipality SES were not carried out because of the few cases of incident diabetes.

Working status and employment status

We investigated if adults with diabetes have a lower probability of being employed than adults without diabetes; and if this association was stronger among adults with a longer duration of diabetes. There was an association between working status and diabetes, but not between employment status and diabetes. Adults who reported diabetes in either 2002 or 2005 were more likely to report not working in 2005 than adults without diabetes. However, after adjustment for other variables, only adults who were recently diagnosed or who reported to have diabetes in 2005 were more likely to not work in 2005. Hence, contrary to what we expected, it was adults with a short duration of diabetes who had an increased risk of not working. We speculate that the reason for this is related to the presence of complications among those who reported diabetes in 2005.

Among adults with diabetes, about 20% do not know that they have this condition (Olaiz et al., 2003). Adults may not be aware of having diabetes until they have complications or other related diseases and have the need to use curative or hospitalization services. This may be one of the causes of being diagnosed in our data since it relies on self-reports. Therefore, the presence of complications may not allow adults to continue working, at least during a short period of time.

People with diabetes go through four stages of change after they are diagnosed with this condition (SSA, 2001a). First, patients experience shock and negation. Second, patients resist changing their habits. Third, patients accept the disease and adapt to the changes. And fourth, patients participate and collaborate to manage their condition. After accepting having diabetes and adhering to treatment, a person may be more likely to continue with normal activities, including work. That may be a reason why no difference in the probability of working was found between adults without diabetes and adults with diabetes who were diagnosed for a longer time, before 2002.

An interaction between having diabetes in 2002 and area of residence showed that adults living in less urbanised areas were less likely to work if they had diabetes. Because most of the people living in rural areas are uninsured (Olaiz et al., 2003), they may be less likely to have an early detection of diabetes until they have complications. Then, because the type of work in rural areas may be more physical (agricultural workers for example), the presence of complications may have a more serious impact on their ability to work.

Other studies have shown a relationship between diabetes and employment status (Bastida et al., 2002; Kraut et al., 2001; Tunceli et al., 2005). One study showed that men and women with diabetes were less likely to be working than their counterparts without diabetes (Tunceli et al., 2005). However, the study included mainly older adults and incident cases were excluded. Another study found a lower probability of employment but only among men (Bastida et al., 2002). The study was based on a panel study of Mexican Americans living close to the border. It included adults aged 45 and over; however, the sample was small (n=1021). Another study showed an association between employment status and diabetes, but only when adults who had diabetes complications were compared with adults without diabetes (Kraut et al., 2001). The study was based on a longitudinal study (1983-1990) from Manitoba, Canada that included 26,126 adults in the working ages. Their definition of employment status coincided with ours. Adults not in the labour force were excluded from the study, and unemployed adults were those actively seeking work.

The association between diabetes and employment status was not further investigated because there were few cases of diabetes among the unemployed. The lack of association may be due to the definition of employment status and the short period between the two waves. Since employment status excludes people who are not in the labour force; employed adults may be more likely to have a formal or stable job. On the other hand, working status additionally includes adults whose main activity is student, retired or home maker, who may have a more infrequent job which may be easier to stop in a short term if they had an illness.

Among adults who were working in 2002 but not in 2005, we did not find an association between diabetes and type of activity or reason to stop working. These analyses would have shown if adults with diabetes were more likely to be retired or to stop working because of a severe illness or being disabled possibly due to complications (Kraut et al., 2001).

Change in waist circumference

We investigated the association between diabetes and change in waist circumference. Our initial analyses showed that a diagnosis of diabetes between 2002 and 2005 was associated with waist circumference increase; however, the association disappeared after adjusting for other variables. Waist circumference decrease was not associated with diabetes status either in unadjusted or adjusted analyses. Most of the studies on weight change are based on body mass index, or only on weight (Colditz et al., 1995), and not on abdominal obesity. We found only two studies that examined waist circumference change and incidence of diabetes; however, one study was restricted to older people (Biggs et al., 2010). The second study was based on 22,171 men from the Health Professionals Follow-up Study. It found that men who had an increase of 14.6 cm in waist circumference were 1.7 times more likely to have diabetes than men who had a stable waist (Koh-Banerjee et al., 2004). Our findings showed a similar result only in unadjusted analysis.

Because no relationship between diabetes and waist circumference change was found, no further analyses were carried out to investigate the interaction between diabetes and socioeconomic status. However, socioeconomic status was associated with waist circumference change. The association between socioeconomic status and waist circumference increase was similar to the association between diabetes and SES. Waist circumference increase was negatively associated with education, and positively associated with municipality SES. We observed that the Deprivation Index was slightly more significant than the Human Development Index to identify waist circumference increase. However, both measures showed a higher probability of waist circumference increase among the least deprived municipalities. Moreover, there was a negative u-shaped association between waist circumference increase and household wealth. This supports the idea that the shift in the prevalence of diabetes across socioeconomic groups is associated with the shift in obesity.

Among adults with obesity, only area measures were associated with waist circumference decrease (urbanisation and the Deprivation Index). This suggests that environmental influences should be considered when planning interventions in waist circumference reduction.

Limitations

The study has some limitations. Diabetes was identified by self-reports which present several problems. Firstly, self-reports can be subject to recall bias. For instance, 23% of the adults who self-reported diabetes in 2002 did not report it in 2005. It is possible that adults with complications were more likely to recall their diabetes status than adults without them. On the other hand, adults who were diagnosed only by symptoms, and probably improved after treatment, may had considered themselves as not having currently diabetes. Therefore, severity of disease at present may be important in reporting diabetes status. However, the specific question was: have you ever been diagnosed with diabetes? and not “currently diagnosed” with diabetes. Thus, another explanation for a lower reporting in 2005 is that the question may have been misinterpreted. A study used two separate questions to inquire about the diabetes status of German residents (Helmert et al., 1994). The first question inquired if people had ever had diabetes, and the second question inquired if they currently had diabetes. To these questions, 5.2% men and 4.3% women reported having ever had diabetes, and 3.2% and 2.8% reported to have diabetes at present.

A lower reporting of diabetes in 2005 could also be attributed to the accuracy of the diagnosis in 2002. If the diagnosis was based on a single test it is possible that the test resulted in a high blood glucose level due to other abnormal health conditions. If the diagnosis was based on symptoms which improved over time; then the patient reported not having diabetes on the second interview. For studies of chronic diseases, it would be useful to have information about the severity and duration of the condition in order to assess if the diagnosis was due to early detection and efficiency in screening by health institutions; or if it was due to complications or related diseases.

Secondly, because people living in the most deprived areas were more likely to be undiagnosed, the incidence of diabetes may be underestimated in these areas. Although we could not quantify the total number of cases with diabetes between 2002 and 2005, the study is helpful at determining the socioeconomic factors which the diagnosis of diabetes depended on at this specific period. In addition, it has been suggested that diabetes self-reports have some degree of accuracy (Tang et al., 2003). However, undiagnosed diabetes may be a problem when analyses are restricted to adults with diabetes. For instance, our analyses showed that the ratio of undiagnosed diabetes to total diabetes increases with decreasing household and municipality SES.

Thirdly, because only self-reported diabetes was assessed, it was not possible to distinguish between type 1 and type 2 diabetes. Incident cases of type 1 diabetes could have been identified if the adults used insulin as part of the treatment; however, this information was not available. Thus, because type 1 diabetes is less common among adults, we assumed that all cases had type 2 diabetes. And fourthly, adults that were not successfully tracked in the study of incidence of diabetes were more likely to have higher education and to live in more affluent municipalities. Therefore, the odds ratios for diabetes incidence in the higher SES groups may be underestimated.

The MXFLS data allowed the analysis of the effects of SES on the incidence of diagnosed diabetes, however, the follow-up was very short and only two waves were available at the beginning of the study. Longitudinal data, national-representative, and with a larger number of waves may be necessary to analyze cause-effect associations between diabetes and SES.

Conclusion

We have confirmed an association between the incidence of diabetes and SES. However, because we only have data on previously diagnosed diabetes, the SES variables may have reflected increased screening in vulnerable populations. We also found that diabetes was associated with working status, but not with employment status and change in waist circumference. Studies with longer follow-up and with the inclusion of medical exams for the screening of diabetes are needed to further investigate the factors associated with an increased incidence of diabetes.

7 CONCLUSIONS

This thesis has investigated the association between socioeconomic status and type 2 diabetes among Mexican adults. The study used data from the NHS-2000 and MXFLS-2002 and -2005, and two-level logistic regression models. Auxiliary information was retrieved from the ENIGH-2000 and from official statistics. Firstly, it provides a detailed analysis of the prevalence of diabetes (total, diagnosed and undiagnosed), and the incidence of diagnosed diabetes. In contrast with previous studies, it uses SES measures at the individual, family and municipality levels simultaneously. A particular focus is the measure of the variation at the municipality level and the analysis of how the relationship between diabetes and SES changes across different settings. Secondly, it explores if diabetes is associated with employment status and changes in waist circumference using longitudinal data.

The first section of this chapter discusses the key findings from this study in relation to the specific research questions presented in section 1.2. The discussion of the first question of section 1.2 is divided in two parts: one specific for the prevalence of diabetes; and one specific for the incidence of diabetes. The second section emphasizes the main findings in order to draw policy implications. Finally, the third section describes directions for further research.

7.1 Key findings in relation to specific research questions

Is there a relationship between the prevalence of diabetes and SES? If so, what is the nature of this relationship? Does the relationship between diabetes and SES vary by urban/rural areas, level of municipality deprivation and sex?

This research confirms that there is a relationship between the prevalence of diabetes and SES that is independent of risk factors and other variables associated with health. However, the nature of this relationship varies by SES measure and setting. Generally, the prevalence of diabetes had a negative association with education; a non-linear or positive association with household SES; and a positive association with municipality SES (using the Human Development Index). On the other hand, undiagnosed diabetes had an inverse u-shaped association with household wealth; and a negative association with municipality SES (using the Deprivation Index).

In support of previous studies, lower education was associated with an increased prevalence of diabetes (Vazquez-Martinez et al., 2006). One possible explanation for this is that obesity and adverse psychosocial factors (such as stress and depression) are more common among the lowest SES groups. The more educated may be more likely to engage in healthy behaviours such as a nutritious diet and physical activity. Additionally, they may deal better with stressful and difficult situations, since stress may cause changes in the metabolism. Moreover, it has been proposed that successful students integrate and adapt better to their environments (Cabrera et al., 2006). Consequently, people with higher levels of education may make healthier choices in more urbanised areas; where diets are high in calories and fat, and jobs and leisure activities are more sedentary. Therefore, education may be related to diabetes through obesity and other factors, mainly psychosocial.

However, the association between the prevalence of diabetes and education was not significant among the most deprived municipalities. As our analyses showed, both the prevalence of diabetes and the level of education tend to be lower in the most deprived municipalities than in the better-off municipalities. In addition, the most deprived municipalities were also rural areas. Contrary to urban areas, populations in rural areas are characterized for keeping a more traditional lifestyle which protects them from developing risk factors for CHD and diabetes. In an environment where mediators of risk are hardly available and healthy behaviours prevail, the level education may make little difference in making healthy choices. Hence, it is possible that education is the most important SES measure for diabetes only in more urbanised and industrialized areas.

The association between household wealth and diabetes tended to be positive or negative u-shaped. Although the association between household income and diabetes was similar to that of household wealth, only the latter was kept because it had a greater significance in the models. The majority of households in the first category of household wealth were located in the rural area. This may explain the low prevalence of diabetes among the lowest household wealth groups. Moreover, we found a significant interaction between education and household wealth which was more remarkable in rural areas and in municipalities with medium-high HDI. The interaction showed that there was a negative association between education and diabetes among the highest household wealth groups; and a positive association between education and diabetes among the lowest household wealth groups. Therefore, it is possible that when populations face modernization, income is the most important SES measure to acquire unhealthy behaviors; and then, among the more affluent families, the better educated engage in healthier behaviours more rapidly.

Furthermore, there was a positive association between diabetes and urbanisation; and between diabetes and the municipality Human Development Index. Because the Human Development Index includes an indicator of health that reflects undernutrition and infectious disease; it may be an indicator of the stage of the nutritional and epidemiological transition in which municipalities are. For instance, the systematic literature review gave an indication of this across countries. The Deprivation Index was not associated with diabetes. Since urbanisation was closely associated with the municipality HDI, and both have a positive association with diabetes, they may be capturing similar characteristics of the environment.

The interaction between education and household wealth suggesting different directions in the relationship between diabetes and SES; and the positive association between diabetes and urbanisation, are consistent with findings from developing countries. These results support the speculation of Reddy (2007) about how obesity translates gradually from the highest to the lowest SES groups. According to this, the availability of mediators of risk (novelty foods and sedentary entertainments) covers gradually the populations from the most to the least developed. In more urbanised areas, the wealthier are the first to acquire them because they have more resources to access them; which produces sudden changes in their diet and physical activity. Then, among wealthier families, the more educated acquire healthier behaviours more rapidly. The consistent negative association between education and diabetes, and the interaction between education and household wealth gave evidence of this.

Therefore, urbanisation may be the most important variable for the development of diabetes risk factors. It is an environment that provides mediators of risk (e.g. unhealthy diets and sedentary occupations and leisure activities) in which income and wealth are important to access them. In this type of environment, the more educated may be more able to engage in healthy behaviours, independently of income.

Only household wealth and the Deprivation Index were associated with undiagnosed diabetes. There was an inverse u-shaped association between household wealth and undiagnosed diabetes. However, it was only significant in the full sample, urban areas and in women. Lower municipality SES was associated with a higher prevalence of undiagnosed diabetes in the full sample, rural areas and in women. The Deprivation Index may be an indicator of the availability of health services and a population that can afford them. However, an association between health care access and undiagnosed diabetes could not be confirmed.

Is there a relationship between the incidence of diabetes and SES? If so, what is the nature of this relationship? Does the relationship between diabetes and SES vary by urban/rural areas, level of municipality deprivation and sex?

Our analyses showed that there was a relationship between diabetes and SES, but only with education and municipality SES. Education had a clear negative association with the incidence of diabetes. However, it was not significant in rural areas and women. In the rural area, there was a positive association between the incidence of diabetes and the Human Development Index. These results agree with those of the prevalence of diabetes.

In urban areas, lower Deprivation Index values were associated with a higher incidence of diabetes. We could not investigate the incidence of the total cases of diabetes because only self-reported diabetes was available. Therefore, it was difficult to conclude if the incidence of diagnosed cases was due to an increase in the number of 'total' cases, or to an increase in 'diagnosed' cases. Therefore, our results may reflect early detection and efficacy in screening by health institutions. Alternatively, it is possible that the Deprivation Index indicates some characteristics of the poorest urban areas that have an impact in the development of diabetes. However, this needs to be investigated at lower area levels.

Moreover, the relationship between the incidence of diabetes and SES could not be investigated by municipality deprivation, because of the small number of incident cases that would result from stratifying the sample. To examine this, it would be necessary to use data from a longer period of time with a sufficient number of cases. However, since municipality deprivation and urbanisation have a close association, variations in the relationship between the incidence of diabetes and SES were somehow noted when the analyses were performed by urban and rural stratum.

What is the relationship between diabetes and employment status?

We explored two aspects of employment: working status and employment status. We could only investigate the effect of diabetes on working and employment status; but not the effect of working and employment status on diabetes. This was due to the small sample of adults that were unemployed or not working at baseline.

We found that of the adults who were working in 2002, adults who reported to have diabetes in 2005 were more likely to not work in 2005. A possible explanation for this is that adults who self-reported diabetes in 2005 were more likely to have complications. However, we could not corroborate this. Moreover, we found an interaction between diabetes and area of residence. It showed that in less urbanised areas, adults with diabetes were more likely to not work than adults without diabetes. Because people in less urbanised areas are less likely to be insured, it is possible that they are diagnosed until they have complications. Moreover, because jobs in less urbanised areas may involve more physical work, the presence of complications may have a bigger impact.

There was no association between diabetes and employment status. However, among adults with diabetes, those who were diagnosed between 2002 and 2005 were slightly more likely to be unemployed in 2005. The definition of employment status may imply a more formal or stable job than the definition of working status. Therefore, the employed may be more likely to be insured, to have an early detection of diabetes, and a lower impact on their job status.

Is there a relationship between diabetes and waist circumference change? If so, is change in waist circumference related to SES?

We found that there was no association between diabetes and waist circumference change. Hence, further analyses were not carried out to investigate the association of these variables with SES. It is possible that the categories of waist circumference were too extreme to detect changes. For instance, people with WC values farther from the normal cut-off point would have more difficulty to achieve a normal WC than people with WC closer to the normal cut-off point. Further research should consider investigating increase or decrease of the continuous waist circumference values.

7.2 Policy implications

Our findings showed that there was an association between diabetes and SES that was independent of genetic, biological and lifestyle factors, and other potential mediators or moderators of the association between diabetes and SES. However, obesity was the most important factor associated with diabetes.

Furthermore, we found that the prevalence of diabetes was associated with a higher municipality human development. In urban areas, municipality deprivation was associated with a higher incidence of diabetes. However, after controlling for individual and family characteristics; deprivation did not explain all the variation between municipalities. Higher municipality SES was also associated with increases in obesity. For reducing the risk of obesity and diabetes, it is necessary to design and implement effective public health programs and/or interventions that use a multidisciplinary approach that take into account the characteristics of individuals and their environments.

We found that the prevalence of diabetes increased with urbanisation; and that there was an interaction between education and household wealth, particularly in rural areas. The association between SES and diabetes is more similar to that of developing countries undergoing the epidemiological and nutritional transition, than to that of developed countries. Hence, further social and economical development, the ageing process, and increases in obesity and urbanisation may shift the prevalence of diabetes towards the most disadvantaged populations, as in developed countries and regions. In a country like

Mexico, where the poorest are less likely to be insured, people with diabetes in the lowest SES groups will be more affected because the lack of health care will not facilitate the prevention and treatment of complications. The presence of complications can also have an impact on their jobs, particularly among adults living in less urbanised areas, as we found in our analyses. It is important to reinforce screening programs and the promotion of healthy behaviours mainly among the most socially disadvantaged strata of the population.

Governments and researchers have been previously concerned with environmental sustainability, that is, to protect the environment while facing economical development. It is probably time to think about health sustainability in developing and least developed countries. That is, to protect the health of the population while facing economical development and urbanisation. It is necessary to ensure that people have the knowledge and resources to follow healthy behaviours as mediators of risk are presented to them.

Information on the spatial distribution of diabetes and groups at high risk is necessary for the development of public health policies in the prevention and control of diabetes. However, surveys are costly and do not cover all of the population. Health institutions should consider keeping records and registers for follow up, or implementing a surveillance program to monitor the incidence of diabetes.

7.3 Directions for further work

We found three main problems when measuring socioeconomic status. First, according to our literature review, occupation has a negative association with diabetes. However, occupation was a nominal category in our data and, consequently, we could not identify the direction of association between diabetes and SES. Further studies may consider using a measure of occupational status where the categories are ordered. Second, we found that there was no association between household wealth and diabetes in the urban stratum. It is possible that household wealth was not a good measure to differentiate the socioeconomic status of households in the urban area. Besides, households located in urban areas have most of the assets and facilities that we proposed, and they are constructed with stronger materials. Other characteristics of the households should be incorporated to distinguish wealth, particularly in urban areas. And third, it was difficult to distinguish between rich and poor areas within the urban stratum. Future studies may consider to examine measures of deprivation at lower area levels (e.g. locality, AGEB, neighbourhood).

In our analyses, a significant variation between municipalities remained even after controlling for individual, family and municipality variables. The classification by urban and rural areas only distinguishes localities by the size of their population. The Deprivation Index and the Human Development Index mostly reflect the provision of education and public services by the government. Future studies should look at other area variables for explanations. There is a need of variables that measure the degree of modernization and industrialization of the municipalities and localities. In addition, it is necessary to investigate other characteristics of the localities and neighbourhoods that may be related to obesity and chronic disease. Moreover, further research is needed to identify the underlying mechanisms that link SES and diabetes, particularly obesity, diet composition, energy consumption, occupational and leisure physical activity, and stress.

An association between diabetes and SES has been confirmed in cross-sectional data. However, not much work has been done to establish the direction of association between diabetes and SES. We could only confirm an association between self-reported diabetes and working status, particularly in less urbanised areas. Further studies may investigate the association between diabetes status and SES using surveys with a longer follow-up, and that include information on total diabetes, as well as on its duration and severity.

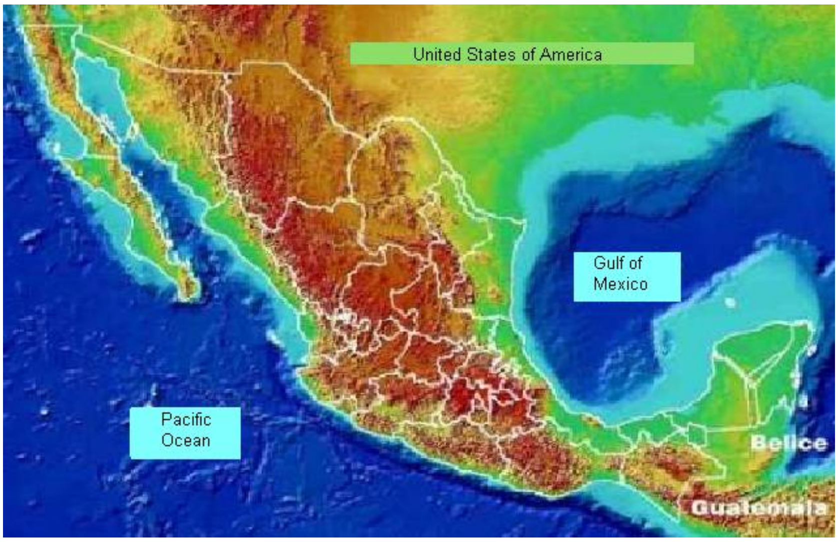
It was difficult to observe an association between diabetes and waist circumference change because the analyses considered transitions from normal circumference to abdominal obesity. Further studies may consider investigating the association between diabetes and obesity using continuous values.

Last of all, the analyses in this thesis could be updated after considering: to use the third wave of the Mexican Family Survey (MXFLS-2008); or to analyze other more recent surveys, such as the NHSNUT-2006.

8 APPENDIX

Appendix A

Figure 8.1 Map of Mexico: borders and political division



Source: INEGI

Appendix B

Table 8.1 Studies relating prevalence of diagnosed diabetes to SES

Country	Population	N	Age	Diabetes measurement	SES	Form of association
High HDI						
Europe	Adults from ten national representative health surveys (Espelt et al., 2008)*	-	30-64	Self-report	Education	Negative association in men (overall, Norway, Belgium, Italy)[1,PR] / women(overall, Finland, Sweden, Belgium, Italy, Spain)[1,PR] No association in the rest[1,PR]
Europe	Adults from eight national representative health surveys (Dalstra et al., 2005)	3,700 to 41,200	25-79	Self-report	Education	Negative association overall/men/women/overall 25-59 years/overall 60-79 years/Netherlands/ Belgium/France/Italy/Spain[1,OR] No association Denmark/Great Britain[1,OR]
Australia	Melanesian ni-Vanuatu adults (Taylor et al., 1991)	1,369	20+	Self-report, OGTT	Urbanisation	No association in men/women[1,%]
					Others	No association in men/women[1,%]
Canada	Adults from the 1978-79 Canada Health Survey (Millar et al., 1986)	18,494	20-69	Self-report	Education	Negative association in men/women[5,%]
Canada	Adults from the National Population Health Survey 1994/1995 (James et al., 1997)	17,626	25+	Self-report	Household income	Negative association[5,%]
Canada	Adults from the National Population Health Survey 1996-1997 (Tang et al., 2003)	39,021	40+	Self-report	Education	No association in men[3,OR] Negative association in women[3,OR]
					Household income	No association in men[3,OR] Negative association in women[3,OR]
US	Adults from a national representative sample BRFSS-2000 (Mokdad et al., 2001)	184,450	18+	Self-report	Education	Negative association[5,%]

OGTT oral glucose tolerance test; % Prevalence; PR Prevalence ratio; OR odds ratio; / indicates separate analyses; *Finland, Sweden, Norway, Denmark, Belgium, Italy, Spain, Czech Republic, Lithuania and Estonia; [1]age adjusted; [2]age and sex adjusted; [3]adjusted at least by age and obesity; [4]adjusted for other variables; [5]Other measure (χ^2tests; ANOVA; SE; accounts for the sampling design, adjustment for undercount CR, accounting for clustering).

Country	Population	N	Age	Diabetes measurement	SES	Form of association
US	Men from the NHANES II-IV (Smith, 2007)	-	25-70	Self-report , II-OGTT III,IV-HbA1c	Education	No association in self-report/total in II[3,probit] No association in self-report in III[3,probit] Negative association in total in III[3,probit] No association in self-report/total in IV[3,probit]
					Household income	Negative association in self-report/ total in II[3,probit] Negative association in self-report in III[3,probit] No association in total in III[3,probit] Negative association in self-report/ total in IV[3,probit]
US	Adults from a national representative sample BRFSS-1990,1998 (Mokdad et al., 2000)	149,806 in 1998	18+	Self-report	Education	Negative association 1990/1998[5,%]
US	Adults from the 1976 Health Interview Survey (Pincus et al., 1987)	5,652	18-64	Self-report	Education	Negative association[OR]
US	Black, Mexican-American, and White adults from the NHANES III (Cubbin et al., 2001)	9,961	25-64	Self-report, FPG	Education	Negative association in black women/ white men[1,4,OR] No association in Mexican-American women/black men/Mexican-American men[1,4,OR] Negative u-shaped association in white women[1,4,OR]
					Household Income	Negative association in black women/ white women[1,4,OR] No association in Mexican-American women/black men/Mexican-American men/white men[1,4,OR]
					Area	Negative association in black women[1,4,OR] No association in Mexican-American women/black men/Mexican-American men/white men/white women[1,4,OR]

OGTT oral glucose tolerance test; FPG fasting plasma glucose; % Prevalence; OR odds ratio; / indicates separate analyses; [1]age adjusted; [2]age and sex adjusted; [3]adjusted at least by age and obesity; [4]adjusted for other variables; [5]Other measure (χ^2tests; ANOVA; SE; accounts for the sampling design, adjustment for undercount CR, accounting for clustering).

Country	Population	N	Age	Diabetes measurement	SES	Form of association
US	American women from the BRFSS-2000 (Beckles et al., 2002)	109,680	25+	Self-report	Education	Negative association[4,OR]
					Household Income	Negative association[4,OR]
US	Black, Mexican-American, and White adults from the NHANES III (Winkleby et al., 1999)	10,029	25-64	Self-report, FPG	Education	Negative association in men/women[1,4,OR]
					Household income	Negative association in women[1,4,OR] No association in men[1,4,OR]
US	Black, Mexican-American, and White women from the NHANES III (Winkleby et al., 1998)	5,266	25-64	Self-report, FPG	Education	Negative association[1,4,5,OR]
					Household income	Negative association[1,4,5,OR]
US	Mexican Americans and non-Hispanic whites from San Antonio, Tx. (Hazuda et al., 1988)	2,217	25-64	Self-report, FPG, OGTT	Occupation	No association in men[1,OR] Negative association in women[3,OR]
US	Mexican Americans and Anglos from San Antonio, Tx. (Stern et al., 1984)	2,217	25-64	Self-report, medications, FPG, OGTT	Area	Negative association in Mexican American/anglos//men/women[1,%]
US	African Americans and whites from the NHANES II 1976-1980 (Cowie et al., 1993)	4,379	20-74	Self-report, OGTT	Education	Negative association[3,5,OR]
					Household income	No association[3,5,OR]
US	African Americans and non-Hispanic whites from the NHANES III (Robbins et al., 2001)	4,978	40-74	OGTT, medications	Education	No association in African-American women /white women/ African-American men/white men[3,OR]
					Household income	Negative association in African-American women /white women/ white men[3,OR] No association in African-American men[3,OR]
					Occupation	No association in African-American women /white women/ African-American men/white men[3,OR]

OGTT oral glucose tolerance test; FPG fasting plasma glucose; % Prevalence; OR odds ratio; / indicates separate analyses; // indicates that each separate analysis is repeated by the following strata; [1]age adjusted; [2]age and sex adjusted; [3]adjusted at least by age and obesity; [4]adjusted for other variables; [5]Other measure (χ^2tests; ANOVA; SE; accounts for the sampling design, adjustment for undercount CR, accounting for clustering).

Country	Population	N	Age	Diabetes measurement	SES	Form of association
US	African Americans and whites (Brancati et al., 1996)	1,393	35-54	Self-report, OGTT	Composite indicator	No association[3,OR] Positive association among whites[3,OR] Negative association among African Americans[3,OR]
					Education	No association[3,OR] Positive association among whites[3,OR] Negative association among African Americans[3,OR]
US	Japanese-American men from King County, Washington (Leonetti et al., 1992)	229	45-74	Self-report, medications, OGTT	Education	Negative u-shaped association[3,OR]
					Occupation	Negative association[5,%]
					Household income	No association[5,%]
US	Filipino-Americans from Houston, Texas Metropolitan (Cuasay et al., 2001)	831	20-74	Self-report	Education	No association overall/women[3,OR]
					Household Income	No association overall[3,OR] Negative association in women[3,OR]
US	Filipino-American women (Langenberg et al., 2007)	389	40-86	OGTT, medications	Education	No association[3,OR]
					Household income	Negative association[3,OR]
					Employment	No association[3,OR]
					Others	No association[3,OR]
Netherlands	South Asian adults (Middelkoop et al., 1999)	3,131	30+	Self-report	Area	Negative association in <60 age group[1,OR] No association in 60+ age group[1,OR]
UK	British women from 23 towns (Andersen et al., 2008)	4,286	60-79	Self-report, registers	Area	Negative association[3,OR]
UK	Adults from general practices from Avon and Somerset (Eachus et al., 1996)	28,080	35+	Self-report	Area	No association in men/women[1,%] No association overall[2,OR]
UK	Adults from Middlesbrough and East Cleveland (Connolly et al., 2000)	287,157	20+	Registers	Area	Negative association in men/women[1,%]
UK	Adults from an urban district in Liverpool (Ismail et al., 1999)	105,772	30+	Registers	Area	Negative association[5,%]

OGTT oral glucose tolerance test; % Prevalence; OR odds ratio; / indicates separate analyses; [1]age adjusted; [2]age and sex adjusted; [3]adjusted at least by age and obesity; [4]adjusted for other variables; [5]Other measure (χ^2tests; ANOVA; SE; accounts for the sampling design, adjustment for undercount CR, accounting for clustering).

Country	Population	N	Age	Diabetes measurement	SES	Form of association
UK	London civil servants from the Whitehall II study (Marmot et al., 1991)	10,314	35-55	Self-report	Occupation	Negative association in men/women[1,OR]
Italy	Adults from the 1983-NHS (Lavecchia et al., 1987)	58,462	25+	Self-report	Education	Negative association[2,RelR]
Italy	Residents of Turin (Gnavi et al., 2008)	897,743	21+	Registers	Education	Negative association men/women[1,PR]
					Area	Negative association men/women[1,PR]
New Zealand	Adults from worksites in Auckland and Tokoroa (Scragg et al., 1991)	5,677	40-64	Self-report, OGTT	Household income	Negative association[1,4,RelR]
					Occupation	No association[1,4,RelR]
New Zealand	Adults from a local workforce (Metcalf et al., 2007)	5,677	40-78	Self-report, OGTT	Occupation	No association[2,4,OR]
					Household income	Negative association[2,4,OR]
					Education	No association[2,4,OR]
New Zealand	Adults from Auckland (Metcalf et al., 2008)	4,020	35-74	Self-report, OGTT	Occupation	No association total/self-report[2,4,5,OR]
					Household income	Negative association total/self-report[2,4,5,OR]
					Education	No association total/self-report[2,4,5,OR]
					Area	No association total/self-report [2,4,5,OR]
Germany	Adults from Western Germany (Helmert et al., 1994)	44,363	25-69	Self-report	Composite indicator	Negative association men/women[3,OR]
Germany	Adults from the Augsburg region, South of Germany (Rathmann et al., 2006)	1,476	55-74	Self-report, OGTT, medications	Composite indicator	No association in men[3,5,OR] No association in women[3,5,OR]
Germany	Insured adults from the Mettman District, Nordrhein-Westfalen (Geyer et al., 2006)	97,707	25-74	Medication registers	Income	Negative association[2,4,OR]
					Occupation	Negative association[2,4,OR]
					Education	Negative association[2,4,OR]
Germany	Insured adults from the Mettman District, Nordrhein-Westfalen (Geyer, 2004)	77,294	20+	Registers and medication registers	Occupation	Negative association[2,OR]

OGTT oral glucose tolerance test; PR Prevalence ratio; OR odds ratio; RelR relative risk; / indicates separate analyses; [1]age adjusted; [2]age and sex adjusted; [3]adjusted at least by age and obesity; [4]adjusted for other variables; [5]Other measure (χ^2tests; ANOVA; SE; accounts for the sampling design, adjustment for undercount CR, accounting for clustering).

Country	Population	N	Age	Diabetes measurement	SES	Form of association
Spain	Adults from three National Health Surveys (Regidor et al., 2002)	5,998-15,312	25-74	Self-report	Education	No association in men 1987/1995 [1,PR] Negative association in women 1987/1995[1,PR]
					Others	No association in men 1987/1995[1,PR] No association in women 1987[1,PR] Negative association in women 1995[1,PR]
Spain	Adults from 61 general practitioners in the Basque country (Larranaga et al., 2005)	65,651	24+	Registers	Area	Negative association overall/men/women[1,OR]
Hong Kong	Hong Kong Chinese adults (Ko et al., 2001)	2,847	34±0.2 in women 39.7±0.5 in men	OGTT	Education	Negative association in men/women[1,OR]
					Occupation	No association in men[1,OR] Negative association in women[1,OR]
Qatar	Adults from urban and semi-urban Qatar (Bener, 2009)	1,117	20-59	Self-report, OGTT, FPG	Education	Negative association[5,%]
Mexico	Adults from the NHS-2000 (Olaiz-Fernandez et al., 2007)	45,294	20+	Self-report, CG	Education	No association in men[3,5,OR] Negative association in women[3,5,OR] Negative association overall[5,%]
					Household income	Negative association overall/women[5,%] No association in men[5,%]
Mexico	Insured adults from the NHS-2000 (Vazquez-Martinez et al., 2006)	-	20+	Self-report, CG	Education	Negative association total[3,OR] Negative association self-report[5,%]
Mexico	Adults from Mexico City and periurban areas with low SES (Avila-Curiel et al., 2007)	1,279	30+	Self-report, CG	Education	No association total[3,5,OR] No association self-report[5,%]
					Composite indicator	No association total/self-report[5,%]
Medium HDI						
Malaysia	Orang Asli and Malay adults (Ali et al., 1993)	706	18+	OGTT	Urbanisation	Positive association among Malay[1,%] No association among Orang Asli[1,%]
					Education	No association[5,%]
					Income	Positive association[OR]

OGTT oral glucose tolerance test; FPG fasting plasma glucose; CG capillary glucose; % Prevalence; PR Prevalence ratio; OR odds ratio; / indicates separate analyses; [1]age adjusted; [2]age and sex adjusted; [3]adjusted at least by age and obesity; [4]adjusted for other variables; [5]Other measure (χ^2tests; ANOVA; SE; accounts for the sampling design, adjustment for undercount CR, accounting for clustering).

Country	Population	N	Age	Diabetes	SES	Form of association
Oman	Adults from the 2000-NHS (Al-Moosa et al., 2006)	7,179	20+	Self-report, FPG	Urbanisation	Positive association[3,OR]
					Education	No association overall/urban[3,OR] Negative association among rural[3,OR]
China	Adults from 19 provinces and areas (Pan et al., 1997b)	224,251	25-64	Self-report, medications, CG, OGTT	Income	Positive association[3,OR]
					Education	Negative u-shaped association[5,%] Negative in people with higher income[3,OR]
China	Adults from urban and rural areas of NanJing municipality (Xu et al., 2006)	29,340	35+	Self-report	Urbanisation	Positive association[3,5,OR]
					Household income	Positive association overall/urban[3,5,OR] No association rural[3,5,OR]
					Education	Negative association[3,5,OR]
					Occupation	Positive association[3,5,OR]
Egypt	Adults from the Cairo and surrounding rural villages (Herman et al., 1995)	4,620	20+	Self-report, CG, OGTT	Urbanisation	Positive association overall/men/women[2,5,%]
					Area	Positive association overall/men in urban[2,5,%] Negative association women in urban[2,5,%]
India	Adults from six major cities across India (Ramachandran et al., 2001)	11,216	20+	Self-report, FPG, OGTT	Household income	Positive association[3,5,OR]
India	Adults from urban Madras (Ramachandran et al., 2002)	2,383	40+	Self-report,CG, medications	Household income	Positive association overall[3,OR] Positive association men/women[5,%]
India	Adults from a city, a town and periurban villages (PUV) (Ramachandran et al., 2008)	7,066	20+	Self-report, FPG, OGTT	Urbanisation	Positive association[3,OR]
					Education	Positive association[3,OR] Negative association in city[3,OR] No association in town and PUV[3,OR]
					Income	No association[3,OR] Positive association in city[3,OR] No association in town and PUV[3,OR]
India	Employees and their family members from 10 medium-to-large industries (Reddy et al., 2007)	19,969	20-69	Self-report, FPG	Education	No association in men[1,4,PR] Negative association in women[1,4,PR] Negative association in highly urban/urban[1,4,%] Positive association in periurban[1,4,%]
Bangladesh	Adults from urban and rural areas (AbuSayeed et al., 1997)	2,371	20+	CG, OGTT	Urbanisation	No association[3,OR]
					Others	Positive association[3,OR]

OGTT oral glucose tolerance test; FPG fasting plasma glucose; CG capillary glucose; % Prevalence; OR odds ratio; / indicates separate analyses; [1]age adjusted; [2]age and sex adjusted; [3]adjusted at least by age and obesity; [4]adjusted for other variables; [5]Other measure (χ^2tests; ANOVA; SE; accounts for the sampling design, adjustment for undercount CR, accounting for clustering).

Table 8.2 Studies relating prevalence of undiagnosed diabetes to SES

Country	Population	N	Age(years)	Outcome	SES	Form of relationship
High HDI						
Sweden	Adults from five municipalities in Stockholm (Agardh et al., 2004)	7,949	35-56	OGTT	Occupation	Negative association in men[3,RelR] Negative u-shaped association in women[3,RelR]
Sweden	Adults from five municipalities in Stockholm (Agardh et al., 2007)	7,949	35-56	OGTT	Education	No association in men/women[3,RelR]
					Occupation	Negative association in men[1,RelR] Negative u-shaped association in women[1,RelR]
UK	British women from 23 towns (Andersen et al., 2008)	4,286	60-79	Self-report, registers	Area	No association[5,%]
New Zealand	Adults from Auckland (Metcalf et al., 2008)	4,020	35-74	FPG, OGTT	Occupation	No association[3,OR]
					Household income	No association[3,OR]
					Education	No association[3,OR]
					Area	No association[3,OR]
Germany	Adults from the Augsburg region, South of Germany (Rathmann et al., 2005)	1,354	55-74	OGTT	Education	No association in men/women[3,OR]
					Occupation	No association in men[3,OR] Negative association in women[3,OR]
					Income	No association in men[3,OR] No association in women[3,OR]
Mexico	Insured adults from the NHS-2000 (Vazquez-Martinez et al., 2006)	-	20+	Self-report, CG	Education	Negative association[5,%]
Mexico	Adults from Mexico City and periurban areas with low SES (Avila-Curiel et al., 2007)	1,279	30+	Self-report, CG	Education	No association[5,%]
					Composite indicator	No association[5,%]
Medium HDI						
Egypt	Adults from the Cairo and surrounding rural villages (Herman et al., 1995)	4,620	20+	Self-report, CG, OGTT	Urbanisation	Positive association overall/men/women[2,5,%]
					Area	Positive association overall/men[2,5,%] No association women[2,5,%]

OGTT oral glucose tolerance test; FPG fasting plasma glucose; CG capillary glucose; % Prevalence; OR odds ratio; RelR relative risk; / indicates separate analyses; [1]age adjusted; [2]age and sex adjusted; [3]adjusted at least by age and obesity; [4]adjusted for other variables; [5]Other measure (linear trend; 95%CI; standard error; accounts for the sampling design).

Table 8.3 Studies relating incidence of diabetes to SES

Country	Population	N	Age(years)	Outcome	SES	Form of relationship
High HDI						
US	Adults from Alameda County (Maty et al., 2005)	6,147	17-94	Self-report	Education	No association[3, HR]
					Household income	No association[3,HR]
					Occupation	No association men/women[3,HR]
US	Adults from the NHANES I Epidemiologic Follow-up Study (Robbins et al., 2005)	11,069	25-74	Self-report, registers	Education	Negative association men/women[3,HR]
					Household income	No association in women[3,HR] Negative association in men[3,HR]
					Occupation	Negative association in women[3,HR] No association in men[3,HR]
US	White and black adults from the NHANES I Epidemiologic Follow-up Study (Lipton et al., 1993)	11,097	25-70	Self-report, registers	Education	Negative association overall/women/white women[3,OR] No association in men/white men/black men/black women[3,OR]
US	Married or widowed women from the Nurses' Health Study (Lidfeldt et al., 2007)	55,115	30-55	Symptoms, FPG, medications	Others	Negative association[3, RelR]
US	Mexican Americans from San Antonio, Tx (Monterrosa et al., 1995)	844	25-64	Self-report, medications, FPG, OGTT	Occupation	No association in men/women[3,OR]
US	Mexican Americans and non-Hispanic whites from San Antonio, Tx. (Burke et al., 1999)	3,226	25-64	Self-report, medications, FPG, OGTT	Occupation	No association[2,4,OR]
					Area	Negative association[3,OR]
US	Mexican Americans and non-Hispanic whites from San Antonio, Tx (Haffner et al., 1991)	923	25-64	Self-report, medications, FPG, OGTT	Education	Negative association[3,OR]
US	African American and white adults from the NHANES I Epidemiologic Follow-up Study (Resnick et al., 1998)	11,383	25-74	Self-report, registers	Education	Negative association in men/women[3,OR]

OGTT oral glucose tolerance test; FPG fasting plasma glucose; OR odds ratio; HR hazard ratios; RelR relative risk; / indicates separate analyses; [1]age adjusted; [2]age and sex adjusted; [3]adjusted at least by age and obesity; [4]adjusted for other variables.

Country	Population	N	Age(years)	Outcome	SES	Form of relationship
US	U.S. military personnel (Paris et al., 2001)	2,046	18-55	Registers	Occupation	Negative association overall/ whites[3,OR] No association African-Americans/Hispanic and other[3,OR]
UK	Adults from nine British towns (Barker et al., 1982)	-	18-50	Registers	Area	Negative association[2,R]
					Others	Non linear association[2,R]
UK	Adults from the Whitehall II study (Kumari et al., 2004)	10,308	35-55	Self-report, OGTT	Occupation	Negative association in men[3,OR] No association in women[3,OR]
					Assets and material belongings	No association in men/women[1,4,OR]
					Assets and material belongings	Negative association in men[1,4,OR] No association in women[1,4,OR]
					Others	Negative association in men/women[1,4,OR]

OGTT oral glucose tolerance test; OR odds ratio; R incidence rates per 100 000 population; / indicates separate analyses; [1]age adjusted; [2]age and sex adjusted; [3]adjusted at least by age and obesity; [4]adjusted for other variables

Table 8.4 Classifications of SES variables in the studies included in the systematic literature review

Population	SES measure	Classification of variable
European adults from ten national representative health surveys (Espelt et al., 2008)*	Education	Lower secondary or less; upper secondary; and tertiary
European adults from eight national representative health surveys (Dalstra et al., 2005)	Education	Low (no education and primary education); high (secondary education, post secondary education, and tertiary education)
Melanesian ni-Vanuatu adults, Australia (Taylor et al., 1991)	Urbanisation	Rural; semi-rural; urban.
	Others	Modernity score: island of origin; father's employment; education; employment; employment duration; residence in an urban centre; ease of access to an urban centre; and housing type.
Adults from the 1978-79 Canada Health Survey (Millar et al., 1986)	Education	Elementary; secondary; university/college
Adults from the National Population Health Survey 1994/1995, Canada (James et al., 1997)	Household income	<$10,000; $10,000-29,999; $30,000-59,999; $60,000+
Canadian adults (Tang et al., 2003)	Education	Less than secondary school education; secondary school education completed; post secondary school
	Household income	Low, medium, high (based on total household income and members)
Adults from the NHANES II-IV, US (Smith, 2007)	Education	Less than, equal to, or more than high school education
	Household income	Tertiles
Adults from a US national representative sample BRFSS-2000 (Mokdad et al., 2001)	Education	Less than high school; high school; some college; college degree and higher
Adults from a US national representative sample BRFSS-1990,1998 (Mokdad et al., 2000)	Education	Less than high school; high school; some college; college degree and higher
Adults from the 1976 Health Interview Survey (Pincus et al., 1987)	Education	1-8; 9-11; 12; greater than 12 years
American women from the BRFSS-2000 (Beckles et al., 2002)	Education	Less than high school; high school or above
	Household income	Annual household income
Black, Mexican-American, and White adults (Cubbin et al., 2001)	Education	0-8; 9-11; 12; greater than 12.
	Household income	$0-4,050; >$4,050-8,500; >$8,500-16,250; >$16,250-75,000.
	Area	Townsend Deprivation Index. Quartiles.
Black, Mexican-American, and White adults (Winkleby et al., 1999)	Education	Continuous, years centered at age 12
	Household income	Continuous. Residuals of the regression between education and log family income.
Black, Mexican-American, and White women (Winkleby et al., 1998)	Education	Continuous, years centered at age 12
	Household income	Continuous, centered at sample mean. Family income divided by the family size.
Mexican Americans and non-Hispanic whites from San Antonio, Tx. (Hazuda et. al, 1988)	Occupation	Quartiles. Duncan Socioeconomic Index.

Population	SES measure	Classification of variable
Mexican Americans and Anglos from San Antonio, Tx. (Stern et al., 1984)	Area	Low-income barrio; a middle income transitional neighborhood; and a high-income suburb.
African Americans and whites from the NHANES 1976-1980 (Cowie et al., 1993)	Education	<9th; ≥9th.
	Household income	Annual family income. <$10,000; ≥$10,000.
African Americans and non-Hispanic whites from the NHANES III (Robbins et al., 2001)	Education	Years. 0-8; 9-11; 12; ≥13
	Household income	Poverty income ratio. <1; 1-1.999; ≥2. Annual family income divided by the federal poverty line.
	Occupation	Duncan Socioeconomic Index score. <21; 21-32; >32
African Americans and whites (Brancati et al., 1996)	Composite indicator	Education and occupation. Tertiles.
	Education	Years. <12; ≥ 12.
Japanese-American men from King County, Washington (Leonetti et al., 1992)	Education	High school; technical; college
	Occupation	Unskilled; skilled; office; self-employed; professional.
	Household income	Greater or less than $30,000
Filipino-Americans from Houston, Texas Metropolitan (Cuasay et al., 2001)	Education	High school or lower; above high school
	Household Income	≥$20,000; <$20,000
Filipino-American women (Langenberg et al., 2007)	Education	≤12; 13-15; ≥16
	Household income	≤15,000; 15,000-44,999; ≥45,000
	Employment	Yes; no.
	Others	Household members. Continuous.
South Asian adults, Netherlands (Middelkoop et al., 1999)	Area	Continuous.
British women from 23 towns (Andersen et al., 2008)	Area	Quintiles. Carstairs score at ward level
Adults from general practices from Avon and Somerset, UK (Eachus et al., 1996)	Area	Fifths. Townsend deprivation score at district level
	Area	Relative index of inequality
Adults from Middlesbrough and East Cleveland, UK (Connolly et al., 2000)	Area	Fifths. Deprivation Index at ward level.
Adults from an urban district in Liverpool, UK (Ismail et al., 1999)	Area	Continuous. Townsend index at ward level
London civil servants from the Whitehall II study, UK (Marmot et al., 1991)	Occupation	Grade 1 (unified grades 1-6); grade 2 (unified grade 7); grade 3 (senior executive officer); grade 4 (higher executive officer); grade 5 (executive officer); grade 6 (clerical and office support staff). According to salary.
Adults from the 1983-NHS, Italy (Lavecchia et al., 1987)	Education	Primary school or less; middle school; high school or university
Residents of Turin, Italy (Gnavi et al., 2008)	Education	High (university or high school); medium (middle school); low (primary school or no formal education)
	Area	Four categories of income (percentiles). Median income in census tracts (about 207 inhabitants).

Population	SES measure	Classification of variable
Adults from worksites in Auckland and Tokoroa, New Zealand (Scragg et al., 1991)	Household Income	Household gross annual income. <30000; 30-40000; >40000.
	Occupation	Elley-Irving scale based on current occupation or spouse's occupation.
Adults from a local workforce, New Zealand (Metcalf et al., 2007)	Occupation	Class 1 (legislators and administrators); class 2 (various professionals); class 3 (corporate managers, associate professionals, and the armed forces); class 4 (trade workers, plant operators and office clerks); class 5 (other trade workers, machine operators and laborers); class 6 (market-orientated agricultural and fishery workers). New Zealand Socioeconomic Index (NZSEI). Current occupation of the participant or their spouse.
	Household income	<$20,000; $20,000 to <$30,000; $30,000 to <$40,000; ≥$40,000. Household gross annual income.
	Education	No tertiary education; trade; technical college; university.
Adults from Auckland, New Zealand (Metcalf et al., 2008)	Occupation	As above (Metcalf et al., 2007)
	Household income	Missing; $30,000; $30,001-$50,000; $50,001-$70,000; >$70,000. Household gross annual income.
	Education	No tertiary education; certificate; diploma; degree.
	Area	NZDep2001 at meshblock level (median of approximately 90 people)
Adults from Western Germany (Helmert et al., 1994)	Composite indicator	Upper class; upper middle class; middle class; lower middle class; lower class. Social class index of education, occupation and income.
Adults from Augsburg region, Germany (Rathmann et al., 2006)	Composite indicator	Low SES (first quintile); middle SES (second to fourth quintiles); high SES (fifth quintile). Index of education; occupation (of the participant or their spouse, latest if retired); and household income per capita divided in categories according to the median.
Insured adults from the Mettman District, Nordrhein-Westfalen, Germany (Geyer et al., 2006)	Income	Quintiles. Individual gross income before tax, including earnings, sick leave and parental leave benefits.
	Occupation	Intermediates/professionals; skilled non-manual; skilled manual; semi or unskilled manual.
	Education	University education; 13 years of school with or without apprenticeship; 9 or 10 years of school and completed apprenticeship; maximum 10 years without having completed apprenticeship.
Insured adults from the Mettman District, Nordrhein-Westfalen, Germany (Geyer, 2004)	Occupation	Intermediates/professionals; skilled non-manual; skilled manual; semi or unskilled manual.

Population	SES measure	Classification of variable
Adults from three National Health Surveys, Spain (Regidor et al., 2002)	Education	Low (no education or education terminated at 14-15 years); middle (terminated at 16-19 years or non–university education); high (university studies)
	Others	Upper-level non manual workers; lower level non-manual workers; and skilled and unskilled manual workers. Occupation of household head.
Adults from 61 general practitioners in the Basque country, Spain (Larranaga et al., 2005)	Area	Deprivation Index at census section of residence
Chinese adults, Hong Kong (Ko et al., 2001)	Education	High school or university; middle school; illiterate or up to elementary school.
	Occupation	Professional or managerial; non-manual, manual; unskilled.
Adults from urban and semi-urban Qatar (Bener, 2009)	Education	Illiterate; primary; secondary; high; university.
Adults from the NHS-2000, Mexico (Olaiz-Fernandez et al., 2007)	Education	Primary school or below; secondary; high school or above.
	Household income	Minimum salaries. Lower than 1; 1-1.9; 2-2.9; 3-4.9; 5 or more.
Insured adults from the NHS-2000, Mexico (Vazquez-Martinez et al., 2006)	Education	Illiterate-preschool; primary-secondary; high school or above.
Adults from Mexico City and periurban areas with low SES (Avila-Curiel et al., 2007)	Education	Illiterate-primary; secondary; high school or above.
	Composite indicator	Tertiles. Index of: household characteristics, overcrowding, income and expenditure.
Orang Asli and Malay adults, Malaysia (Ali et al., 1993)	Urbanisation	Urban; rural; remote rural.
	Education	None; formal education
	Income	≥M$250; <M$ 250
National representative sample of adults, Oman (Al-Moosa et al., 2006)	Urbanisation	Urban; rural.
	Education	Illiterate; less than secondary school; secondary or above.
Adults from 19 provinces and areas, China (Pan et al., 1997b)	Income	RMB yuan/year: <2,500; 2,500-5,000; >5,000
	Education	Illiteracy; middle school; college
Adults from urban and rural areas of NanJing municipality, China (Xu et al., 2006)	Urbanisation	Urban; rural.
	Household income	Tertiles. Total monthly incomes of all family divided by family size.
	Education	Years: 0-9; 10-12; ≥13.
	Occupation	Blue collar (farmer, factory worker, forestry worker, fisher); white collar (office worker, teacher, doctor, retired people).
Adults from the Cairo and surrounding rural villages, Egypt (Herman et al., 1995)	Urbanisation	Urban higher SES; urban lower SES; rural
	Area	Urban higher SES; urban lower SES.
Adults from six major cities across India (Ramachandran et al., 2001)	Household income	Monthly family income (rupees): ≤5000; 5001-10000; >10000.
Adults from urban Madras, India (Ramachandran et al., 2002)	Household income	Family income: <Rs. 30000/annum; Rs. ≥ 60,000/annum.

Population	SES measure	Classification of variable
Adults from a city, a town and periurban villages (PUV), India (Ramachandran et al., 2008)	Urbanisation	A city; a town; a periurban village.
	Education	Illiterate; school; college.
	Income	Monthly: low <5000; middle 5000-10000; high >10000.
Employees and their family members from 10 medium-to-large industries, India (Reddy et al., 2007)	Education	Graduates plus; above secondary school and up to graduation; above primary level up to secondary school; no formal education and up to primary level.
Adults from urban and rural areas in Bangladesh (AbuSayeed et al., 1997)	Urbanisation	Urban; rural.
	Others	Social class. Rich (urban: housing estates for government employees; rural: landholders); poor (urban: slums; rural: landless farmers).
Undiagnosed diabetes		
Adults from four municipalities in Stockholm, Sweden (Agardh et al., 2004)	Occupation	High (high- and medium-level non-manual employees); middle (low-level non-manual employees); low (unskilled and skilled manual workers)
Adults from five municipalities in Stockholm, Sweden (Agardh et al., 2007)	Education	High (university), middle ("3-4 year secondary high school" and "2 year secondary high school"); low ("elementary school or nine-year compulsory school" and :junior secondary school")
	Occupation	High (high- and medium-level non-manual employees); middle (low-level non-manual employees); low (unskilled and skilled manual workers)
Adults from Augsburg, Germany (Rathmann et al., 2005)	Education	Primary; secondary; tertiary.
	Occupation	Low; medium; high.
	Income	<50%, 50-100%, 101-150%, 151-200%, >200%. Median income.
Incidence of diabetes		
Adults from Alameda County, US (Maty et al., 2005)	Education	≤12; 12; ≥12 years.
	Household income	Tertiles: low; moderate; high.
	Occupation	White collar; blue collar
Adults from the NHANES I Epidemiologic Follow-up Study, US (Robbins et al., 2005)	Education	Years. <9; 9-12 but not a high school graduate; high school graduate; 13-15; 16+.
	Household income	Poverty income ratio. 0-0.999; 1-1.999; 2-2.999; 3-4.999; >5.
	Occupation	Duncan Socioeconomic Index. Quartiles.
White and black adults from the NHANES I Epidemiologic Follow-up Study, US (Lipton et al., 1993)	Education	Years. <9; ≤12; >12.
Married or widowed women from the Nurses' Health Study, US (Lidfeldt et al., 2007)	Others	Spouse's education. High school; any college; graduate school.
Mexican Americans from San Antonio, Tx (Monterrosa et al., 1995)	Occupation	Duncan Socioeconomic Index. 10 scale points.

Population	SES measure	Classification of variable
Mexican Americans and non-Hispanic whites from San Antonio, Tx. (Burke et al., 1999)	Occupation	Duncan Socioeconomic Index.
	Area	Low-income barrio; a middle income transitional neighbourhood; and a high-income suburb.
Mexican Americans and non-Hispanic whites from San Antonio, Tx (Haffner et al., 1991)	Education	Less than high school; high school diploma; greater than high school.
African American and white adults from the NHANES I Epidemiologic Follow-up Study (Resnick et al., 1998)	Education	Less than high school; at least high school.
U.S. military personnel (Paris et al., 2001)	Occupation	Rank. Officer; senior enlisted; junior enlisted.
Adults from nine British towns, UK (Barker et al., 1982)	Area	Better; intermediate; worse.
	Others	Social class. I, II; III N; III M; IV, V.
Adults from the Whitehall II study, UK (Kumari et al., 2004)	Occupation	Administrative, executive and clerical
	Assets and material belongings	Housing tenure. Owner occupied; council rented; private rented; other.
	Assets and material belongings	Car ownership. Yes; no.
	Others	Material problems (financial, housing and neighbourhood difficulties). Low; medium; high.

Table 8.5 SES measures included in the studies of the prevalence of diabetes

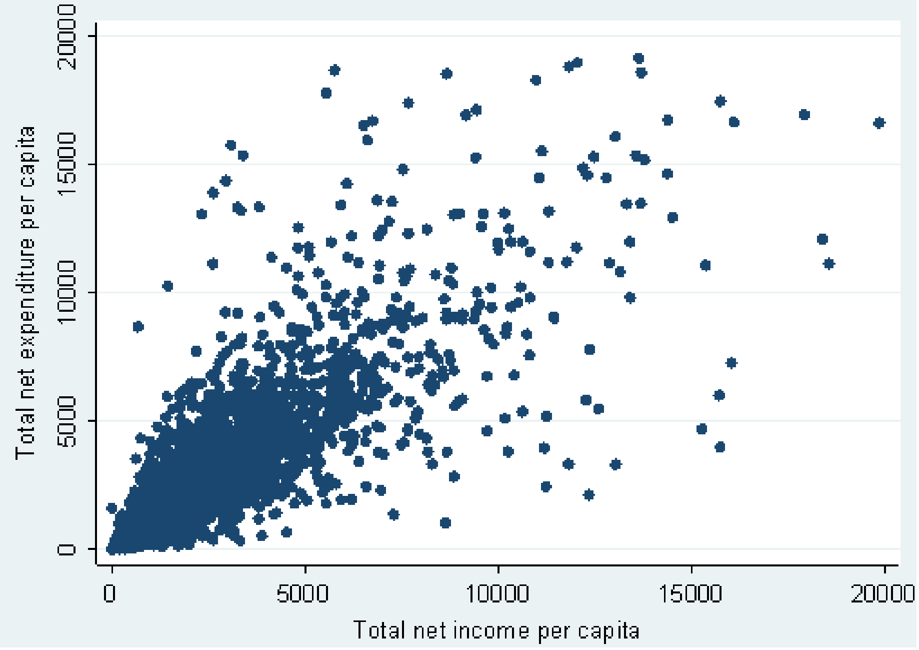
SES measure	Number of studies
Education	35
Occupation	11
Income	5
Household income	18
Employment	1
Composite indicator	3
Area	12
Others	4
Urbanisation	7

Table 8.6 Number of associations between the prevalence of diagnosed diabetes and SES

Direction of association	Men	Women	Both sexes combined			Total
			Urban	Rural	Overall	
Positive	2	1	7	1	13	24
Negative	26	41	3	1	36	107
No association	42	22	3	3	28	98
Non linear	1	1	0	0	1	3
Total	71	65	13	5	78	232

Appendix C

Figure 8.2 Scatter plot of the net income per capita and net expenditure per capita



Note: the graph includes only non negative values of 20,000 pesos or less for both

Figure 8.3 Cumulative standard normal distribution of the ranked expenditure

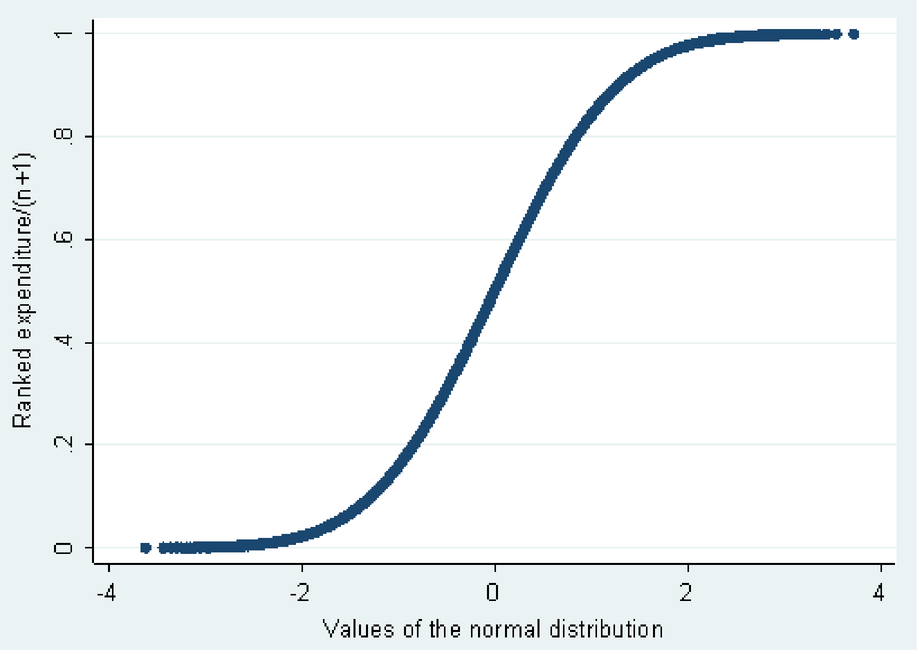


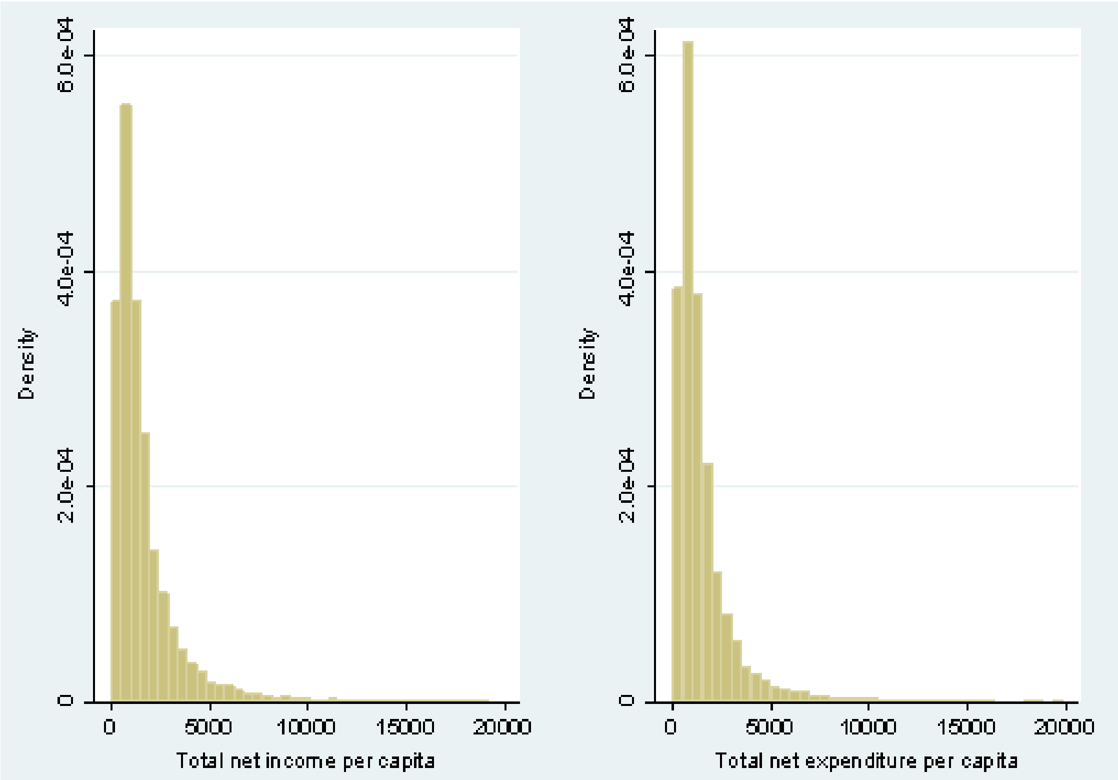
Table 8.7 Median of the net income per capita and net expenditure per capita by household materials and facilities, and by stratum (pesos)

Indicator	Net Income Per Capita		Net Expenditure Per Capita	
	Urban	Rural	Urban	Rural
Total (n=10,108)	5,494	4,614	5,494	4,614
Median (in pesos)	1501.8	713.2	1374.8	680.3
Type of wall				
Residue materials, shingle, clays, etc.	767.0	412.9	701.5	390.1
Other	1522.7	743.7	1393.9	706.6
Type of roof				
Residue materials, linden tree, etc.	1041.4	583.7	955.4	561.4
Other	1697.4	949.4	1540.3	870.3
Type of floor				
Soil	651.2	381.1	635.8	370.7
Cement	1143.2	765.6	1060.4	710.9
Other	2173.1	1396.2	1926.3	1271.6
Have a room for cooking				
No	978.6	595.0	901.6	559.4
Yes	1604.5	730.5	1454.8	699.3
Overcrowding				
4 or more	776.3	394.8	713.2	407.2
3 or more but less than 4	1008.8	633.5	930.3	571.2
2 or more but less than 3	1426.5	794.9	1308.3	730.7
1 or more but less than 2	2228.7	1203.3	1967.3	1101.2
Less than 1 person per room to sleep	4008.0	1803.7	4340.7	2275.8
Have piped water				
No	766.5	452.4	736.1	448.4
Outside the household or land	877.4	581.2	846.2	570.2
Inside the household or land	1789.6	1255.2	1611.1	1113.1
Have a toilet				
No	866.8	556.1	824.7	542.6
Yes	1806.2	1318.2	1637.3	1195.1
Have electricity				
No	468.7	368.0	401.0	323.5
Yes	1503.6	746.5	1378.6	707.1
Type of fuel for cooking				
Wood	492.4	389.5	453.5	386.7
Other	1513.6	955.8	1390.0	884.6

Table 8.8 Median of the net income per capita and net expenditure per capita by household assets and by stratum (pesos)

Indicator	Net Income Per Capita		Net Expenditure Per Capita	
	Urban	Rural	Urban	Rural
Total (n=10,108)	5,494	4,614	5,494	4,614
Median (in pesos)	1501.8	713.2	1374.8	680.3
Own a radio/radio tape player				
No	1436.7	702.8	1337.3	684.9
Yes	1523.5	717.8	1392.7	679.1
Own a television				
No	887.6	403.4	907.2	396.6
Yes	1527.3	821.8	1399.5	771.4
Own a VCR				
No	1155.0	629.5	1086.6	607.5
Yes	2108.8	1359.3	1889.7	1251.7
Own a blender				
No	990.6	442.7	949.0	435.8
Yes	1562.7	898.8	1422.0	835.9
Own a fridge				
No	804.9	455.7	756.6	452.1
Yes	1667.8	1014.8	1496.5	941.8
Own a washing machine				
No	1079.5	560.8	1023.8	548.6
Yes	1770.8	1106.2	1585.5	1003.3
Own a phone				
No	1057.3	629.1	982.2	604.1
Yes	2157.4	1575.8	1912.3	1414.2
Own a boiler				
No	1091.6	617.4	1011.8	596.8
Yes	2152.6	1385.4	1905.4	1231.7
Own a car or truck				
No	1152.9	598.3	1068.9	578.1
Yes	2360.9	1292.4	2058.2	1129.5

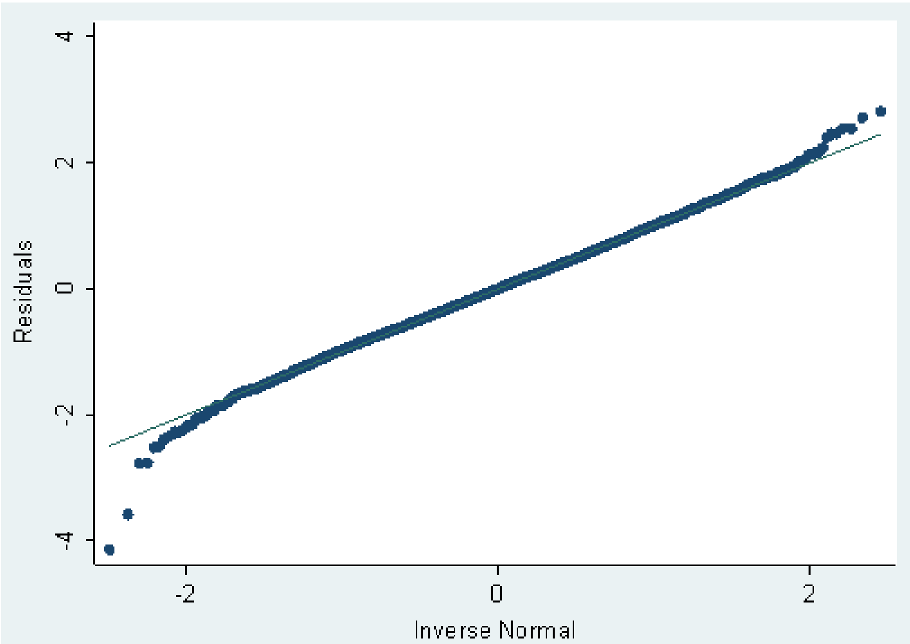
Figure 8.4 Histogram of the net income per capita and net expenditure per capita



Note: the graph includes only values between zero and 20,000 pesos or less

Figure 8.5 Residuals of the final model of the transformed rank of net expenditure per capita

a. QQ plot of the residuals



b. Residuals vs fitted values

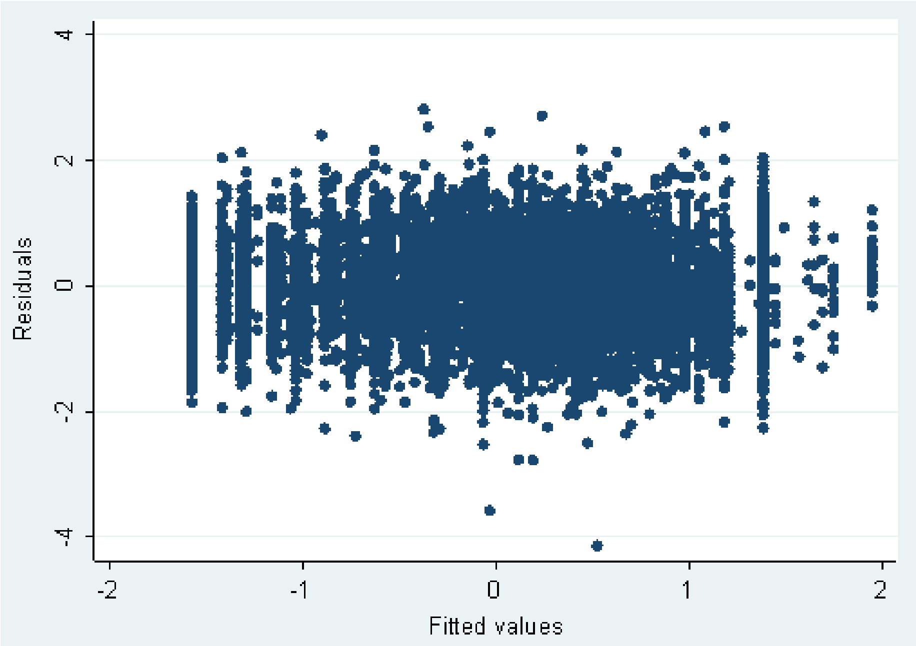
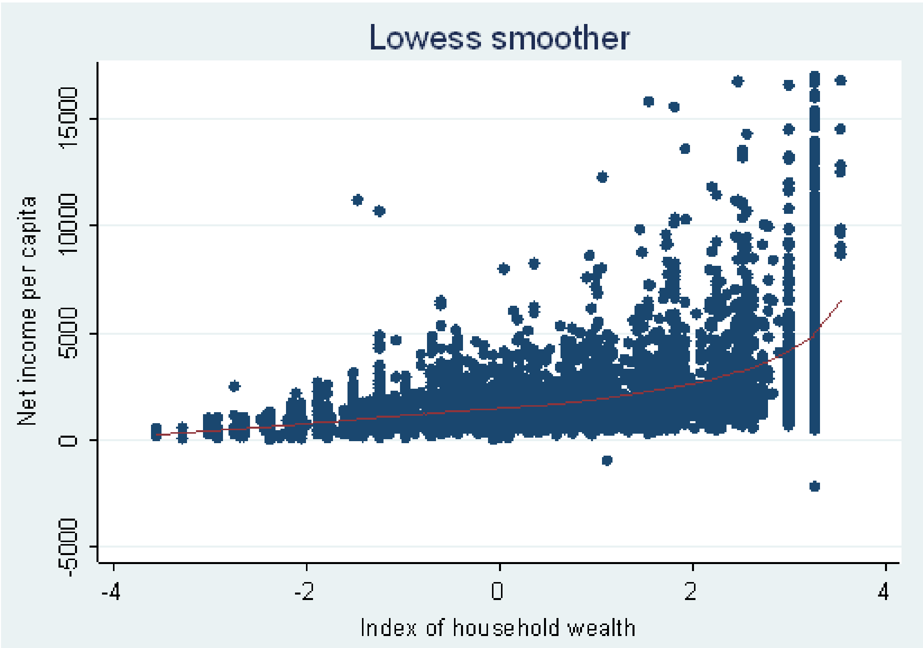


Figure 8.6 Lowess smoothing of income per capita by stratum

a. Urban



b. Rural

Appendix D

Figure 8.7 Scatter plot of height against weight in the NHS-2000

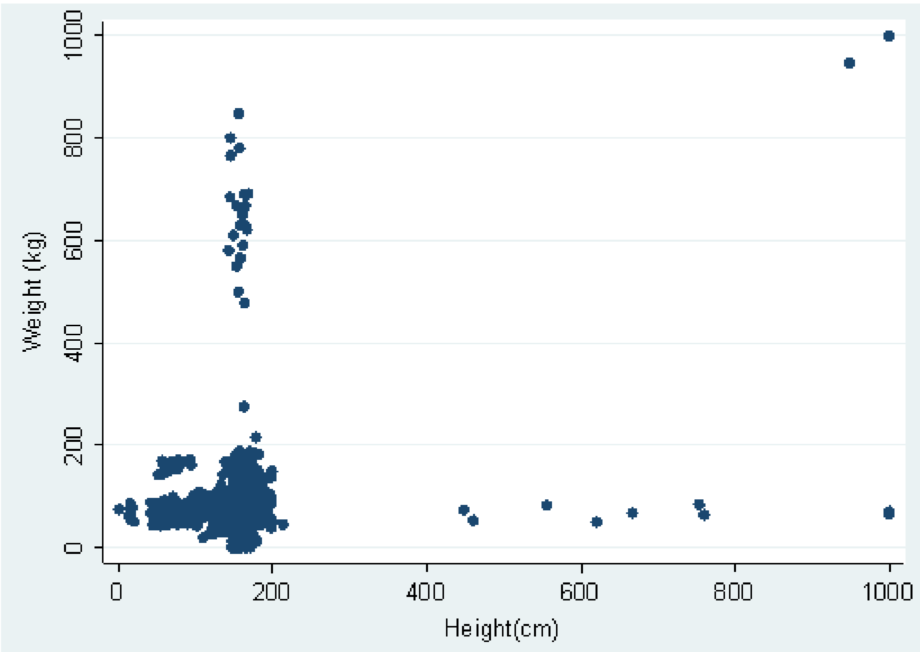


Figure 8.8 Scatter plot of waist circumference against weight in the NHS-2000

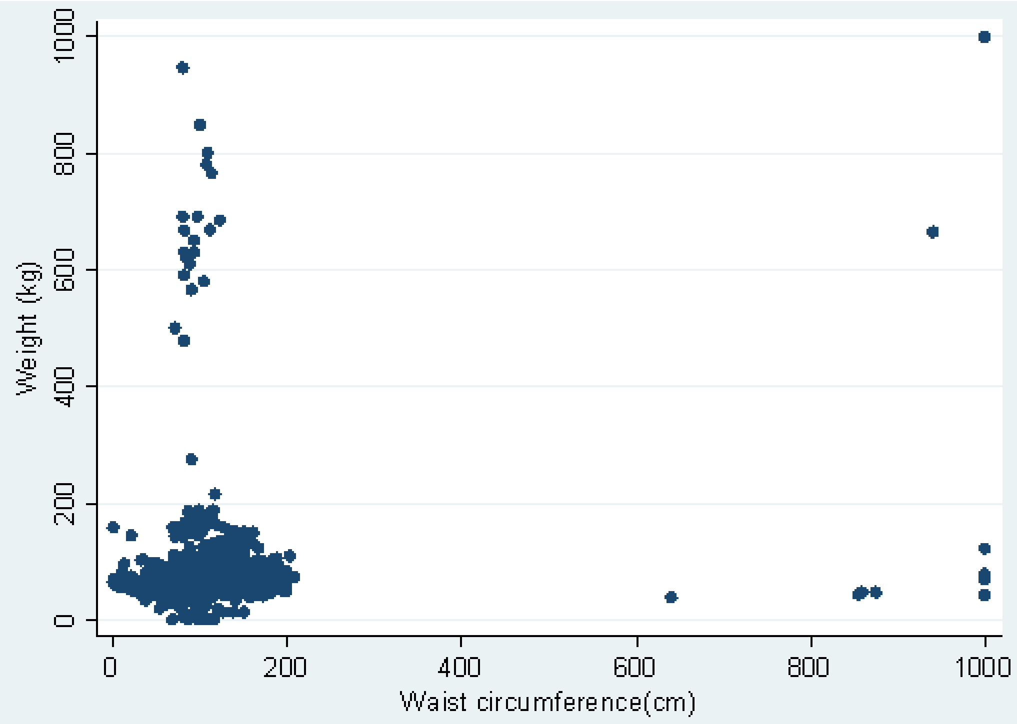


Table 8.9 Distribution of the indicators of the NHS-2000 included in the index of household wealth

Indicator	Stratum		Total
	Urban	Rural	
Total (n=100%)	21,606	18,174	39,780
Type of fuel for cooking (%)			
Wood	2.2	36.4	17.8
Other	97.5	63.4	81.9
Not known/no answer	0.3	0.2	0.2
Own a phone (%)			
No	50.2	87.0	67.0
Yes	49.6	12.8	32.8
Not known/no answer	0.2	0.2	0.2
Own a boiler (%)			
No	51.2	81.3	65.0
Yes	48.5	18.5	34.8
Not known/no answer	0.3	0.2	0.2
Own a car (%)			
No	60.8	79.0	69.1
Yes	38.9	20.8	30.6
Not known/no answer	0.3	0.2	0.3
Overcrowding (%)			
4 or more	14.5	26.9	20.2
3 or more but less than 4	13.7	18.1	15.7
2 or more but less than 3	31.1	29.8	30.5
1 or more but less than 2	35.7	22.6	29.7
Less than 1	4.9	2.6	3.9
Not known/no answer	0.1	0.0	0.1
Type of floors (%)			
Soil	3.6	20.1	11.1
Cement	51.2	65.6	57.8
Other	44.9	14.1	30.9
Not known/no answer	0.3	0.2	0.2
Own a fridge (%)			
No	15.2	46.4	29.4
Yes	84.6	53.4	70.4
Not known/no answer	0.2	0.2	0.2
Own a VCR (%)			
No	49.9	77.8	62.7
Yes	49.9	22.0	37.1
Not known/no answer	0.2	0.2	0.2

Table 8.10 Summary statistics and scoring factors of the index of household wealth in the NHS-2000

	Mean	Std. dev.	Scoring factors of first component	Scoring factors / Std. Dev.
Fuel for cooking	0.82	0.38	0.33	0.87
Phone	0.33	0.47	0.38	0.81
Boiler	0.35	0.48	0.39	0.81
Car	0.31	0.46	0.34	0.74
Overcrowding	2.81	1.18	0.30	0.25
Type of floors	2.20	0.62	0.37	0.60
Fridge	0.71	0.46	0.37	0.80
VCR	0.37	0.48	0.35	0.73
Index	0.00	1.89		

n=39,516

Figure 8.9 Histogram of the index of household wealth in the NHS-2000

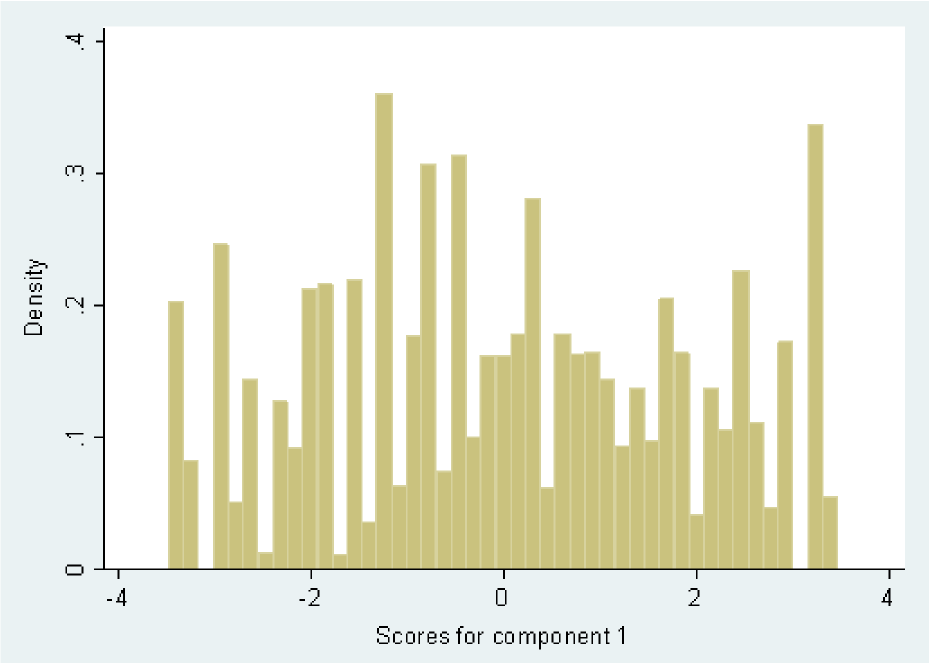


Table 8.11 Number of adults with self-reported diabetes, undiagnosed diabetes, and without diabetes

	self-reported diabetes	undiagnosed diabetes	no diabetes	Total
Total	2396	727	36657	39780
Age groups				
20-29	78	56	11783	11917
30-39	238	128	10455	10821
40-49	540	212	6965	7717
50-59	803	204	4469	5476
60-69	737	127	2985	3849
Sex				
Men	685	245	11224	12154
Women	1711	482	25433	27626
Language				
Only Spanish	2250	659	33270	36179
Only indigenous language	19	5	532	556
Indigenous language and Spanish	123	62	2757	2942
No answer	4	1	98	103
Family history of diabetes				
None	1284	467	26610	28361
Only father	259	69	3007	3335
Only mother	568	137	5093	5798
Both parents	211	30	994	1235
Not known/no answer/missing	74	24	953	1051
BMI				
Normal	472	112	11993	12577
Underweight	13	6	606	625
Overweight	930	264	13410	14604
Obese	909	326	9491	10726
Height or weight out of range/missing	72	19	1157	1248
Waist circumference				
Normal	622	187	18027	18836
Abdominal obesity	1693	510	16722	18925
Missing	81	30	1908	2019
Education				
None/preschool	85	20	691	796
Incomplete primary	925	265	9135	10325
Complete primary	563	168	9303	10034
Secondary	185	63	5633	5881
High school or above	323	111	9062	9496
Missing	315	100	2833	3248

Note: Total = self-reported diabetes + undiagnosed diabetes + no diabetes

Table 8.11 Number of adults with self-reported diabetes, undiagnosed diabetes, and without diabetes (cont.)

	self-reported diabetes	undiagnosed diabetes	no diabetes	Total
Total	2396	727	36657	39780
Household income quintiles				
1 (lowest SES)	312	142	6972	7426
2	401	140	6819	7360
3	469	131	6714	7314
4	482	146	6598	7226
5 (highest SES)	478	107	6707	7292
Missing	254	61	2847	3162
Poverty lines				
1 (lowest SES)	779	287	14507	15573
2	676	206	9687	10569
3	175	46	2396	2617
4 (highest SES)	512	127	7220	7859
Missing	254	61	2847	3162
Household wealth quintiles				
1 (lowest SES)	256	143	8072	8471
2	417	156	6875	7448
3	532	156	7126	7814
4	622	147	7153	7922
5 (highest SES)	559	118	7184	7861
Missing	10	7	247	264
Household wealth categories				
1 (lowest SES)	71	46	3362	3479
2	444	194	8965	9603
3	382	127	5877	6386
4	859	201	10302	11362
5 (highest SES)	630	152	7904	8686
Missing	10	7	247	264

Note: Total = self-reported diabetes + undiagnosed diabetes + no diabetes

Table 8.11 Number of adults with self-reported diabetes, undiagnosed diabetes, and without diabetes (cont.)

	self-reported diabetes	undiagnosed diabetes	no diabetes	Total
Total	2396	727	36657	39780
Occupation				
Employee	348	154	8677	9179
Agricultural worker	37	24	1433	1494
Self employed/boss	565	160	7492	8217
Non-remunerated work	33	15	893	941
Home maker	1099	312	15525	16936
Retired	136	18	549	703
Other	178	44	2088	2310
Marital status				
Married/Cohabiting	1728	532	27709	29969
Single	135	66	5174	5375
Divorced/Separated	201	50	2000	2251
Widowed	331	78	1748	2157
Not known/no answer	1	1	26	28
Kinship				
Household head	1302	384	15963	17649
Spouse	940	269	15082	16291
Other	154	74	5612	5840
Health care				
Public	1306	308	15202	16816
Private or both	21	4	381	406
None/other	1062	415	20944	22421
Missing	7	0	130	137
Live in a remote area				
Non remote area	1888	542	26495	28925
Remote	508	185	10162	10855
Stratum				
Urban	1444	375	19787	21606
Rural	952	352	16870	18174
Deprivation Index				
Very low	1352	334	18181	19867
Low	495	135	7069	7699
Medium	321	139	5686	6146
High	202	100	4290	4592
Very high	26	19	1431	1476
HDI				
Low	0	0	89	89
Medium low	50	34	2035	2119
Medium high	1075	364	17497	18936
High	1271	329	17036	18636

Note: Total = self-reported diabetes + undiagnosed diabetes + no diabetes

Table 8.12 Odds ratios for total diabetes adjusting by genetic, biological and lifestyle factors and potential mediators (base model 1)

	Odds ratios
Age	
20-29	0.14***
30-39	0.35***
40-49	1.00
50-59	2.17***
60-69	2.96***
Family history of diabetes	
None	1.00
Only father or mother	2.18***
Both parents	4.51***
Not known/no answer/missing	1.21
Language	
Only Spanish	1.00
Only indigenous language	0.54**
Indigenous language and Spanish	0.87
No answer	0.63
Sex	
Men	1.00
Woman	0.73***
Waist circumference	
Normal	1.00
Abdominal obesity	1.41***
Missing	1.71**
Health care access	
Public and/or private	1.00
None/other	0.87***
Missing	0.82
Marital status	
Married/Cohabiting	1.00
Single	0.80**
Divorced/Separated/Widowed	1.13*
Sex*waist circumference	
Woman*abdominal obesity	1.49***
Woman*missing	0.97

Dependent variable "diabetes in adult" no(0), yes(1); *p<0.05 **p<0.01 ***p<0.001; model at national level.

Table 8.13 Odds ratios for total diabetes by socioeconomic status

Socioeconomic status	Unadjusted	Adjusted§
Education		
High school or above	1.00	1.00
None/preschool	3.17***	1.69***
Incomplete primary	2.72***	1.67***
Complete primary	1.64***	1.48***
Secondary	0.92	1.32***
Missing	3.06***	1.66***
Household income quintiles		
1 (Poorest)	0.75***	1.01
2	0.91	1.20**
3	1.02	1.24***
4	1.09	1.22**
5 (Richest)	1.00	1.00
Missing	1.27**	1.22*
Poverty lines		
1 (lowest SES)	0.83***	1.10
2	1.03	1.22***
3	1.04	1.18
4 (highest SES)	1.00	1.00
Missing	1.25**	1.21*
Household wealth quintiles		
1 (lowest SES)	0.52***	0.98
2	0.88*	1.34***
3	1.02	1.30***
4	1.14*	1.33***
5 (highest SES)	1.00	1.00
Missing	0.73	0.87
Household wealth categories		
1 (lowest SES)	0.35***	0.71**
2	0.72***	1.14*
3	0.88**	1.21**
4	1.04	1.20***
5 (highest SES)	1.00	1.00
Missing	0.70	0.81
Deprivation Index		
Very low	1.15*	1.04
Low	1.10	1.04
Medium	1.00	1.00
High	0.87	0.96
Very high	0.39***	0.55***
HDI		
Low-Medium low	0.48***	0.64***
Medium high	1.00	1.00
High	1.14***	1.05
Stratum		
Urban	1.00	1.00
Rural	0.84***	0.97
Living in a remote area		
Non remote area	1.00	1.00
Remote area	0.74***	0.85***

§ Adjusted by genetic, biological and lifestyle factors and potential mediators (base model 1); *p<0.05, **p<0.01, ***p<0.001.

Table 8.14 LR statistic for the step model of total diabetes

Stage		LR statistic	p-value
Stage 1	Genetic and biological factors	3561.17	0.0000
Stage 2	Genetic and biological factors+Lifestyle	141.04	0.0000
Stage 3	Genetic and biological factors+Lifestyle+SES	125.65	0.0000
Stage 4	Genetic and biological factors+Lifestyle+SES+mediators	28.58	0.0000
Stage 5	Genetic and biological factors+Lifestyle+SES+mediators +environment	11.38	0.0007
Stage 6	Genetic and biological factors+Lifestyle+SES+mediators +environment+interactions	34.24	0.0000
Stage 7	Genetic and biological factors+Lifestyle+SES+mediators +environment+interactions+municipality deprivation	7.31	0.0068
Stage 8	Genetic and biological factors+Lifestyle+SES+mediators+ environment+ interactions+municipality deprivation+r.e.	-	-

Table 8.15 Odds ratios for self-reported diabetes by socioeconomic status

Socioeconomic status	Unadjusted	Adjusted§
Education		
High school or above	1.00	1.00
None/preschool	3.40***	1.81***
Incomplete primary	2.79***	1.72***
Complete primary	1.69***	1.55***
Secondary	0.92	1.41***
Missing	3.05***	1.66***
Household income quintiles		
1 (lowest SES)	0.63***	0.90
2	0.82**	1.14
3	0.98	1.22**
4	1.02	1.15
5 (highest SES)	1.00	1.00
Missing	1.25**	1.21*
Poverty lines		
1 (lowest SES)	0.76***	1.06
2	0.98	1.19**
3	1.03	1.18
5 (highest SES)	1.00	1.00
Missing	1.25**	1.23*
Household wealth quintiles		
1 (lowest SES)	0.41***	0.82*
2	0.77***	1.22**
3	0.95	1.24**
4	1.11	1.33***
5 (highest SES)	1.00	1.00
Missing	0.51*	0.60
Household wealth categories		
1 (lowest SES)	0.27***	0.59***
2	0.62***	1.04
3	0.81**	1.15*
4	1.05	1.23***
5 (highest SES)	1.00	1.00
Missing	0.50*	0.58
Deprivation Index		
Very low	1.33***	1.18*
Low	1.25**	1.17*
Medium	1.00	1.00
High	0.83*	0.94
Very high	0.33***	0.48***
HDI		
Low-Medium low	0.38***	0.55***
Medium high	1.00	1.00
High	1.22***	1.09
Stratum		
Urban	1.00	1.00
Rural	0.77***	0.93
Living in a remote area		
Non remote area	1.00	1.00
Remote area	0.70***	0.84**

§ Adjusted by genetic, biological and lifestyle factors and potential mediators (base model 1); *p<0.05, **p<0.01, ***p<0.001.

Table 8.16 Odds ratios for undiagnosed diabetes by socioeconomic status

Socioeconomic status	Unadjusted	Adjusted§
Education		
High school or above	1.00	1.00
None/preschool	2.36***	1.29
Incomplete primary	2.37***	1.46**
Complete primary	1.47***	1.26
Secondary	0.91	1.11
Missing	2.88***	1.62**
Household income quintiles		
1 (lowest SES)	1.28	1.37*
2	1.29	1.43**
3	1.22	1.33*
4	1.39*	1.46**
5 (highest SES)	1.00	1.00
Missing	1.34	1.25
Poverty lines		
1 (lowest SES)	1.12	1.23
2	1.21	1.30*
3	1.09	1.15
4 (highest SES)	1.00	1.00
Missing	1.22	1.13
Household wealth quintiles		
1 (lowest SES)	1.08	1.54**
2	1.38**	1.75***
3	1.33*	1.53***
4	1.25	1.36*
5 (highest SES)	1.00	1.00
Missing	1.73	1.94
Household wealth categories		
1 (lowest SES)	0.71*	1.05
2	1.13	1.45**
3	1.12	1.39**
4	1.01	1.11
5 (highest SES)	1.00	1.00
Missing	1.47	1.64
Deprivation Index		
Very low	0.75**	0.76**
Low	0.78*	0.76*
Medium	1.00	1.00
High	0.95	1.00
Very high	0.54*	0.71
HDI		
Low-Medium low	0.77	0.87
Medium high	1.00	1.00
High	0.93	0.95
Stratum		
Urban	1.00	1.00
Rural	1.10	1.11
Living in a remote area		
Non remote area	1.00	1.00
Remote area	0.89	0.88

§ Adjusted by genetic, biological and lifestyle factors and potential mediators (base model 1); *p<0.05, **p<0.01, ***p<0.001.

Appendix E

Table 8.17 Sociodemographic profile of the adults in the study of the incidence of diabetes 2002-2005

	Urban	Rural[1]	Men	Women[2]	Total
Total (n=100%)	4,114	5,967	4,085	5,996	10,081
Age groups (%)		p<0.001		p<0.001	
20-29	29.8	25.9	25.5	28.9	27.5
30-39	28.9	27.6	26.0	29.5	28.1
40-49	21.2	21.4	21.9	20.9	21.3
50-59	12.5	14.5	15.5	12.5	13.7
60-69	7.6	10.7	11.1	8.3	9.4
Family history of diabetes (%)		p<0.001		p<0.001	
None	28.5	28.6	27.3	29.4	28.5
Only father	6.3	3.7	4.3	5.1	4.8
Only mother	9.7	6.9	7.2	8.6	8.1
Both parents	1.8	0.9	1.1	1.4	1.3
Not known/ missing	53.7	59.9	60.0	55.6	57.4
Sex (%)		p=0.069			
Men	39.5	41.3	-	-	40.5
Women	60.6	58.7	-	-	59.5
Ethnicity (%)		p<0.001		p=0.177	
Non indigenous	92.1	79.5	84.1	85.0	84.6
Indigenous	6.4	20.3	15.3	14.2	14.6
Missing	1.5	0.2	0.6	0.8	0.7
BMI (%)		p<0.001		p<0.001	
Normal	24.2	28.2	27.4	26.0	26.6
Underweight	1.1	1.3	1.3	1.1	1.2
Overweight	35.3	34.8	37.9	33.1	35.0
Obese	25.0	24.9	18.6	29.2	24.9
Missing	14.4	10.9	14.9	10.5	12.3
Waist circumference (%)		p<0.001		p<0.001	
Normal	63.0	63.6	73.0	56.7	63.3
Abdominal obesity	21.5	24.0	11.9	30.5	23.0
Missing	15.6	12.4	15.1	12.8	13.7
Waist-to-hip ratio (%)		p<0.001		p<0.001	
Normal	58.1	50.7	54.9	52.9	53.7
Obesity	26.1	36.8	29.9	34.1	32.4
Missing	15.8	12.6	15.2	13.0	13.9

[1]chi-square test urban compared with rural; [2]chi-square test men compared with women

Table 8.17 Sociodemographic profile of the adults in the study of the incidence of diabetes 2002-2005 (cont.)

	Urban	Rural[1]	Men	Women[2]	Total
Total (n=100%)	4,114	5,967	4,085	5,996	10,081
Education (%)		p<0.001		p<0.001	
None/preschool	5.6	14.1	9.6	11.3	10.6
Incomplete primary	13.8	32.8	25.7	24.6	25.0
Complete primary	23.2	25.7	23.8	25.3	24.7
Secondary	24.6	16.6	17.9	21.2	19.9
High school or above	32.6	10.5	22.6	17.5	19.6
Missing	0.1	0.3	0.4	0.2	0.3
Occupation (%)		p<0.001		p<0.001	
Employee	42.5	21.3	44.6	20.0	29.9
Agricultural worker	1.0	17.7	24.1	1.9	10.9
Self employed/boss	16.1	12.4	18.5	10.8	13.9
Non-remunerated	2.2	3.3	2.6	3.0	2.8
Home maker	30.2	39.5	0.7	59.5	35.7
Retired	1.5	1.1	2.7	0.2	1.2
Other	6.6	4.8	6.9	4.6	5.5
Household income quintiles (%)		p<0.001		p<0.001	
1 (lowest SES)	6.8	23.0	15.7	16.9	16.4
2	13.3	21.8	18.2	18.4	18.3
3	17.2	15.4	16.6	15.8	16.1
4	23.6	11.1	17.6	15.3	16.2
5 (highest SES)	25.6	7.9	16.2	14.4	15.1
Missing	13.4	20.8	15.7	19.2	17.8
Household wealth quintiles (%)		p<0.001		p=0.920	
1 (lowest SES)	4.5	34.2	22.3	21.8	22.0
2	10.8	24.8	19.1	19.1	19.1
3	19.9	17.9	18.5	18.9	18.7
4	28.7	14.6	20.0	20.6	20.3
5 (highest SES)	34.8	7.7	19.1	18.5	18.8
Missing	1.2	0.9	1.0	1.0	1.0
Deprivation Index (%)		p<0.001		p=0.052	
Very low	76.4	15.2	39.2	40.8	40.2
Low	16.0	30.4	25.9	23.6	24.5
Medium	6.4	29.6	20.3	20.0	20.1
High	1.2	18.1	10.7	11.6	11.2
Very high	0.0	6.7	3.8	4.1	4.0
HDI (%)		p<0.001		p=0.013	
Medium low	0.0	12.1	6.5	7.6	7.2
Medium high	31.0	71.3	56.4	53.7	54.8
High	69.1	16.6	37.1	38.7	38.0

[1]chi-square test urban compared with rural; [2]chi-square test men compared with women

Table 8.17 Sociodemographic profile of the adults in the study of the incidence of diabetes 2002-2005 (cont.)

	Urban	Rural[1]	Men	Women[2]	Total
Total (n=100%)	4,114	5,967	4,085	5,996	10,081
Marital status (%)		p<0.001		p<0.001	
Married/Cohabiting	71.6	76.8	77.3	72.9	74.7
Single	19.2	16.1	18.7	16.5	17.4
Divorced/Separated/Widowed	9.2	7.1	4.0	10.6	7.9
Not known/no answer	0.0	0.0	0.0	0.0	0.0
Kinship (%)		p=0.872		p<0.001	
Household head	38.7	39.2	75.6	14.0	39.0
Spouse	37.6	37.2	0.8	62.3	37.4
Other	23.7	23.6	23.6	23.7	23.7
Health care access (%)		p<0.001		p=0.475	
Public	56.0	29.5	41.0	39.9	40.3
Private or both	2.1	0.2	1.1	0.9	1.0
None/other	41.2	70.0	57.5	58.8	58.3
Missing	0.6	0.3	0.5	0.5	0.5
Live in a remote area (%)				p=0.041	
Non remote area	100.0	19.8	51.3	53.4	52.5
Remote	0.0	80.2	48.7	46.7	47.5
Stratum (%)				p=0.069	
Urban	-	-	39.7	41.5	40.8
Rural	-	-	60.3	58.5	59.2

[1]chi-square test urban compared with rural; [2]chi-square test men compared with women

Table 8.18 Odds ratios for the incidence of diabetes adjusting by genetic, biological and lifestyle factors (base model 2)

	Odds ratios
Age	
20-29	0.24***
30-39	0.39***
40-49	1.00
50-59	1.25
60-69	1.43*
Family history of diabetes	
None	1.00
Family history of diabetes	1.82***
Not known/no answer/missing	1.15
BMI	
Normal	1.00
Overweight	1.58*
Obese	4.34***
Missing	2.26**

Dependent variable “diabetes in adult” no(0), yes(1); *p<0.05 **p<0.01 ***p<0.001; model at national level.

Table 8.19 Odds ratios for the incidence of diabetes by socioeconomic status

Socioeconomic status	Unadjusted	Adjusted§
Education		
High school or above	1.00	1.00
None/preschool	3.07***	1.61
Incomplete primary	2.59***	1.52
Complete primary	2.25***	1.65*
Secondary	1.47	1.62*
Household income quintiles		
1 (lowest SES)	0.98	1.16
2	0.90	1.06
3	0.89	1.03
4	1.21	1.25
5 (highest SES)	1.00	1.00
Missing	1.08	1.00
Household wealth quintiles		
1 (lowest SES)	0.75	0.96
2	0.82	1.00
3	0.82	0.94
4	1.06	1.00
5 (highest SES)	1.00	1.15
Deprivation Index		
Very low	1.06	1.10
Low	0.75	0.76
Medium	1.00	1.00
High	0.70	0.84
Very high	1.21	1.44
HDI		
Medium low	1.17	1.31
Medium high	1.00	1.00
High	1.29*	1.30*
Stratum		
Urban	1.00	1.00
Rural	0.81	0.81
Living in a remote area		
Non remote area	1.00	1.00
Remote area	0.90	0.90

§ Adjusted by genetic, biological and lifestyle factors (base model 2); *p<0.05, **p<0.01, ***p<0.001.

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