SOCIOECONOMIC INEQUALITIES IN TYPE 2 DIABETES MELLITUS IN EUROPE

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A l'Isaac

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Seria d'injustícia, no recordar els inicis del doctorat i no recordar-me dels bons moments que vam passar fent el master de salut pública, on vaig decidir que faria el doctorat en diabetis, amb la Irene Garcia, la Gemma Vellalta, el Filippos Analitis o la Laura Costas. Imagina't si dóna 4 anys, que una està vivint a Brasil, l'altra ha deixat la salut pública per la medicina i l'últim està ensenyant castells a Alemanya.

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Summary

Type 2 diabetes mellitus (T2DM) has become a major health problem worldwide. The St. Vincent declaration emphasized the urgent need to improve the epidemiological knowledge of this disease in Europe. Within Europe, research on the link between socioeconomic position (SEP) and type 2 diabetes is scarce.

The objective of this thesis was to conduct an extensive review of the current literature on socioeconomic inequalities in type 2 diabetes within European countries, while analyzing the relationship between, incidence, prevalence and mortality due to T2DM and SEP. In addition, we also analyzed trends on SEP inequalities in the prevalence of T2DM in Spain (1983-2006). Finally, we also assessed the appropriate use of health surveys with self-reported diagnosis in order to further analyze the relation between SEP and T2DM.

Different sources of information were used throughout the study. The systematic review was completed using the PUBMED database (www.pubmed.com) while the empirical studies used data of two European projects, the EUROTHINE (www.eurothine.org), SHARE (www.share-project.org) and the Spanish National Health Survey (study of trends in SEP inequalities in T2DM) along with the Catalonia health surveys (study of validation). The thesis consists of 5 papers that attempt to respond to the different objectives.

The studies included in this thesis suggest that socio-economic position (SEP) inequalities affect the incidence, prevalence and

mortality by T2DM in Europe. These SEP inequalities are partly explained for body mass index, diet and physical activity. Moreover, these inequalities seemed to have remained constant or increased over time. Finally, health interview surveys with self-reported T2DM seems to be a good instrument to evaluate SEP inequalities in T2DM.

Resum

La Diabetis Mellitus Tipus 2 (DM2) ha esdevingut un dels principals problemes de salut a nivell mundial. La declaració de ST VINCENT emfatitzava la necessitat i la urgència de millorar-ne el coneixement epidemiològic a nivell Europeu. Els estudis a nivell europeu sobre les desigualtats per Posició Socioeconòmica (PSE) en la DM2 eren força escassos.

L'objectiu d'aquesta tesi era fer una revisió extensa dels estudis publicats sobre desigualtats per PSE en la DM2 a Europa, així com analitzar la relació entre la incidència, la prevalença i la mortalitat per DM2 i la PSE. Un altre objectiu també era analitzar la tendència de les desigualtats per PSE en la prevalença de DM2 a Espanya (1983-2006). Finalment, com a objectiu també hi figurava el valorar l'ús adequat de les enquestes de salut amb auto - declaració de DM2 per tal d'avaluar les desigualtats per PSE en la DM2.

Per tal de dur a terme els objectius es van emprar diferents fonts d'informació. Per tal de dur a terme la revisió sistemàtica es va emprar la base de dades de PUBMED (www.pubmed.com) mentre que pels estudis empírics es van utilitzar les dades de dos projectes europeus com són el projecte EUROTHINE (www.eurothine.org) i el SHARE (www.share-project.org) i les enquestes nacionals de salut d'Espanya (per la tendència de diabetis) i de Catalunya (per la validació). La tesi consta de 5 articles que intenten donar resposta als diferents objectius.

Els estudis inclosos en aquesta tesi suggereixen que existeixen desigualtats per posició socioeconòmica (SEP) en la DM2, tant en la incidència, en la prevalença com en la mortalitat a Europa. Aquestes desigualtats per PSE s'expliquen en part per l'índex de massa corporal, la dieta o l'activitat física. A més a més, aquestes desigualtats sembla que s'han mantingut constants o han crescut al llarg del temps. Finalment, s'ha vist que les enquestes de salut amb la pregunta d'auto-declaració de la diabetis són un bon instrument per avaluar les desigualtats per PSE en la DM2.

Preface

This thesis was completed at the Agència de Salut Pública de Barcelona (Public Health Agency of Barcelona) during the years 2008-2011, under the supervision of Dr. Carme Borrell Thió. It was presented as a collection of publications according to the Phd in Biomedicine program regulations at the Department of Experimental and Health Sciences at the University of Pompeu Fabra. This thesis is divided into 5 sections: introduction, justification, hypothesis and objectives, methods and results, and discussion. Within the section on methods and results the five resulting papers are presented (3 published and 2 of them currently submitted).

This thesis was made possible with the collaboration of different researchers within Catalonia, Spain and abroad. The first study was conducted with the collaborative efforts of different Spanish researchers resulting in a published chapter of a textbook on social inequalities and type 2 diabetes, developed by the Spanish Society of Epidemiology. The second one was produced with the collaboration of two leading Catalan endocrinologist (Dr Alberto Goday and Dr Josep Franch). The third study was conducted under the project Eurothine, a European study drawing on various experts on the socio-economic situation of Europe. The fourth and fifth study were developed at two different stances in Holland and Italy with the generous support of Dr. Anton Kunst, Dr. Robert Gnavi and Dr. Teresa Spadea.

My personal contributions in the production of the articles presented in this thesis include, a literature review, study design, statistical analysis of the data and the writing of the reports.

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Abbreviation List

BMI	Body Mass Index, weight in kilograms divided by height in meters squared. A BMI between 25 and 30 is considered overweight while a BMI over 30 is considered obese.
Eurothine	Acronym for the Tackling Health Inequalities in Europe project.
SHARE	Acronym for the Survey of Health, Ageing and Retirement in Europe study.
RII	Index related to inequalities. RII=1 indicated inequality. In this these, a RII>1 indicates poor health in disadvantaged socioeconomic positions.
SII	Absolute index of inequalities.
SEP	Socio-economic position. The socioeconomic position can be reflected by level or education, income or employment.
T2DM	Type 2 Diabetes Mellitus

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PART I

Introduction

1. INTRODUCTION

1.1 Type 2 Diabetes Mellitus (T2DM)

Diabetes mellitus (DM) consists of a group of metabolic disorders that share the hyperglycemia phenotype (Harrison, 2004). Diabetes mellitus is characterized by the presence of high blood glucose levels due to food consumption. Most individuals with diabetes are classified into two subtypes: Type 1 diabetes (T1DM) and Type 2 diabetes (T2DM). In the first one, the body does not produce insulin while in the second one the body cannot produce insulin or use it adequately. Insulin is a hormone that helps keep the blood sugar level within normal limits. T2DM accounts for almost 90% of diagnosis of diabetes (Arteagoitia & Piniés, 2009; Gan, 2003).

The World Health Organization (WHO) and the American Diabetes Association (ADA) use various criteria in order to diagnose a patient with diabetes according to the tests completed (Table 1). The basal levels of plasma glucose and intolerance to glucose, are risk factors and indicators of developing diabetes (Arteagoitia & Piniés, 2009; Mata et al., 2009). All diagnosis are based on blood glucose tests and are tested twice for validity. However, in the case that high blood glucose levels are accompanies with hyperglycemia, polyuria, polydipsia and weight loss, a second test would not be required in order to diagnose the individual with diabetes (Mata et al., 2009).

Table 1: Diabetes mellitus diagnostic criteria

Diagnostic test	Diabetes
Random plasma glucose test	≥200 mg/dl and presence of symptoms such as polyuria, polyphagia, polydipsia and weight loss
Fasting plasma glucose test	≥126 mg/dl
Oral glucose tolerance test	≥ 200mg/dl

Source: Mata et al (2009).

One of the greatest problems of T2DM is that elevated hyperglycemia can produce pathological changes in different organs for years without any detectable symptoms. Hyperglycemia develops gradually and goes undetected until reaching advanced stages. Therefore, many cases remain in the early stages and are not diagnosed resulting in an underestimate of the total numbers of individuals with diabetes. Examples of this underestimation due to the inability to diagnose early are found in studies conducted in the U.S (Franse et al., 2001) and in Germany (Rathmann et al., 2003). In the United States during 1998, approximately one third of older people with diabetes had yet to be diagnosed while in Germany during 2000 this figure was 50% (Franse et al., 2001; Rathmann et al., 2003).

Complications of diabetes can be either acute or chronic. Acute complications (hypoglycemia or hyperglycemia) can result in coma, convulsions, neurological disorders or death. Chronic complications of diabetes largely depend on the control of the disease and the

presence of related cardiovascular risk factors (Arteagoitia & Piniés, 2009). In addition, chronic complications can result in the alteration of small arteries or microangiopathy (retinopathy and nephropathy), disruptions in the medium caliber arteries or microangiopathy resulting in cardiovascular disease (heart disease, cerebrovascular disease and peripheral arterial disease) and alterations in the nervous system (autonomic neuropathy and polineuritis) (Arteagoitia & Piniés, 2009).

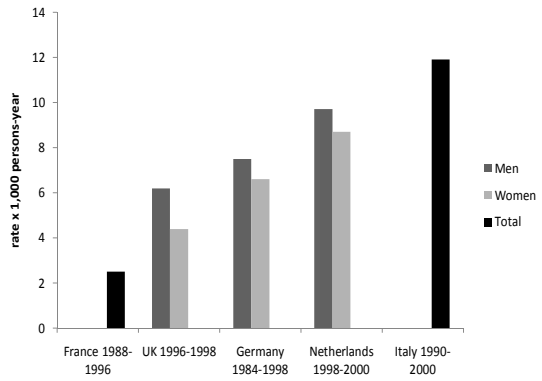
a) Incidence of T2DM

In individuals under the age of 30, the incidence of T2DM is less than 1 per 1,000 people per year (Gonzalez, 2009) and this incidence rate increases with age. In fact, one of the risk factors associated with diabetes is being over the age of 40 where the incidence of diabetes becomes more prominent (Mata et al., 2009). For example, within the Spanish population, individuals above the age of 56 were 3.90 (95%CI: 2.00-7.51) times more likely to develop diabetes compared to individuals within the ages of 18 to 20 years (Soriguer et al., 2008). Although different studies provide various data, it is important to note that estimates of the incidence rates of T2DM are difficult to calculate because this estimation imply a stable population being constantly screened due to the high percentage of population with undiagnosed T2DM. In addition, most studies on the incidence of diabetes collect data from medical histories or the self-declaration of diabetes, leaving out the undiagnosed population (Fagot-Campagna et al., 2005).

Furthermore, existing research has used different age groups and different methodologies, making it difficult to compare results. In

Figure 1 we can see a collection of some of the estimates of the incidence of T2DM in individuals between 65 to 69 years in Europe obtained from a recent review. We can see that the incidence is higher in men compared to women and the range of incidence runs from 2 in 2000 people in France per year to 12 in 1000 people in Italy per year (Fagot-Campagna et al., 2005).

Figure 1: Estimates of incidence rates of T2DM in individuals 65 to 69 years living in different countries in Europe



Source: Fagot- Campagna et al. (2005)

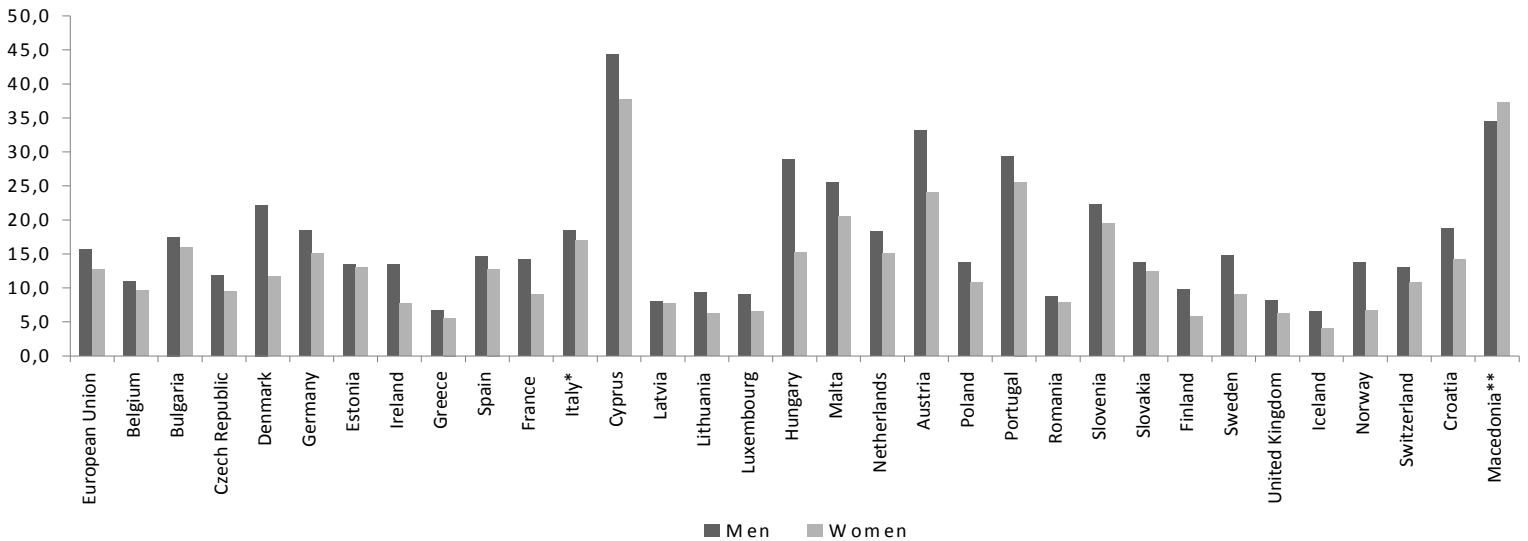
An important fact is that the incidence of T2DM has increased over the years as described in two studies completed in the UK and in Canada (Gonzalez et al., 2009; Lipscombe & Hux, 2007). In the UK, the incidence rate of T2DM in individuals aged 10 to 79 rose from 2.6 per 1,000 people in 1996 to 4.3 in 1,000 people in 2005. In Canada the incidence rate has increased from 6.6 per 1,000 people in 1997 to 8.3 in 2003 among individuals over the age of 20.

It is important to note that the incidence of T2DM has not increased equally across all age groups. In fact, the younger age groups have experienced a greater increase while those aged 80 years and over have remained more stable (Leibson et al., 1997; Lipscombe & Hux, 2007).

b) Mortality by T2DM

In 2000, 5.2% of deaths worldwide were attributed to diabetes (Roglic et al., 2005). In Europe, this percentage was much higher in 2010 with an estimated 11% of mortality among individuals aged 20 to 79 years was attributed to diabetes (Roglic & Unwin, 2010). Although attention must be paid when comparing data from mortality records due to data collection procedures, the statistics office of Europe allow us to see mortality rates of diabetes in the different European countries (figure 2). The lowest rates are from Iceland (5.5 per 100,000 individuals-year in men and 4.1 for women) while the highest rates are found in Cyprus (44.4 in 100,000 individuals-year in men and 37.8 for women).

Figure 2: Mortality rates due to diabetes mellitus by sex, standardized by age and by 100,000 habitants in different European countries during 2005



*Italy rates represent 2006 data for men and 2004 data for women. **Formerly known as the Yugoslavian Republic of Macedonia.

Source: EUROSTAT (http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/).

Contrary to incidence rates of diabetes which have been increasing over the years, diabetes related mortality rate has been decreasing. For example, in the UK, the mortality rate among individuals aged 30 or more has gone from 47.9 per 1,000 men-year and 37.4 per 1,000 women-year in 1996 to a rate of 25.2 in 1,000 men-year and 27.6 in 1,000 women-year in 2006 (Latinovic, 2008). In Canada, this decrease in mortality has been higher among the youth compared to other age groups (Lipscombe & Hux, 2007).

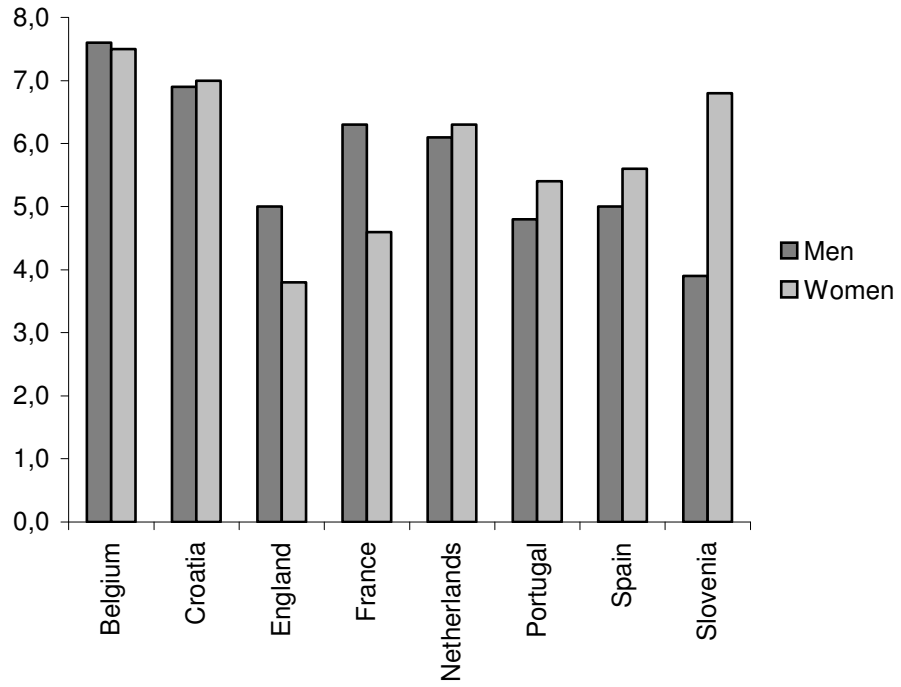
An important fact about mortality and diabetes is that individuals with diabetes are more likely to die compared to those individuals who do not have diabetes (Gu, 1998).

c) Prevalence of T2DM

Worldwide there have been various estimates of the prevalence of diabetes. Wild et al. estimated that in 2000, the prevalence of diabetes was 2.8% among individuals over the age of 20 and predicted that this figure would increase to 4.4% by the year 2030 (Wild, 2004). Recently, Shaw et al. (2010) estimated that in 2010 this figure was 6.4% in individuals 20 to 79 years and would increase to 7.7% by 2030. This would mean that by 2030 there would be more than 439 million adults with diabetes around the world (Shaw et al., 2010). This increase has been on two key aspects. One, mortality has decreased and two, there has been an increase in incidence (Charlton et al., 2008; Lipscombe & Hux, 2007).

In 2000, Europe presented considerable variability in the prevalence of diabetes according to the data reported by sentinel networks (figure 3). The prevalence rate among women over the age of 45 was lowest in England (3.8%) and highest in Belgium (7.5%) while in men over 45, the lowest rate was in Portugal (5%) and highest in Belgium (7.6%) (Fleming et al., 2004).

Figure 3: Age standardized prevalence of diabetes by sex in individuals over 45 years in various European countries between 1999 and 2000.



Source: Fleming et al. (2004)

However, as noted above, caution must be taken when comparing data as methodological approaches differ with every study. Age is a risk factor of the prevalence of diabetes and therefore, the

highest prevalence rates of T2DM are among the older age groups (The DECODE Study Group, 2003). At the end of the 20th century in Europe, individuals 30 to 39 years had a T2DM prevalence rate of 2.5% (women) and 2.9% (men) while those 80 to 89 years had prevalence rates of 43.3% (women) and 19.5% (men) (The DECODE Study Group, 2003). However, as previously explained, the studies confirm a wide range of rates throughout Europe (Dalstra et al., 2005; Fleming et al., 2004).

1.2 Risk factors of T2DM

According to the American Diabetes Association (ADA) (www.diabetes.org), T2DM has a stronger genetic basis than type 1 although T2DM depends more on environmental factors. An explanation is that family history is a risk factor for T2DM, but by adopting certain lifestyle choices, the disease onset can be postponed or completely avoided (Zimmet et al., 2001).

a) Risk factors in the incidence of T2DM

There are several risk factors associated with diabetes and most of them can be prevented (Hu et al., 2001). In this sense, aside from a family history of diabetes (indication that T2DM may be genetically dependent), other risk factors like age, body mass index (BMI), cholesterol and triglycerides in the blood, hypertension, physical inactivity and tobacco consumption are the main known risk factors (Joseph et al., 2010), with slight differences among men and women. An example of these gender differences is that

physical inactivity is a stronger risk factor in women than in men (Meisinger et al., 2002).

In this sense, the American Diabetes Association (ADA) recommends that in order to prevent or delay the onset of diabetes, exercise and appropriate diet are important, which are also factors for controlling obesity and overweight, two of the major risk factors of T2DM (Arteagoitia & Piniés, 2009) and proposes one of its objectives to identify and/or develop community resources and public policies that help promote healthy lifestyles (American Diabetes Association, 2010). However, it should be noted that the adoption of healthy lifestyles goes beyond the individual's responsibility as there are social factors that influence the adoption of these lifestyles. Therefore, the recommendations should go beyond those proposed by the ADA and should be based on social triggers of unhealthy behaviors (see section 3.8).

b) Mortality risk factors of T2DM

T2DM risk factors affecting incidence rates are also the same as those affecting mortality rates. Therefore having a BMI less than or greater than normal, being a smoker, gender and time since onset, can all increase the risk of mortality among individuals with T2DM (Mulnier et al., 2006). Moreover the control of the illness appears as another important risk factor.

In general, people with diabetes have a higher risk of dying compared to people without diabetes. In fact, in a study conducted in the UK in which a group of individuals were followed for 6 years, results showed that individuals aged 35 to 89 years with diabetes

were 1.93 (CI95% 1.89-1.97) times at greater risk of dying when compared to those without diabetes (Mulnier et al., 2006).

1.3 SEP inequalities in T2DM

The socioeconomic position (SEP) refers to social and economical factors that influence the place occupied by an individual or group within a society's structure. In epidemiology and public health research, many SEP indicators have been used including education, income and wealth (Krieger et al., 1997). When we talk about socioeconomic inequalities in health, we refer to those inequalities that occur systematically and potentially evitable among social, demographic or geographically defined groups. These inequalities cause that individuals within socially advantaged positions have worst opportunities or resources, due to their social position, to enjoy a healthy life than most socially disadvantaged positions. WHO stresses the moral and ethical dimensions that permeate the concept of health inequalities in order to deal with the difference and unnecessary injustice (Whitehead, 1992).

a) SEP inequalities in the incidence of T2DM

Studies have found SEP inequalities in the incidence of diabetes. In a recent review, the magnitude and variability of these inequalities was seen across the studies. Depending on the methodology, the countries studied or even the SEP indicators (education, income, or employment) chosen, we can find different estimates (Agardh et al., 2011). According to a meta-analysis conducted by Agardh et al. (2011), individuals with less favorable

occupational class, education or income levels, are 1.31 (CI95% 1.09-1.57), 1.41 (CI95% 1.28-1.55), and 1.40 (CI95% 1.04-1.88) times respectively at higher risk of T2DM than those with more favorable SEP (Agardh et al., 2011).

Different studies have given the explanation that SEP inequalities in T2DM exist because of multiple factors. On one hand, we known that obesity, physical inactivity and poor diet, that have led to the onset of T2DM, (Joseph et al., 2010), have shown a pattern of inequality. Meaning that people with deprived SEP who have higher risk to be obese, to be a person with low physical activity or to have a poorer diet (Dowler, 2001). On the other hand, this relationship is not so clear because while some studies have shown that these events could explain the SEP inequalities in the incidence of diabetes while others have failed to fully explain it (Agardh et al., 2011). Some studies suggest that other causes such as psychosocial factors which lead to stress, could help explain these inequalities. This is because long-term stress has been seen as a possible risk factor for diabetes as it increases levels of glucose in the blood and has negative effects on immune system (Pickup & Crook, 1998). Essentially, this could lead to the onset of T2DM in the individuals with most deprived SEP as they tend to be more at risk of having stress (Lantz et al., 2005).

Gender as another cause of inequality

In general, inequalities by SEP in the incidence of diabetes are more prominent in women than in men and could be party because women from most deprived SEP tend to be more obese, lack physical activity and experience more psychosocial stress when

compared to their male counterparts. However, these gender differences are not as great within the higher SEP (Agardh et al., 2011; Kumari et al., 2004; Loucks et al., 2007; Norberg et al., 2007; Tang et al., 2003). Reasons for this difference can be found in social factors that go beyond the individual and relate to the unequal power of men and women in our society.

b) SEP inequalities in mortality by T2DM

Various studies have found links between SEP inequalities and mortality due to T2DM. In Switzerland, a study showed that the risk of mortality by T2DM was 1.31 (CI95%: 1.11-1.55) times more in individuals from the manual social classes compared to those in non-manual social classes (Lawlor et al., 2006). These inequalities in mortality can be attributed to factors that play a role in diabetes onset (lifestyle, stress, etc.) and to those that affect the access and delivery of health services (Brown et al., 2004).

In general, individuals with T2DM who have most deprived SEP situations also have poorer disease control such as, glycemic control and lower response rates to treatment (Larrañaga et al., 2005; Larrañaga et al., 2009) or they often receive poorer treatment. In U.S. (Dray-Spira et al., 2010) and in Italy (Gnavi et al., 2011) it has been seen that relative SEP inequalities in mortality are greater in individuals without diabetes compared to those with diabetes. However, the absolute impact is greater in persons with diabetes due to the higher mortality rates (Dray-Spira et al., 2010).

Gender as another cause of inequality

Both Barcelona and the Basque country have found inequalities in mortality from diabetes (Esnaola et al., 2006; Borrell et al., 2008). An important result from the Esnaola et al. (2006) was that the results did not significant inequalities in mortality from diabetes among men, while in women over the age of 65 they were significant (Esnaola et al., 2006). In Barcelona, although inequalities in mortality are higher in women than in men in individuals 18 years and over, from 1992 to 2003 these numbers have been increasing in men while decreasing in women (Borrell et al., 2008). However, it should be noted that these trends were not statistically significant.

c) SEP inequalities in the prevalence of T2DM

SEP inequalities in the prevalence of T2DM have been related to inequalities in the incidence and mortality rates of T2DM. During the 90s in Europe, social inequalities affecting various chronic diseases including diabetes were noted (Dalstra et al., 2005). The magnitude of these inequalities varies across countries. For example, in Denmark, individuals between 25 and 79 years with primary education level or less were 1.16 (CI%95 0.7-1.82) times more likely to be at risk of T2DM compared to individuals with more than primary educational level; while in Spain, the magnitude of this educational difference was greater [1.99 (CI95%, 1.38-2.87)] (Dalstra et al., 2005). These inequalities are not unique to Europe as populations from the United States and Canada have also shown similar results. For example, a study showed that in the

United States, the most deprived areas had the higher prevalence rates of diabetes (Connolly et al., 2000).

An important aspect is that when we took into account the risk factors mentioned above (age, BMI, physical activity, smoking, family history of diabetes, etc.), the SEP inequalities decreased but did not disappear (Escolar, 2009) or almost disappeared only among women (Agardh et al., 2004). One of the factors that could explain these inequalities is obesity which explains 26% and 36% of SEP inequalities in men and women respectively (Roskam et al., 2009).

Gender as another cause of inequality

Inequalities by SEP in the prevalence of diabetes are different in men and women, with greater inequalities in women than in men (Dalstra et al., 2005) and even some studies have found SEP inequalities in the prevalence of T2DM among women and inconsistent results among men (Robbins, et al., 2001).

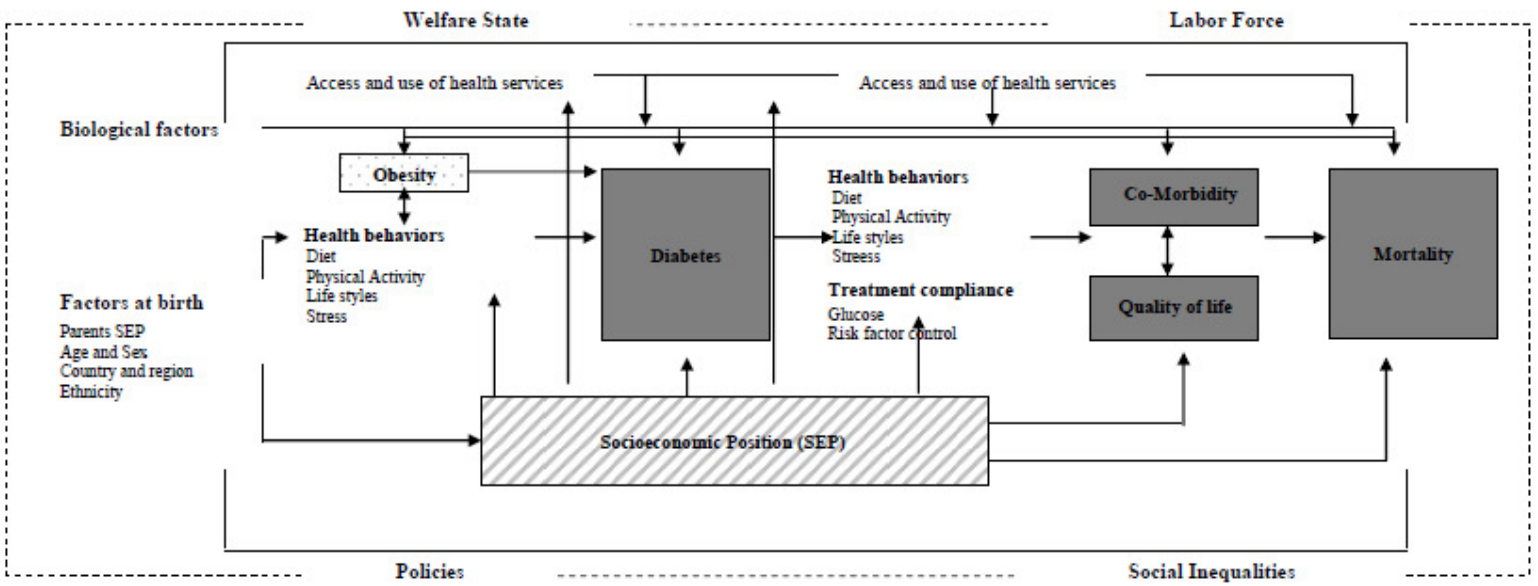
1.4 Conceptual framework of SEP inequalities in T2DM

As we have seen, SEP inequalities influence the various stages of T2DM including, pre-diabetes, the onset, the illness and the morality from T2DM. Biological and social factors have influence on the health of individual from the fetus period to death (Krieger et al., 1997) and diabetes is no exception.

Figure 4 represents the conceptual framework developed for this dissertation illustrating the relation between SEP and T2DM. The map is a result of a book chapter on the SEP inequalities affecting diabetes (Larrañaga et al., 2009) and the systematic review conducted by Brown et al (2004).

The biological factors at birth affect the likelihood of developing diabetes later on. It is estimated that around 40% of predispositions to diabetes are attributed to genetic causes. These are preventable as the individual will be influenced by factors associated to birth such as the parent's SEP, the age and stage of the onset, the country or region where the community lives and the ethnicity of the individual. All these factors determine the onset of diabetes and accompany the individual until his/her death. For example, the quality of life depends on the ability to have a healthy diet, physical activity and maintaining a good control of blood glucose levels (Glasgow et al., 1997).

Figure 4: Conceptual framework of SEP inequalities in T2DM.



Font: Espelt et al (2011).

Obesity has also been described as one of the principal risk factors of T2DM and its onset (Zimmet et al., 2001). Individuals from the U.S. with a BMI greater than 27kg/m^2 were 4.04 (CI95% 3.38-4.27) more likely of developing diabetes than those with a lower BMI (Bays et al., 2007). In addition, obesity is also closely linked to the different individual health behaviors (diet, physical activity, lifestyle and stress) which in turn may influence the onset of diabetes (Zimmet et al., 2001). Finally, access and usage of health services is essential for preventing and detecting diabetes at an early stage.

The majority of diabetes risk factors discussed have also been linked to the SEP of the individual such that individuals with the most deprived SEP demonstrate higher percentages in those risk factors (higher obesity, unhealthy diets and less physical activity) (Charafeddine et al., 2009; Droomers et al., 2001; Prynne et al., 2002). Therefore, these risk factors may modulate the inequalities found by socioeconomic position in T2DM. It should be noted that poor lifestyles (smoking, alcohol consumption and poor diet) especially in individuals from disadvantaged SEP, could be means used to cope with adverse and stressful situations. These unhealthy behaviors must be understood in the context of limitation in resources and limited access to the main determinants of health (Benach et al., 2001; Borrell et al., 2010).

However, as mentioned, once diabetes has been diagnosed, the risk factors mentioned still exist and can further affect the health of the individual by becoming possible risk factors for co - morbidities and a poorer quality of life which can ultimately lead to death. Moreover, once diabetes appears a new important factor needs to be considered: the adherence and control treatment (Glasgow et

al., 1997; McEwen et al., 2007). In this regard, the control of blood glucose, medication intake, and risk factors of the disease will be of considerable importance. Some studies suggest that the most SEP disadvantaged individuals will have the poorest control on blood glucose and chronic complications (Larrañaga et al., 2005).

2. JUSTIFICATION

Along with genetic susceptibility, T2DM has been linked to environmental and behavioral factors such as sedentary lifestyles, poor diet and obesity (Zimmet et al., 2001). During the twentieth century, major social changes have occurred worldwide (globalization, new technologies, changes in types of jobs) that have brought about changes in traditional lifestyles that should be accompanied with changes in public policy (Barrientos-Pérez & Flores-Huerta, 2008).

The St. Vincent declaration emphasized the need and urgency to improve epidemiological knowledge of diabetes in each European country in order to be able to establish strategies that reduce its prevalence and complications («Diabetes care and research in Europe: the Saint Vincent declaration», 1990). By 2000, it was estimated that prevalence rates would increase worldwide and that by 2030 there would be a significant increase in T2DM cases (Wild et al., 2004). Moreover, complications of diabetes would affect mortality since individuals with diabetes were most likely to die than people without diabetes throughout the course of the disease (Gu et al., 1998).

From the time that SEP inequalities in health took on a ethical and moral position by WHO because they considered them as avoidable and unjust (Whitehead, 1992), it has begun appearing in many studies that consider the influence of SEP inequalities on different disease around the world. A clear example is the study on SEP inequalities in Europe published by Mackenbach et al (2008).

However T2DM studies are minimal. In 2007, there were few European studies published that addressed SEP inequalities in T2DM and none really addressed the relation between SEP inequalities and the incidence, prevalence or mortality from diabetes in Europe during the turn of the century (Espelt et al., 2011). One of the few studies at the European level considered other disease but did not provide an extensive look at the results found on the inequalities in the prevalence of diabetes, although it pointed out interesting results (Dalstra et al., 2005).

The fact that recent estimates have increased the estimates of prevalence in diabetes by 2030 (Shaw et al., 2010) have led to the emphasis of needing to know what will happen to the trends in SEP inequalities noted so far. These trends in inequalities remain unknown. In Europe, only German researchers Icks et al. (2007) pointed out an increase in the inequalities in diabetes, although the study did not allow them to reach a statistically significant conclusion (Icks et al., 2007).

A major barrier in quantifying the SEP inequalities of T2DM is the great under-reporting that occurs (Franse et al., 2001; Rathmann et al., 2003). Some studies on SEP inequalities in T2DM use self-reported responses to questions on disease diagnosis while other use medical records or results from blood analyses. The first two present problems as no study analyzes the possible changes in response by validating the self-reported responses according to SEP.

Therefore, to study in depth the SEP inequalities on either the incidence, prevalence or mortality by T2DM at the European level, to study trends of these inequalities and to validate of self-reporting

T2M by SEP in surveys is necessary in order to tackle SEP inequalities in T2DM. Conducting a systematic review of available European studies would summarize the existing evidence on the SEP inequalities of T2DM in order to generate new hypotheses, new research studies and to promote successful methodologies in order to improve research focus and/or create successful interventions (Manchado et al., 2009).

PART II

Hypothesis and Objectives

3. HYPOTHESES AND OBJECTIVES

2.1 Hypotheses

The following assumptions were made:

1.- There exists inequalities in the incidence, prevalence and mortality of T2DM in Europe.

2.- Existing questionnaires are appropriate tools for the evaluation of SEP inequalities of T2DM.

3.- SEP inequalities of T2DM have increased over the years in Spain.

4.- Risk factors such as BMI, physical activity, cholesterol or hypertension contribute to the explanation of SEP inequalities of the incidence and prevalence of T2DM.

2.1 Objectives

a) General Objectives

The overall objective of this thesis is to analyze the socioeconomic position inequalities of the incidence, prevalence and mortality by type 2 diabetes mellitus.

b) Specific objectives

1.- To summarize the results of studies published between 1999 and 2009 on socioeconomic positions of the incidence, prevalence and mortality by type 2 diabetes in Europe.

2.- To validate the self-reported responses to diabetes within health surveys in order to assess the suitability of using them to estimate the relationship between socioeconomic position and self-reported diabetes.

3.- To analyze the trend in socioeconomic position inequality in the prevalence of type 2 diabetes mellitus in Spain in people aged 35 and above between the years 1987 and 2006.

4.- To determine and quantify the socioeconomic position inequalities in the prevalence and mortality by type 2 diabetes mellitus in Europe at the beginning of 21st century.

5.- To compare the prevalence and incidence of type 2 diabetes mellitus in relation to the magnitude of the inequalities in socioeconomic position.

6.- To analyze the influence of BMI and other risk factors on the socio-economic position inequalities of the prevalence and incidence of T2DM in individuals over the age of 50 in Europe between 2004 and 2006.

PART III

Methods and Results

4. METHODS AND RESULTS

In order to carry out the objectives, the thesis was carried out in 5 separate studies. These five studies were divided into 5 scientific articles:

a) Article 1: **Espelt A**, Arriola L, Borrell C, Larrañaga I, Sandín M, Escolar-Pujolar A. Socioeconomic position and type 2 diabetes mellitus in Europe 1999-2009: a panorama of inequalities. Curr Diabetes Rev. 2011 May 1;7(3):148-58.

b) Article 2: **Espelt A**, Goday A, Franch J, Borrell C. Validity of self-reported diabetes in health interview surveys for measuring social inequalities in the prevalence of diabetes. J Epidemiol Community Health. 2011 Apr 17.

c) Article 3: **Espelt A**, Borrell C, Roskam AJ, Rodríguez-Sanz M, Stirbu I, Dalmau-Bueno A, Regidor E, Bopp M, Martikainen P, Leinsalu M, Artnik B, Rychtarikova J, Kalediene R, Dzurova D, Mackenbach J, Kunst AE. Socioeconomic inequalities in diabetes mellitus across Europe at the beginning of the 21st century. Diabetologia. 2008 Nov;51(11):1971-9.

d) Article 4: **Espelt A**, Kunst AE, Palència L, Gnavi R, Borrell C. Twenty years of socio-economic inequalities in type 2 diabetes mellitus prevalence in Spain, 1987-2006. Eur Jour Public Health. Submitted

e) Article 5: **Espelt A**, Borrell C, Palència, Goday A, L, Gnavi R, Spadea T, Font-Ribera L, Kunst AE. Socioeconomic inequalities in the incidence and prevalence of diabetes among older people in Europe 2004-2006.xxx.submitted.

ARTICLE 1

Socioeconomic position and type 2 diabetes mellitus in Europe 1999-2009: a panorama of inequalities

Espelt A, Arriola L, Borrell C, Larrañaga I, Sandín M, Escolar-Pujolar A.

Curr Diabetes Rev. 2011 May 1;7(3):148-58

ARTICLE 2

Validity of self-reported diabetes in health interview surveys for measuring social inequalities in the prevalence of diabetes

Espelt A, Goday A, Franch J, Borrell C.

J Epidemiol Community Health. 2011 Apr 17

ARTICLE 3

Socioeconomic inequalities in diabetes mellitus across Europe at the beginning of the 21st century

Espelt A, Borrell C, Roskam AJ, Rodríguez-Sanz M, Stirbu I, Dalmau-Bueno A, Regidor E, Bopp M, Martikainen P, Leinsalu M, Artnik B, Rychtarikova J, Kalediene R, Dzurova D, Mackenbach J, Kunst AE.

Diabetologia. 2008 Nov;51(11):1971-9

ARTICLE 4

Twenty years of socio-economic inequalities in type 2 diabetes mellitus prevalence in Spain, 1987-2006

Espelt A, Kunst AE, Palència L, Gnavi R, Borrell C.

European Journal of Public Health. Submitted

Espelt A, Kunst AE, Palencia L, Gnavi R, Borrell C. Twenty years of socio-economic inequalities in type 2 diabetes mellitus prevalence in Spain, 1987-2006. Eur J Public Health. 2011 Dec 13. [Epub ahead of print]

Abstract

Background: To analyze trends in socio-economic inequalities in the prevalence of diabetes among men and women aged ≥35 years in Spain during the period 1987-2006.

Methods: We analyzed trends in the age-standardized prevalence of self-reported diabetes and obesity in relation to level of education using data from the Spanish National Health Survey for the years 1987, 1993, 1995, 1997, 2001, 2003 and 2006(86,345 individuals aged ≥35). To assess the relationship between education level and diabetes and obesity, we computed the Slope Index of Inequality and the Relative index of Inequality for each year. Additional models were fit to take into account mediator variables in SEP diabetes inequalities.

Results: The prevalence of self-reported diabetes was higher among persons of low educational level, increasing more rapidly over time among people with lower education level (5.0% to 12.6% in men, and 8.4% to 13.1% in women between 1987 and 2006) than among those with higher education level (6.3% to 8.7% in men and 3.8% to 4.0% in women). Relative inequalities showed a weak tendency to increase. In women, the RII of self-reported diabetes increased from 3.04(1.95-4.74) in 1987 to 4.28(2.98-6.13) in 2006, while in men were constant since 1993. Trends in SEP inequalities in diabetes prevalence were attenuated when mediator variables were taken into account in women but not in men.

Conclusion: SEP inequalities in diabetes existed more than 20 years ago and have increased, especially among women. These patterns may be explained by trends in health behaviors and obesity, but only to a limited extent.

ARTICLE 5

Socioeconomic inequalities in the incidence and prevalence of diabetes among older people in Europe 2004-2006

Espelt A, Borrell C, Palència L, Goday A, , Gnavi R, Spadea T, Font-Ribera L, Kunst AE.

. Submitted

Abstract

Objective: To compare prevalence and incidence of diabetes with regards to the degree of SEP inequalities, and the contribution of Body Mass Index (BMI) and other risk factors of SEP inequalities in diabetes, in people aged 50 years or more in Europe during 2004-2006.

Methods: This is a cross-sectional and longitudinal study of different countries in Europe. The study population included men and women aged 50 years or more who resided in 11 European countries. Data came from the Survey of Health, Ageing and Retirement in Europe in 2004 and 2006. All the people in the first period were included to calculate prevalence of diabetes. The second period included only people who did not have diabetes during the first period and were used to calculate incidence of diabetes. Dependent variables were self-reported presence of diabetes. The main independent variable was educational level. Prevalence Ratio(PR) and Relative Risk(RR) were calculated in order to study the association between educational level and prevalence and incidence of diabetes. Finally, we designed additional models using BMI, smoking, physical activity, cholesterol level, blood pressure and alcohol consumption as mediator variables.

Results: People with low educational level present the highest age-standardized prevalence and incidence of diabetes. People classified as ISCED equal or lower than 2 present higher risk than those classified as ISCED higher than 2 [PR =1.41 (95%CI: 1.28-1.57) in prevalence of diabetes; RR=1.42 (95%CI: 1.13-1.78) in incidence of diabetes]. Taking into account mediator variables, it

was found that the BMI was the major contributor for this inequalities (BMI explains 22% and 28.6% of these inequalities, respectively). After controlling for mediator variables, inequalities persist.

Conclusion: SEP inequalities in diabetes exist in prevalence of diabetes and in the incidence of diabetes among elderly. BMI has been shown as the main important factor to reduce these inequalities in Europe among elderly.

PART IV

Discussion

5.- DISCUSSION

The main results of this thesis are: 1) there are SEP inequalities in the incidence, prevalence and mortality from T2DM in Europe. 2) Over the past 30 years, the SEP inequalities in the prevalence of T2DM in Spain have increased especially among women. 3) During the past 30 years, the inequalities were greater among women than in men. 4) The risk factor that contributes most to the emergence of SEP inequalities of T2DM is the body mass index. 5) Self-reporting of diabetes on health surveys is an appropriate tool to measure the SEP inequalities of T2DM.

In order to discuss the findings of the thesis, the discussion has been divided. The first section of discussion is based on the use of the health surveys with self-reported diabetes to analyze SEP inequalities of diabetes. This first section is important because self-reporting of T2DM is the base of many studies on the SEP inequalities of the prevalence and incidence of T2DM. This allows us to discuss this issue prior to beginning the discussion in the following sections.

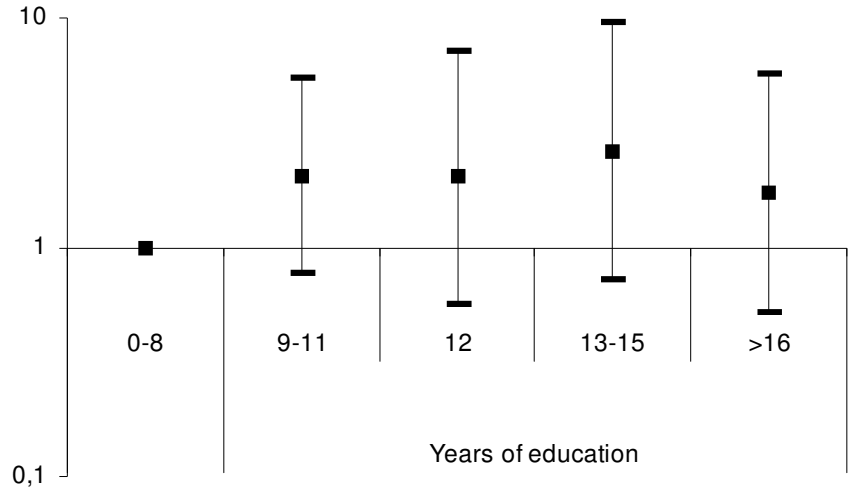
The remaining sections explain the findings of incidence, prevalence and mortality rates from T2DM by comparing them to other existing research. Therefore, the discussion section has been further divided into five subsections; the SEP inequalities in incidence of T2DM, SEP inequalities in mortality from T2DM, SEP inequalities in prevalence of T2DM, the evolution of inequalities in the prevalence of T2DM and the analysis of SEP inequalities of T2DM in Europe and around the world. Finally, we conclude with

limitations of the study and with a section for the conclusion and recommendations of the study.

3.1 Using health surveys to evaluate the SEP inequalities in T2DM

In the second study (Espelt et al., 2011), It was observed that there were no statistically significant differences between SEP and the sensitivity and specificity of self-reported T2DM in the health surveys. The sensitivity of less than primary educational level was 39% (95%CI 25.7 to 52.3) while an educational level of primary or more was 27.1% (95%CI 20.3-34.0). Although the estimated confidence intervals were quite wide because of the sample size, the results were still consistent with other studies. In Figure 5 we can see that Wilder et al. (2005) also found no differences in educational level and the probability of being diagnosed with T2DM (Wilder et al., 2005).

Figure 5: Odds Ratio of non-diagnosed diabetes in individuals 20 years and over by educational level.



Font: Wilder et al.(2005)

Wilder et al found contradicting results to their previous hypothesis (which was that there was SEP inequalities in undiagnosed T2DM). In the United States, individuals from the most deprived SEP would be more undiagnosed because in the United States, SEP affects access to health services and in turn the diagnosis of T2DM which would be diagnosed during routine check-ups or the appearance of complications (Wilder et al., 2005). In study 2 (Espelt et al., 2011), the findings might be as expected since Spain has a national health care system in which individuals receive free health care according to their needs. Therefore, individuals from most deprived SEP would receive medical attention more often than individuals from more advantaged SEP, regardless of their health status (Garrido-Cumbrera et al., 2010).

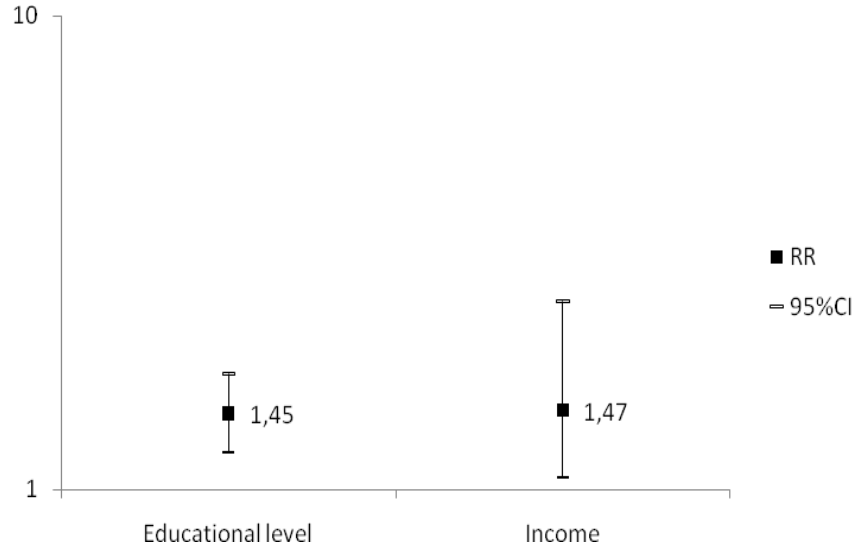
The fact that the conclusions from studies that use the self-reported T2DM variable and studies that use blood analyses variables are not significantly different, would also support the results of study 2 (Espelt et al., 2011). Therefore, it appears that health surveys with self-reported T2DM are an appropriate instrument for assessing SEP inequalities of T2DM.

These results are important because health surveys unlike administrative data are population based and therefore allow an estimate resembling more the population. In addition, health surveys include many more variables and therefore allow the analysis of many other areas as presented in this thesis.

3.2 SEP inequalities in the incidence of T2DM

As seen throughout the development of this thesis, studies in Europe found SEP inequalities in the incidence of T2DM. These results are summarized in study 1 (Espelt et al., 2011) and are supported by a recent systematic review (Agardh et al., 2011) (figure 6). The Agardh et al. (2001) study adds an interesting perspective at the worldwide level as it finds that despite the income of the country, there exists SEP inequalities of T2DM although in countries with high income these inequalities are more consistent (Agardh et al., 2011).

Figure 6: SEP inequalities (most deprived compared to the most advantaged) of the incidence of T2DM in Europe.



Source: Agarhd et al. (2011)

These results are similar to the ones found in study 5 where we saw that at the European level, individuals over 50 without T2DM and from deprived SEP, were at higher risk of developing diabetes than in people from more favorable SEP [RR= 1.38 (CI95%: 0.99-1.92)]. An important finding of this study was that these inequalities were significantly different according to gender. In women aged 50 years and over and from deprived SEP the risk of developing T2DM was 2.04 (95%CI, 1.20-3.49) times higher than those from more favourable SEP, while there was no significant difference notes in men (study 5).

After adjusting for variables such as age, physical activity, BMI and diet, the SEP inequalities of incidence of diabetes decreased (Kumari et al., 2004), and therefore indicated that these inequalities

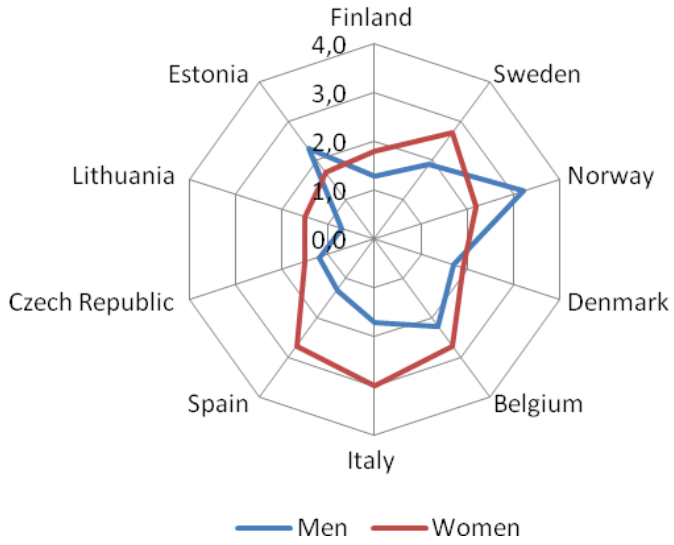
may be partially explained by these risk factors of developing T2DM. In fact, study 5 found that nearly 35.7% of the inequalities in the incidence of T2DM can be explained by these factors which are similar to the results found by Roskam et al. (2009) which placed the influence of BMI on inequalities of the prevalence of T2DM at around 30% (Roskam, 2009). Finally, it was observed that in women, the inequality of prevalence of T2DM trends are influenced by the trends in inequalities by BMI and other risk factors (study 4).

3.3 SEP inequalities in the prevalence of T2DM

In general, research reviewed prior to the start of this thesis (Agardh et al., 2004, 2007; Connolly et al., 2000; Evans et al., 2000; Geyer et al., 2004; Hiltunen, 2005; Icks et al., 2007; Larrañaga et al., 2005; Lawlor et al., 2007; Wandell & Gafvels, 2004) and studies that have been considered during the prepartion of this thesis (Andersen et al., 2008; Escolar, 2009; Gnavi, Karaghiosoff et al., 2008; Imkampe & Gulliford, 2010), have described the inequalities in the prevalence of T2DM in Europe (Espelt et al., 2011) using different measures for the levels of SEP (income, education level, employment or other characteristics describing the residence) (Espelt et al., 2011).

These SEP inequalities of T2DM were observed in most countries across Europe and were higher among women (figure 7). In general, in Europe, men aged 30 to 64 with low educational level were 1.6 (95%CI 1.4-1.9) times higher risk of T2DM than those with higher educational level while for women this ratio of prevalence was 2.2 (95%CI 1.9-2.7) (Espelt et al., 2008).

Figure 7: Inequalities of education level (low levels compared to high levels) in the prevalence of T2DM in men and women in Europe..



Source: Espelt et al.(2008)

In Spain and Italy, SEP inequalities in the prevalence of T2DM are more prominent in women than in men. Research so far has hypothesized that the differences in the magnitude of these SEP inequalities in the prevalence of T2DM between men and women is due to the existence of SEP inequalities in obesity, physical inactivity and psychosocial risks which would be higher among women than in men (Tang et al., 2003). Studies 4 and 5 confirmed that once adjusted for factors like obesity, inequalities decreased in women more than in men. However, these factors explained only part of the inequalities.

Italy and Spain continue to be the two countries in Europe with the greatest SEP inequality of T2DM gap among men and women (Espelt et al., 2008) which may suggest that the differences in

power between genders and the social roles of both groups can play an important role. Thus, countries such as Finland, Sweden, Denmark and Norway which have a high percentage of women in the labor market and redistribute rents higher than those of Spain or Italy (Espelt et al., 2008), have less social inequalities between men and women (i.e. power in society, differences in wages, working overtime, and poor working conditions) (Kroenke et al., 2007; Norberg et al., 2007). A European study found that 5% of men and 18% of women claiming that they had to care for children and elders impeded their ability to do physical activity (Zunft et al., 1999). This was linked to women and men from more advantaged SEP being more likely to divide housework and care of other people compared to individuals from deprived SEP (Badgett & Folbre, 1999), which could explain the differences in SEP inequalities of the prevalence of T2DM.

3.4 SEP inequalities in mortality by T2DM

SEP inequalities of mortality by T2DM in Europe have been studied using different methods:

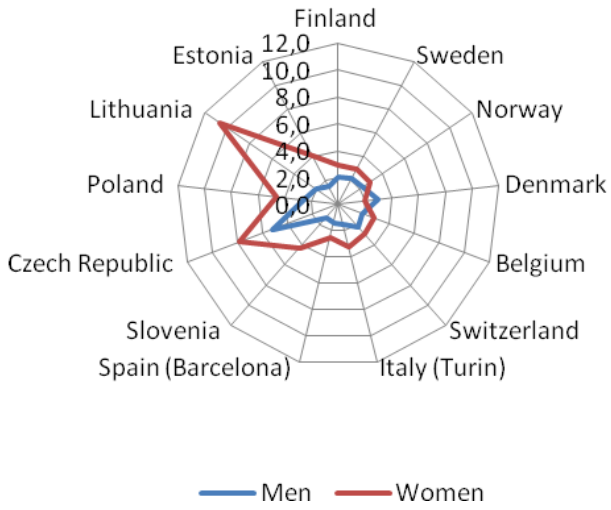
1- Based on cohorts of individuals with diabetes, observing for inequalities of mortality from any cause or diabetes (Forssas et al., 2003; Gnavi et al., 2004, 2011; Lawlor et al., 2007).

2- From death registers with census data linked to them (Espelt et al., 2008)

3- Based on data aggregated by geographical units (Weng et al., 2000).

In all cases, we have seen that there exist SEP inequalities in mortality by T2DM. In figure 8 we can see how in Europe these inequalities are generally greater in the eastern countries, which also have higher inequalities among women. In general, the risk of dying from diabetes in Europe in men was 2.0 (95%CI 2.6-5.4) times higher in people of lower educational levels compared to those from higher educational levels and 3.4 (95%CI 2.6-4.5) times in women (Espelt et al., 2008).

Figure 8: Inequalities of education level (low levels compared to high levels) in mortality by T2DM in men and women in Europe.



Source: Espelt et al. (2008)

These inequalities are multi-causal. In individuals with T2DM it is very important to prevent possible complications of the disease as this will depend on the quality of life and the risk of dying. Individuals from most deprived SEP, tend to be less aware of their health and less efficient in the use of available resources in the

process of care (Brown et al., 2004). In fact, although individuals of deprived SEP use more primary care services, they tend to have poorer control over the disease (Larrañaga et al., 2005) and fair worse on the indicators of quality of care (Hippisley-Cox et al., 2004) compared to those from more favorable SEP.

In this way we have seen that individuals from deprived SEP with T2DM are more likely to have cardiovascular complication, more retinopathy problems, kidney disease and amputations due to poor control of blood glucose, poor access to health care and poor control in the process of self-care (Brown et al., 2004). Multidisciplinary teams of professionals and the integration of psycho-educational interventions could improve the well-being, self-care and disease control in people with T2DM (Wagner et al., 2001) and could help reduce inequalities in mortality.

The differences between the eastern countries and the rest of Europe (Espelt et al., 2008), could be attributed to the characteristics of each country such as the availability of healthy food, access to places for exercise, safety, transportation, environmental exposures and access to health services (Brown et al., 2004) and possibly the degree of socioeconomic development (state of welfare, social spending, labor market and wealth) (Borrell et al., 2007; Navarro et al., 2006).

3.5 Trends in the inequalities in the prevalence of T2DM

It is estimated that the increase in the prevalence of T2DM at a worldwide level (Shaw et al., 2010; Wild et al., 2004) caused

wonders in what would happen with the SEP inequalities in the prevalence of T2DM at the end of the twentieth century in Europe (Espelt et al., 2011).

Icks et al.(2007) and Imkampe & Gulliford (2010) estimated trends in SEP inequalities of T2DM in Germany and England and both studies found an increase in inequality. The first during the 90s and while the second was during 1994 to 2006 (Icks et al., 2007; Imkampe & Gulliford, 2010). However, there were no studies done within Southern Europe that have very different social characteristics. For example, these countries have a prevalence of obesity and T2DM that is higher, as well as patters of diet and other different lifestyles (Moreno et al., 2002; Varo et al., 2002; Vaz et al., 1999), and also different policies and welfare states (Borrell et al., 2009; Espelt et al., 2008).

Study 4 showed that SEP inequalities of T2DM have emerged in men and women and have grown since 1987, confirming that the increase had already been reported in studies from Germany and London (Icks et al., 2007; Imkampe & Gulliford, 2010).

Explanations for this increase in the inequalities of the prevalence of T2DM could be attributed largely to the evolution of SEP inequalities of obesity. As seen in study 4, the trends of the SEP inequalities of obesity are similar to SEP inequality trends of T2DM in a study conducted over 20 years. During these 20 years there were many changes both in Spain and worldwide. In general, there were changes in physical activity levels of the population (declining physical activity) (Brownson et al., 2005; Meseguer et al., 2011), changes in nutrition and diet (introduction of fast-foods and opening of food markets were barriers across countries) (Moreno et al.,

2002)) and changes in social structure (i.e. women entering the work force, changes in types of employment and an increase in education levels) within population and influencing lifestyles which could in turn affect obesity

3.6 Heterogeneity in Europe, homogeneity in the world

Some studies have focus on the social inequalities in the prevalence of some chronic disease, in the mortality and in perceived health at the European level (Dalstra et al., 2005; Espelt, et al., 2008; Huisman et al., 2005; Kunst et al., 1998; Mackenbach et al., 2008). Dalstra et al. (2005) found that in Europe the SEP inequalities of T2DM did not show a very different patter than from those for arthritis, hypertension or heart disease (Dalstra et al., 2005). This study, like our thesis, shows a high degree of variability at the European level that may explain the particular situation of each country. Some studies have found that health inequalities could be reduced when taken into account contextual variables of the welfare state, labor market, wealth and income inequality (Borrell et al., 2009). Moreover, countries with less social or redistribute polices show higher health inequalities (Espelt et al., 2008). Then, the politics of welfare in each country may influence the inequalities of T2DM (unequal access to healthy foods, facilities for sports, health services and so on as SEP). In fact, this in addition to the different effects of globalization in each country in the sense that it affects changes in diet (Thow & Hawkes, 2009) and the type of physical activity of individuals (reduction of physical activity at work is not compensated in free time activity) which may contribute to the evolution of SEP inequality of T2DM in each

country. Thus, we see that within Europe there is great heterogeneity among countries in respect to these inequalities.

However, SEP inequalities of T2DM are not unique to Europe. As we have mentioned, a recent literature review by Agragdh et al. concluded that the risk of developing T2DM is associated with SEP in disadvantaged countries of high, medium and low income (Agardh et al., 2011). Specific studies have found inequalities in other countries like Japan and the United States. These were SEP inequalities of incidence (Maty et al., 2005; Maty et al., 2008), prevalence (Kanjilal et al., 2006) and mortality by T2DM (Dray-Spira et al., 2010; Saydah & Lochner, 2010). Thus we see that despite the diversity of each country, SEP inequalities of T2DM are present in Europe and worldwide, and the democracy, political traditions, globalization and welfare state could play an important role to understand these differences between countries worldwide (Muntaner et al., 2011).

3.7 Limitations

When evaluating the results of this thesis, it should be taken into account certain limitations that appear in different studies. Here are most important ones (to see more details, you can see the limitation section of each article).

Firstly, within the revision study (Espelt et al., 2011) it should be noted that only studied focused exclusively on diabetes was included. Those that included more than one chronic condition were not considered due to the complexity of finding and reviewing all and the little information they would contain on the SEP

inequalities of T2DM. However, the results of the review were similar with other results in the studies that included more than one disease (Dalstra et al., 2005). Another limitation in the study was that the majority of research looked at presented different methodologies that did not allow the conduction of a meta-analysis.

Secondly, within the study on validation, the main limitation was the sample size that did not allow for the stratification by gender and the division into several categories of SEP. The small sample size also meant that the results must be analyzed with precaution (Espelt et al., 2011) while being consistent with other studies (Rathmann et al., 2005; Wilder et al., 2005) as has been mentioned.

Thirdly, in studies 3, 4, 5, a significant limitation was due to the under-diagnosis of T2DM. If the diagnosis of diabetes depended on the SEP, we could estimate or underestimate self-reported cases of T2DM in a given SEP, resulting in an incorrect comparison between the groups. However, here lays the important information provided by study 2 which showed that there are now statistically significant differences in the validity or specificity of self-reported T2DM between SEP (Espelt et al., 2011).

Finally, in study 3, some of the limitations of the design of the mortality study should be taken into account. Some Eastern European countries were not linked with the census data used leading to possibly different results due to the design used. However, we have seen that the differences within the results in the two designs are not very large and not necessarily in the same systematically direction (Kunst, 1997).

3.8 Conclusions and recommendations

The main conclusion of the thesis is that in Europe there exists socioeconomic position inequalities of T2DM and has existed for over 20 years. Moreover, it appears to be larger among women than in men. We have seen that obesity, diet and physical activity are among the main risk factors for developing T2DM. Thus, a possible strategy to control the increase in the prevalence and mortality by T2DM would be the prevention of these factors as recommended by the ADA (American Diabetes Association, 2010). However, it should be noted that the risk factors in individuals with deprived SEP, are usually a result of living conditions and often a way to deal with social and economic situations.

In this sense, significant differences were found for SEP and in order to address these inequalities, public policy should not rely solely on the individual but also focus on promoting and facilitating healthy lifestyles for the whole population (American Diabetes Association, 2010; Barrientos-Pérez & Flores-Huerta, 2008).

This would be necessary in areas where individual and social life occurs, where enacted laws and developing policies are needed to improve the physical and social environment. Currently, some of the actions that have been taken are the improvement of information on food, the removal of unhealthy foods from food machines, the changes to menus served at schools, people being informed about obesity, restrictions on certain advertisement and the promotion of physical activity through various programs (Barrientos-Pérez & Flores-Huerta, 2008). However, trends in SEP inequalities in T2DM in Europe suggest that the strategies undertaken are not sufficient as seen in study 4 where data in

Germany and England show that these SEP inequalities have increased or remained constant (Icks et al., 2007; Imkampe & Gulliford, 2010), although these increases could be attributed to the improvements in diagnosis of individuals with more disadvantaged SEP (Imkampe & Gulliford, 2010).

Thus, a new line of research would be essential to study how contextual factors could influence the SEP inequalities of the incidence, prevalence and mortality by T2DM. Understanding the mechanisms of context is important as individuals with deprived SEP tend to have worse disease control, worse access to health services (Ricci-Cabello et al., 2010) and a less healthy lifestyle (Dowler, 2001) which are important in order to be able implement health policies to prevent individuals from higher risks and mortality by T2DM because of their socioeconomic position.

Finally, another line of research is essential in order to understand the complete social determinants that cause women to experience greater SEP inequalities of T2DM compared to men. To date, the majority of papers have found that most SEP inequalities occur in women compared to men in Europe (Espelt et al., 2011) but they lack the information needed to determine the true causes of this.

6.- SUMMARY OF CONCLUSIONS

The final conclusions of this thesis are:

1. In Europe there exist differences in Socioeconomic Positions (SEP) of Type 2 Diabetes Mellitus (T2DM), and individuals from more deprived SEP have higher incidence, prevalence and mortality by T2DM.

2. In Europe, SEP inequalities of incidence, prevalence and mortality by T2DM were higher in women than in men.

3. The SEP inequalities of the prevalence of T2DM have existed in Spain for over 20 years and have emerged in men.

4. The trend in SEP inequalities of the prevalence of T2DM could be explained by trends in SEP inequalities of obesity and to a lesser extent by other risk factors.

5. There exist SEP inequalities of the incidence of T2DM in women 50 years and over while it does not exist in men

6. The risk factors that best explains these SEP inequalities is obesity.

7. Self-reporting of diabetes on health surveys is an appropriate instrument for analyzing SEP inequalities of T2DM.

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APPENDIX

APPENDIX

ARTICLE 1

[Gender inequalities and type 2 diabetes: the importance of the difference]

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