Time trends in the incidence of cardiovascular disease, hypertension, and diabetes by socioeconomic status in Catalonia, Spain

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Research Article

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Abstract

**Background:** It is unclear how cardiovascular disease, hypertension, and type 2 diabetes mellitus incidence trends have evolved in different population subgroups by age, sex, and socioeconomic status. Our study aims to estimate the trends in cardiovascular disease, hypertension, and type 2 diabetes mellitus incidence in Catalonia, Spain from 2009-2018, considering age, sex, and socioeconomic deprivation.

**Methods:** Our study is a population-based cohort study using prospectively collected data from electronic health records from primary care and hospital settings in Catalonia, Spain, from 2009-2018. Our final study population included 3,247,244 adults (≥40 years). We calculated the annual incidence (per 1000 persons-year) and incidence rate ratios (IRR) between three time periods of cardiovascular disease, hypertension, and type 2 diabetes mellitus to measure trends and changes in incidence during the study period.

**Results:** In 2016-2018 compared to 2009-2012, cardiovascular disease incidence increased in the 40-54 (e.g., IRR=1.61, 95%CI: 1.52-1.69 in women) and 55-69 (1.35, 1.31-1.40 in women) age groups. There was no change in cardiovascular disease incidence in women aged 70+ years, and a slight decrease in men aged 70+ years (0.93, 0.90-0.95). Hypertension incidence decreased in all age groups for both sexes. Type 2 diabetes mellitus incidence decreased in all age groups for both sexes (e.g., 0.72, 0.70-0.73 in women aged 55-69 years), except for the 40-54 year age group (e.g., 1.09, 1.06-1.13 in women). Incidence trends by deprivation for all three conditions mirrored overall trends, although there were higher incidence levels in the most deprived areas, especially in the 40-54 and 55-69 year groups. These differences have remained constant or narrowed in recent years.

**Conclusions:** Overall cardiovascular disease incidence has increased while hypertension and type 2 diabetes mellitus incidence have decreased in the last years in Catalonia, Spain. Differences in trends by age group and socioeconomic deprivation were found. Calling attention to these differences can serve to inform policies aimed at reducing the burden of these conditions and health inequities.

1. Introduction

Cardiovascular disease (CVD) is presently the leading cause of death worldwide, being responsible for nearly 18 million global deaths in 2016 (1). Moreover, current projections estimate that global deaths due to CVD will increase to 23 million by 2030 (2). The high global burden of CVD can be partly attributed to the high prevalence of numerous CVD risk factors, such as tobacco use, high cholesterol, hypertension, and type 2 diabetes mellitus (3). Furthermore, hypertension (HTN) and type 2 diabetes mellitus (T2DM) share common risk factors with CVD, often resulting in similar disease management plans (4).

Previous epidemiological studies have found that trends in CVD (5), HTN (6), and T2DM (7) incidence are stabilizing or declining in most high-income countries. In Spain, CVD, HTN, and T2DM occur in a high percentage of the population, despite Spain having one of the highest life expectancies among European countries (1). However, few studies to this date have taken into account possible differences by population subgroups. For example, past studies have identified that individuals of a low socioeconomic status (SES) are at a greater risk of developing CVD (8), HTN (9), and T2DM (10). Other studies within Spain have also signaled health inequalities by SES (11–13). Moreover, higher prevalences of CVD (14), HTN (15), and T2DM (16, 17) have been found in lower SES population subgroups throughout Spain. Detailed information on CVD, HTN, and T2DM incidence rates is still scarce, however, due in part to a lack of longitudinal data.

Longitudinal data allows for time trend analyses, which are important for monitoring chronic illness rates and planning interventions and prevention strategies directed specifically towards population subgroups whose trends are not improving or evolving at the expected or desired rate. Understanding CVD, HTN, and T2DM trends over time by population subgroup is necessary for developing more comprehensive care plans that take into account the nuanced needs of each specific group and is an important step towards achieving health equity. Our study aimed to estimate the time trends in the incidence of CVD, HTN, and T2DM in Catalonia, Spain from 2009–2018 while considering possible differences by age, sex, and SES.

2. Methods

**Study design, setting, and data source**

We performed a cohort study with prospectively-collected data from the Information System for Research in Primary Care (SIDIAP; www.sidiap.org). SIDIAP is a large, pseudonymized electronic healthcare record (EHR) dataset comprised of data collected by healthcare professionals during routine visits to primary care clinics in Catalonia, Spain since 2006 (18). It contains EHR data on approximately 6 million people (around 75% of the population living in Catalonia) and is highly representative of the resident population of Catalonia in terms of age, sex, and geographic distributions (18). The information recorded in SIDIAP includes demographic and lifestyle factors (e.g., smoking status, alcohol use), clinical measurements (e.g., body mass index, blood pressure), disease diagnoses (International Classification for Diseases, 10th revision [ICD-10]), specialist referrals, laboratory tests, and prescribed and dispensed medications (18). SIDIAP is linked to a hospital discharge database (Conjunt Mínim Bàsic de Dades d’Alta Hospitalària, CMBD) including diagnoses and procedures registered during hospitalization in all public and private hospitals of Catalonia. Because the data in SIDIAP is pseudonymized, consent was waived per the International Ethical Guidelines for Epidemiological Studies (19). This study was approved by the Clinical Research Ethics Committee of the IDIAPJGol (project code: 20/237-P).
Study population

We included all adults at least 40 years of age at time of entry into the study who were registered in SIDIAP between January 1, 2009 and December 31, 2018, with at least one year of observed data, and free of cardiometabolic conditions. Though SIDIAP has data available starting in 2006, we chose for our study period to begin in 2009 to minimize the potential inclusion of prevalent cases of CVD, HTN, and T2DM during the first years of SIDIAP; healthcare professionals recorded data retrospectively and health centers transferred data from paper to EHRs during the computerization process. The index date was the first recorded primary care visit during the study period. Individuals were followed from cohort entry until diagnosis with an outcome of interest, the end of the study (December 31, 2018), death, or transferring out of SIDIAP.

Study variables

Our conditions of interest were CVD, HTN, and T2DM. We defined HTN and T2DM based on ICD-10 codes registered by general primary care practitioners, while we defined CVD as any diagnosis of coronary or cerebrovascular disease registered in ICD-10 or ICD-9 codes in both primary care and hospital settings. The diagnostic codes used for our definitions of CVD, HTN, and T2DM can be found in Table S1. We extracted data on sex (male/female, referred to by gender “men” and “women” throughout the manuscript) and age (groups: 40–54, 55–69, and 70 + years). Information on SES was available for urban areas at the census tract level through the Mortalidad en áreas pequeñas españolas y desigualdades socioeconómicas y ambientales (MEDEA) index of socioeconomic deprivation. The MEDEA index is a composite index that takes into account five indicators of employment status and education level (20). The deprivation index was only available for urban areas, defined as municipalities with more than 10,000 inhabitants and a population density greater than 150 habitants/km². Areas with a lesser population density were considered rural areas. For our study, we categorized the MEDEA index into quintiles, with the first and fifth quintiles representing the least and most deprived urban areas of Catalonia, respectively. For descriptive purposes we also extracted data on nationality (categories), smoking status (categories), and alcohol use (categories).

Statistical analyses

We started by performing a descriptive analysis of our study population. Individuals diagnosed with a CVD, HTN, or T2DM were not considered as eligible incident cases for the same condition in future years after the year of their first diagnosis. We calculated the overall incidence rate of CVD, HTN, and T2DM for each study year from 2009–2018, stratified by sex. Incidence was calculated as the number of new cases of each condition divided by 1,000 person-years of follow-up, and person-years were calculated as the number of years each individual was at risk of developing one of the three conditions during the study period. Next, we calculated yearly incidence rates of all three conditions, stratified by sex and age group. Finally, we restricted these same analyses to individuals living in urban areas and stratified additionally by SES.

To assess incidence trends over time, we calculated incidence in three equivalent sub-periods, from January 1, 2009 to December 31, 2012, January 1, 2013 to December 31, 2015, and January 1, 2016 to December 31, 2018. We then calculated incidence rate ratios (IRRs) and their corresponding 95% confidence intervals (95% CIs) for each age-sex subgroup to analyze the differences in incidence between the sub-periods. To estimate differences in incidence trends by SES, we calculated IRRs and 95% CIs and percent change between the years 2009 and 2018 for the least deprived and most deprived areas. We calculated percent change of incidence by dividing the difference between incidence in 2018 and the incidence in 2009 by the incidence in 2009 and multiplying by 100. Analyses were conducted in Stata 17.0 and in R Core Team 2016 (R Project for Statistical Computing).

3. Results

The study population included 3,247,244 adults over the age of 40, with a median age of entry into the study of 58 years (Interquartile range [IQR]: 47 - 71) (Table 1, Figure S1 & Table S2). 52.6% of the population were women and 92.2% had Spanish nationality. 7.0% of the population was diagnosed with CVD, HTN, and T2DM cases were more frequently current smokers and had high risk alcohol intake. Individuals with a CVD and HTN diagnosis had a similar socioeconomic distribution to the general population. However, individuals with a T2DM diagnosis were more frequently from the lowest socioeconomic quintile, compared to the general population (14.3% vs. 12.2%, respectively).

Cardiovascular disease incidence

Incidence rates of CVD increased from 2009 to 2018 in both sexes, except in the 70+ age group (Figure 1). Incidence increased most sharply in the 40-54 age group in both sexes (e.g., in men from 4.03/1,000 person-years in 2009 to 6.64/1,000 person years in 2018) (Table S2). In women aged 40-54 years, CVD incidence was 61% (95% CI: 52% - 69%) higher from 2016-2018 compared to 2009-2012, while it was 22% (16% - 29%) higher from 2013-2015 compared to 2009-2012 (Figure 2). This suggests a steeper increase in incidence in the most recent years of study. Incidence rates of CVD also increased in the 55-69 age group (e.g., in women from 5.08 in 2009 to 7.43 in 2018), with a steeper increase in CVD incidence in the more recent years of study in both sexes (Table S2 and Figure 2). In the 70+ age group, there was little or no change in CVD incidence in both women and men from 2013-2015 and 2016-2018 compared to 2009-2012, though we observed a slight decrease in CVD incidence in men from 2016-2018 compared to 2009-2012 (IRR = 0.93, 0.90 - 0.95).
Trends in CVD incidence by SES mirrored the overall trends of CVD incidence (Figure 3). We observed higher incidence levels in the most deprived areas, especially in the two youngest age groups. For example, in women aged 40–54 years, the 2009 incidence of CVD was 81% (42% - 131%) higher in the most deprived areas compared to the least deprived areas (Table 2). The 2018 incidence of CVD was 68% (39% - 103%) higher in the most deprived areas compared to the least deprived. This signals a slight narrowing of difference in CVD incidence by SES during the study period in women, though incidence still remains significantly higher in the most deprived areas. Incidence was also higher for the most deprived areas compared to the least deprived areas for the 50–69 age group in both sexes, albeit to a lesser magnitude, and the difference in CVD incidence between the most and least deprived areas remained roughly the same between 2009 and 2018. Differences in incidence by SES were not evident in the 70+ age group. The detailed presentation of these results can be found in Table 2.

Hypertension incidence

HTN incidence increased from 2009 to 2013, before decreasing from 2014 to 2018 for both sexes and in all age groups (e.g., in men aged 55-69 from 36.83 in 2009 to 38.70 in 2013 to 20.57 in 2018) (Figure 1 and Table S2). In both women and men, incidence decreased most sharply in the 70+ age group (e.g., in men from 33.28 in 2013 to 15.92 in 2018). For example, in women aged 70+, HTN incidence decreased by 39% (37% - 40%) in 2016-2018 compared to 2009-2012 and by 10% (9% - 12%) in 2013-2015 versus 2009-2012 (Figure 2). These results suggest that incidence rates have begun to decrease more sharply in recent years. These same trends were consistent in all age groups, except in the case of 40-54 years olds where HTN incidence was higher from 2013-2015 compared to 2009-2012, but then began to decrease in 2016-2018. For example, in women aged 40-54, HTN incidence was 13% (11% - 15%) higher in 2013-2015 compared to 2009-2012, but then decreased by 4% (2% - 6%) in 2016-2018.

Stratifying by SES, higher incidence levels were observed in the most deprived areas in the two youngest age groups (Figure 3). For example, in women aged 40-54 years, the 2009 incidence was 52% (41% - 65%) higher in the most deprived areas compared to the least deprived (Table 2). However, in women aged 70+, HTN incidence in 2009 was 17% (11% - 22%) lower for the least deprived areas. Considering percent change, incidence levels have similarly decreased for both the most and least deprived areas across all age groups in women. However, in men, slight inequalities become evident. For example, in the 40-54 age group, HTN incidence increased by 2.68% in the most deprived areas, while decreasing by 4.15% in the least deprived areas. On the other hand, in the 70+ age group, incidence in the most deprived areas decreased by 53.85% compared to 39.56% in the least deprived areas. The detailed presentation of these results can be found in Table 2.

Type 2 diabetes mellitus incidence

Type 2 diabetes mellitus incidence decreased in the 55-69 and 70+ age groups for both sexes (e.g., in men aged 70+ from 17.78 in 2009 to 10.66 in 2018), while slightly increasing in the 40-54 age group (e.g., in men from 8.33 in 2009 to 9.48 in 2018) (Figure 1 and Table S2). In women aged 40-54 years, T2DM incidence was 9% (6% - 13%) higher in 2016-2018 compared to 2009-2012 (Figure 2). However, T2DM incidence slightly decreased in the 55-69 age group and more sharply in the 70+ age group in both sexes. In women aged 70+, incidence was 37% (34% - 39%) lower in 2016-2018 compared to 2009-2012 and 14% (12% - 17%) lower in 2013-2015 compared to 2009-2012, suggesting a slightly sharper decrease in incidence in more recent years. This same differential in cumulative incidence between 2013-2015 and 2016-2018 compared to 2009-2012 was also observed in the 55-69 age group in both sexes.

When considering socioeconomic status, higher incidence levels were once again observed in the most deprived areas, especially in the 40-54 and 55-69 age groups (Figure 3). For example, in women aged 40-54 years, the 2009 T2DM incidence was 2.85 (2.46 - 3.29) times higher in the most deprived areas compared to the least deprived areas, and 2.19 (1.90 – 2.52) times higher in the most deprived areas compared to the least in 2018 (Table 2). This suggests that inequalities in T2DM incidence by social class have slightly decreased from 2009 to 2018, though incidence still remains significantly higher for those who live in the most deprived areas. Differences in incidence by socioeconomic status are not as evident in the 70+ age group. The detailed presentation of these results can be found in Table 2.

4. Discussion

In this cohort study of over 3.2 million adults, we found that overall CVD incidence increased while HTN and T2DM incidences decreased in both women and men from 2009–2018, although there were slight differences by age group and specific time period. For example, CVD incidence decreased in the 70+ age group, while T2DM incidence increased in the 40–54 age group. HTN incidence increased from 2009–2013, before dropping until 2018. When stratifying by SES, higher incidence levels were observed in the most deprived areas, especially in the youngest two age groups, despite CVD, HTN, and T2DM trends mirroring the overall trends.

Our study found increasing CVD incidence in the 40–54 and 55–69 year age groups, but decreasing CVD incidence in the 70+ year age group. Past studies have mostly identified decreasing CVD incidence in most high-income countries during the late 20th and early 21st centuries (5). Moreover, studies on global (21) and European (22) CVD mortality both found that CVD mortality rates have decreased in past decades in adults. Within the context of specific European countries, a study of incident myocardial infarction in the United Kingdom (UK) found that hospitalization events have been increasing in recent years (23). Moreover, a study from Girona, Spain from 2005 found an increase in heart attack incidence in adults (24). However, the results of these studies have not been stratified by age group and, thus, it is difficult to compare directly with our results.
Few studies have considered differences in CVD trends across multiple age groups in the same study. A study performed in England and Wales found that rates of coronary heart disease increased among the youngest age group of men (35–44 years), despite decreasing steadily among the oldest age group (25). Furthermore, a review of CVD epidemiology in young adults found that, in contrast to older adults, trends in CVD incidence in young adults have been increasing or plateauing in recent decades (26). These results, which are congruent with the findings of our study, highlight the importance of considering potential differences by age when understanding disease trends, as all population subgroups may not exhibit the same trends. Differences in CVD incidence trends by age group may be explained by the fact that in many developed countries, rates of important CVD risk factors such as substance abuse (27, 28), physical inactivity (29), and obesity (30) are increasing among adolescents and young adults. Moreover, these risk factors do not affect all population subgroups equally, with low SES being associated with higher rates of substance abuse (31, 32), physical inactivity (32), and obesity (33). As a result, we would expect higher CVD incidence among individuals of a low SES, which we discuss in more detail below.

Our study found a decrease in HTN incidence after 2013 across all age and sex groups. Few studies to our knowledge have looked at longitudinal time trends in HTN incidence. Our results are consistent with a study of HTN incidence trends from 1995–2015 in the UK, which also found decreasing HTN incidence in adults after a peak in 2007, due in part to greater control and prevention efforts (34). Our results are also consistent with past multi-country studies that have studied HTN prevalence. For example, a worldwide study on trends in hypertension prevalence from 1990–2019 showed that, among high-income countries, HTN prevalence has declined as health systems have achieved high control rates during recent decades (35). Both the data from Spain as well as from other comparable European countries all follow the same decreasing trends (35). Given that HTN prevalence is decreasing, we would expect incidence rates to mirror this decrease as well.

We found a marked decrease in HTN incidence starting in the year 2013. We hypothesize this may be due to the implementation of the electronic prescription system and a plan for HTN control in Catalonia around a similar time. In 2013, the Catalan Health Institute (ICS) officially implemented an electronic prescription system. This system allowed primary care physicians to upload and edit prescriptions for HTN medications to the online system, making it easier to accurately record patients with an incident HTN diagnosis (36). Secondly, in 2011 a plan was implemented by the ICS to better control HTN within the resident population of Catalonia (37). This plan included specific objectives for HTN prevention, with economic benefits for healthcare clinics and providers that met the objectives of the plan (37). This plan and its associated benefits may incentivized HTN prevention and control around 2011 when it was implemented, perhaps leading to a decrease in HTN incidence in subsequent years. Given that both of these changes took place around the same time frame, we hypothesize that their combination may explain the HTN incidence trends observed by our study.

Our study found that T2DM incidence decreased in the both 55–69 and 70+ year age groups, while increasing in the 40–54 year age group. Past studies have found that T2DM incidence is decreasing in a majority of global adult populations during recent decades (38), especially among high income countries (7). A previous study found that T2DM prevalence and incidence was increasing in Europe between the years 1995–1999, including in Spain (39), a trend that reversed both at the European and global levels around 2006 (38). There are few studies on T2DM incidence trends in Spain in recent years, though a past study found that mortality rates for T2DM fell markedly between the years 1998–2013 (40). However, studies conducted within other European countries show varying findings. For example, a study in Portugal found increasing T2DM incidence, especially among older age groups (41), though another study carried out in the UK found decreasing T2DM incidence in recent years (42). Thus, it is important to study T2DM incidence trends by varying populations to have an updated understanding of the situation of each specific population.

There have been few studies to consider trends in T2DM incidence by age group, despite evidence of differences in T2DM prevalence by age group (43). A study performed among a Canadian adult cohort found that T2DM incidence increased at a much greater rate in adults between 20–49 years, compared to adults older than 50 years (44). Similarly, a study of T2DM incidence trends in US American adults found a greater increase in T2DM incidence between 1980–2012 among adults aged 20–44 years, compared to adults aged 45–64 years (45). These differences by age group may be due to a greater increase in obesity prevalence in younger adults compared to older adults, both within Spain (30) as well as globally (46, 47), given that overweight and obesity are among the greatest risk factors for T2DM (48). Although a direct link between obesity and T2DM cannot be established with our study alone, the trends in T2DM incidence found by our study coincide with the increase in obesity in Spain (49, 50). Furthermore, low SES is associated with higher levels of physical inactivity (32) and obesity (33) and we would therefore expect disproportionate T2DM incidence across SES, as we discuss in more detail below.

Based on our results alone, it is difficult to assess whether incidence trends in HTN and T2DM are truly decreasing or if our results highlight a potential deficiency in HTN and T2DM prevention and control. Uncontrolled HTN (51) and T2DM (52, 53) lead to higher CVD incidence in the long term given that they are main risk factors for CVD. Therefore, if prevention and early detection of HTN and T2DM are not effective, patients may never receive a HTN or T2DM diagnosis but may be diagnosed directly with CVD in the long run as a result of not having their HTN and/or T2DM effectively prevented, diagnosed, or controlled. In this scenario, we would expect to see decreases in HTN and T2DM incidences paired with an increase in CVD incidence, as is signaled by our results.

Our study identified higher incidences rates of CVD, HTN, and T2DM in the most deprived areas, despite there being similar trends in incidence as in the least deprived areas. CVD, HTN, and T2DM incidence was especially higher in the 40–54 and 55–69 age groups in both sexes in the most deprived areas compared to the least. This suggests that, compared to individuals from less deprived areas, individuals residing in more deprived areas may be more likely to be diagnosed with CVD, HTN, or T2DM at a younger age. It is well documented that individuals of a low SES are at a higher risk of CVD (54), HTN (9), and T2DM (55, 56) and have a reduced life expectancy and higher risk of premature mortality (57, 58) than
individuals of a higher SES. Past studies have also looked at the effect that low SES has on individual health behaviors such as smoking (59) and their harmful effects on health. However, it is important to also take into account the structural factors that impact individual health and individuals’ abilities to be healthy and take care of themselves. For example, low SES and education levels influence food behaviors (60), physical activity patterns and abilities (61), and access to preventative healthcare (62), all of which influence CVD, HTN, and T2DM risk. Therefore, though individuals of a low SES may understand the components of a healthy lifestyle, they may lack the economic conditions and resources to attain it. This in turn leads to higher risk and rates of illness, comorbidity, and premature mortality.

Inequalities in CVD, HTN, and T2DM incidence may persist due in part to the fact that there have not been equitable reductions in risk factors for these conditions across all social classes (63). Our results add to the growing body of literature which highlights the importance of tailoring interventions to the needs of specific populations, such as by social class, age group, or geographical location. Interventions that do not take population subgroups into account may improve overall trends for the general population, but may not be effective in reducing health inequalities (64). Health inequities can be combated through the creation of equitable health policies that are adapted to meet the needs of vulnerable groups and which enable changes in the health service structure to provide sufficient resources to all populations.

Strengths and limitations

The main strengths of our study are its large, representative sample size and the availability of longitudinal data. Most epidemiological studies that have been performed to this date have considered CVD, HTN, and T2DM trends have been cross-sectional and, thus, have mainly focused on prevalence. In addition to providing longitudinal data, SIDIAP is known to contain a large, highly representative sample of the population living in Catalonia in terms of age, sex, and geographic distributions, lending external validity to our results (18).

However, our study also has some limitations that should be considered when interpreting the results. First, SIDIAP does not include data from health information registered by primary healthcare centers that are not associated with the ICS. Moreover, our definitions of CVD, HTN, and T2DM only took into account diagnostic codes recorded in SIDIAP and not prescriptions or lab reports, leading to a possible underdiagnosis of cases. By nature of being an EHR dataset, SIDIAP is not explicitly designed for calculations of population disease incidence, as the population included in the dataset is not a random population sample, but rather a sample of public healthcare users. However, bias that may be reflected in the capture and recording of outcomes is likely systematic. Finally, our study used the MEDEA index of deprivation, which is an ecological measure based on data from the 2001 census, given that we did not have individual-level data on SES. Additionally, the MEDEA is only calculated for urban areas, and, therefore, we were unable to include individuals who reside in rural areas in our study of trends by SES.

5. Conclusions

This study analyzed CVD, HTN, and T2DM incidence trends between the years 2009-2018, considering differences by age, sex, and SES. Overall cardiovascular disease incidence has increased while hypertension and type 2 diabetes mellitus incidence have decreased in recent years in Catalonia, Spain. Individuals living in the most deprived areas presented the highest incidence rates especially among the 40-54 and 55-69 year age groups, despite following similar trends in incidence during the study period. Specific health initiatives are needed to reduce CVD, HTN, and T2DM incidence rates among middle-aged adults to reduce their future burden of disease on the Spanish healthcare system. Special attention must urgently be given to CVD, HTN, and DM prevention and treatment in middle-aged adults from the most deprived areas, who presented high incidence levels compared to individuals from less deprived areas. Ensuring equitable access to health and healthcare and a high quality of life especially for populations with historically poor health outcomes is urgent and necessary to tackle health inequities by social class.

Abbreviations

CVD – Cardiovascular disease; HTN – Hypertension; T2DM – Type 2 diabetes mellitus; SES – Socioeconomic status; SIDIAP – Information System for Research in Primary Care; EHR – Electronic health record; ICD-10 – International Classification for Diseases (10th revision); CMBD – Conjunt mínim bàsic de dades d’alta hospitalària; MEDEA – Mortalidad en áreas pequeñas españolas y desigualdades socioeconómicas y ambientales; IRR – Incident rate ratio; 95% CI – 95% confidence interval; IQR – Interquartile range; UK – United Kingdom; ICS – Catalan Health Institute

Declarations

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

Ethics approval

This study was approved by the Clinical Research Ethics Committee of the IDIAPJGol (project code: 20/237-P).

Consent for publication
Not applicable

Availability of data and materials

In accordance with current European and national law, the data used in this study is only available for the researchers participating in this study. Thus, we are not allowed to distribute or make publicly available the data to other parties. However, researchers from public institutions can request data from SIDIAP if they comply with certain requirements. Further information is available online (https://www.sidiap.org/index.php/menu-solicitudesen/application-proccedure) or by contacting Anna Moleras (amoleras@idiapjgol.org).

Competing interests

The authors have no competing interests to declare.

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Authors’ contributions

MB and AP led the data analysis. MB, CR, HF, and TDS performed a literature review. All authors were involved in the study conception and design, interpretation of the results, and the preparation of the manuscript.

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Disclaimer

Where authors are identified as personnel of the International Agency for Research on Cancer/World Health Organization, the authors alone are responsible for the views expressed in this article and they do not necessarily represent the decisions, policy, or views of the International Agency for Research on Cancer/World Health Organization.

References


Tables

Table 1. Descriptive characteristics of the total study population from SIDIAP database, 2009 - 2018 (N = 3,247,244).
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total (N = 3,247,244)</th>
<th>Diagnosis with CVD (N = 226,542)</th>
<th>Diagnosis with HTN (N = 565,359)</th>
<th>Diagnosis with T2DM (N = 265,927)</th>
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<tr>
<td>Women</td>
<td>1,707,067 (52.6)</td>
<td>94,237 (41.6)</td>
<td>281,101 (49.7)</td>
<td>117,999 (44.4)</td>
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<tr>
<td>Age at study entry, median (IQR), y</td>
<td>58.0 (47.0 - 71.0)</td>
<td>68.0 (58.0 - 77.0)</td>
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<td>249,541 (93.8)</td>
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<td>41,306 (18.2)</td>
<td>203,281 (36.0)</td>
<td>84,000 (31.6)</td>
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<tr>
<td>55-69</td>
<td>949,871 (29.3)</td>
<td>77,158 (34.1)</td>
<td>213,935 (37.8)</td>
<td>107,281 (40.3)</td>
</tr>
<tr>
<td>70+</td>
<td>896,758 (27.6)</td>
<td>103,887 (47.7)</td>
<td>148,414 (26.2)</td>
<td>74,646 (28.1)</td>
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<td>Diagnoses</td>
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<td>Cardiovascular disease diagnosis</td>
<td>226,542 (7.0)</td>
<td>67,625 (12.0)</td>
<td>39,419 (14.8)</td>
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<tr>
<td>Hypertension diagnosis</td>
<td>565,359 (17.4)</td>
<td>67,625 (29.9)</td>
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<td>91,758 (34.5)</td>
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<tr>
<td>Type 2 diabetes mellitus diagnosis</td>
<td>265,927 (8.2)</td>
<td>39,419 (17.4)</td>
<td>91,758 (16.2)</td>
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<tr>
<td>Deprivation Index, quintile</td>
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<tr>
<td>I, least deprived</td>
<td>518,827 (16.0)</td>
<td>33,156 (14.6)</td>
<td>88,676 (15.7)</td>
<td>34,516 (13.0)</td>
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<tr>
<td>II</td>
<td>459,495 (14.2)</td>
<td>30,395 (13.4)</td>
<td>82,091 (14.5)</td>
<td>36,086 (13.6)</td>
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<tr>
<td>III</td>
<td>445,202 (13.7)</td>
<td>30,033 (13.3)</td>
<td>80,913 (14.3)</td>
<td>38,303 (14.4)</td>
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<tr>
<td>IV</td>
<td>431,773 (13.3)</td>
<td>29,732 (13.1)</td>
<td>77,612 (13.7)</td>
<td>38,857 (14.6)</td>
</tr>
<tr>
<td>V, most deprived</td>
<td>395,797 (12.2)</td>
<td>27,137 (12.0)</td>
<td>69,860 (12.4)</td>
<td>38,113 (14.3)</td>
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<tr>
<td>Missing</td>
<td>996,150 (30.7)</td>
<td>76,089 (33.6)</td>
<td>166,207 (29.4)</td>
<td>80,052 (30.1)</td>
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<td>Smoking status</td>
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<td>Non-smoker</td>
<td>1,776,731 (54.7)</td>
<td>143,779 (63.5)</td>
<td>360,353 (63.7)</td>
<td>165,308 (62.2)</td>
</tr>
<tr>
<td>Smoker</td>
<td>812,902 (25.0)</td>
<td>64,614 (28.5)</td>
<td>162,356 (28.7)</td>
<td>82,447 (31.0)</td>
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<tr>
<td>Ex-smoker</td>
<td>110,819 (3.4)</td>
<td>10,212 (4.5)</td>
<td>22,107 (3.9)</td>
<td>10,849 (4.1)</td>
</tr>
<tr>
<td>Missing</td>
<td>546,792 (16.8)</td>
<td>7,937 (3.5)</td>
<td>20,543 (3.6)</td>
<td>7,278 (2.7)</td>
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<tr>
<td>Alcohol use</td>
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<tr>
<td>No risk</td>
<td>1,576,405 (48.5)</td>
<td>139,676 (61.7)</td>
<td>327,301 (57.9)</td>
<td>161,056 (60.6)</td>
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<tr>
<td>Low risk</td>
<td>828,600 (25.5)</td>
<td>66,120 (28.5)</td>
<td>187,928 (33.2)</td>
<td>83,519 (31.4)</td>
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<tr>
<td>High risk</td>
<td>85,738 (2.6)</td>
<td>7,665 (3.4)</td>
<td>21,778 (3.9)</td>
<td>11,237 (4.2)</td>
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<tr>
<td>Missing</td>
<td>756,501 (23.3)</td>
<td>13,081 (5.8)</td>
<td>28,352 (5.0)</td>
<td>10,115 (3.8)</td>
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</tbody>
</table>

Table 2. Incidence rate ratios and percent change of incidence rates for cardiovascular disease, hypertension, and type 2 diabetes mellitus by sex, age, and deprivation Index, 2009 to 2018.
<table>
<thead>
<tr>
<th>Age</th>
<th>Deprivation</th>
<th>Cardiovascular disease</th>
<th>Hypertension</th>
<th>Type 2 Diabetes Mellitus</th>
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<tr>
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<td></td>
<td>Incidence rate ratio (95%CI)</td>
<td>Change from 2009-2018, %</td>
<td>Incidence rate ratio (95%CI)</td>
</tr>
<tr>
<td>Females</td>
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<td></td>
<td></td>
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<tr>
<td>40-54</td>
<td>Least deprived</td>
<td>1 (Reference)</td>
<td>1 (Reference)</td>
<td>84.42</td>
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<tr>
<td></td>
<td>Most deprived</td>
<td>1.81 (1.42-2.31)</td>
<td>1.68 (1.39-2.03)</td>
<td>70.50</td>
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<tr>
<td>55-69</td>
<td>Least deprived</td>
<td>1 (Reference)</td>
<td>1 (Reference)</td>
<td>30.90</td>
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<tr>
<td></td>
<td>Most deprived</td>
<td>1.5 (1.3-1.74)</td>
<td>1.57 (1.37-1.8)</td>
<td>36.84</td>
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<td>70+</td>
<td>Least deprived</td>
<td>1 (Reference)</td>
<td>1 (Reference)</td>
<td>1.53</td>
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<td></td>
<td>Most deprived</td>
<td>1.08 (0.99-1.19)</td>
<td>1.03 (0.91-1.17)</td>
<td>-3.43</td>
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<td>Males</td>
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<tr>
<td>40-54</td>
<td>Least deprived</td>
<td>1 (Reference)</td>
<td>1 (Reference)</td>
<td>70.28</td>
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<td></td>
<td>Most deprived</td>
<td>1.32 (1.14-1.53)</td>
<td>1.37 (1.22-1.54)</td>
<td>76.68</td>
</tr>
<tr>
<td>55-69</td>
<td>Least deprived</td>
<td>1 (Reference)</td>
<td>1 (Reference)</td>
<td>-2.80</td>
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<td></td>
<td>Most deprived</td>
<td>1.11 (1.01-1.22)</td>
<td>1.11 (0.99-1.24)</td>
<td>-3.13</td>
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<tr>
<td>70+</td>
<td>Least deprived</td>
<td>1 (Reference)</td>
<td>1 (Reference)</td>
<td>-22.61</td>
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<td></td>
<td>Most deprived</td>
<td>0.92 (0.84-1.01)</td>
<td>1.17 (1.01-1.36)</td>
<td>-1.50</td>
</tr>
</tbody>
</table>

**Figures**
Figure 1

Figure 2
Figure 3
Annual incidence of cardiovascular disease, hypertension, and type 2 diabetes mellitus by age, sex and socioeconomic status (SES), 2009-2018.

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