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Original Research

Income and professional inequalities in chronic diseases: prevalence and incidence in France

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ABSTRACT

Objectives: In France, almost nine of 10 deaths are caused by non-communicable diseases, and there is significant social inequality in mortality rates. However, it is not easy to collect robust data on the incidence and prevalence of such diseases according to socio-economic status. Based on data from the link between the primary longitudinal population sample and the national health data system, the aim of our study was to compute the standardised incidence and prevalence of seven major groups of chronic diseases according to socio-economic status.

Study design: Descriptive retrospective cohort study.

Methods: This was a descriptive retrospective cohort study on a weighted representative sample of the French population, comprising 3.4 million individuals from data collected 2016–2017. Main chronic disease categories include diabetes, cancers, psychiatric disorders, liver and pancreatic diseases, neurological conditions, respiratory and cardiovascular diseases, calculated from the 2016–2017 period by combining health care consumption and diagnoses received during hospitalisations and/or associated with specific full healthcare coverage. Socio-economic status was measured by disposable income from the 2013–2014 tax returns and census-derived socioprofessional groups, and findings were standardised for age and sex.

Results: For all disease categories except cancers, standardised incidence rates showed a gradient favouring the wealthiest, with a risk ratio between the first and tenth standard of living deciles ranging from 1.4 (cardiovascular diseases) to 2.8 (diabetes). Incidence of all disease categories, except cancers, was higher for all groups compared with executives and higher academic professions (risk ratios between workers and executives ranged from 2.0 to 1.3 in psychiatric and cardiovascular diseases, respectively). Conversely, cancer incidence rate followed a flat curve, reduced in the two poorest standard of living deciles, and there were no significant differences between socioprofessional groups. Standardised prevalence rates followed the same patterns, although risk ratios were highest for psychiatric diseases, varying according to sex and disease.

Conclusions: Deep social inequalities in incidence and prevalence of chronic diseases were observed in a large representative sample of the French population. The reverse social inequalities in cancer incidence and prevalence calls for more detailed research into cancer types and selection mechanisms, the data from which would allow the long-term monitoring of such disparities.

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Research in context

Evidence before this study

Scientific literature on social inequalities in health relies mainly on mortality data. Studies on incidence and prevalence of non-communicable diseases are more difficult to conduct as they require large longitudinal samples, which can correct for age and sex structures of the selected populations. Those from the poorest backgrounds die younger, and this biases chronic disease prevalence and incidence measures because of selection effects. The pathways of social causation and health selection vary according to the type of disease. The so-called paradox of there still being substantial social inequality in health under welfare states is a pending research question that requires a large population sample to examine further.

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Added value of this study

This is the first study to use health data to comprehensively investigate the incidence and prevalence of the primary chronic diseases in a large longitudinal sample of the French population and their links to socio-economic status. It shows the deep social inequality in disease prevalence and incidence, at comparable age ranges, between each standard of living decile and between socioprofessional groups. Differences in social inequality by sex are also provided. The absence of and reverse social inequality in the case of cancers raises questions that are discussed but not fully explored.

Implications of all the available evidence

In most countries with universal healthcare coverage, social inequality concerning incidence and prevalence of the principal chronic diseases exists and remains. Cancers are a case apart due to the heterogeneity of social gradient according to cancer sites, which obscures some screening inequalities and selection effects based on competitive risks from other chronic diseases. Powerful data tools are becoming increasingly available to monitor such inequalities and to evaluate the political interventions taken to reduce them.

Introduction

Socio-economic status (SES) determines the risk of exposure, degree of susceptibility and the course and outcome of diseases.[1–7] In the context of welfare states, this has been described as a paradox, which has several main hypothesised mechanisms.[1,8] They can be summed up as social causation and social selection. The social causation explanations for health inequalities include theories such as fundamental cause theory (social position gives differential access to both material and immaterial resources that promote health);[9] cultural and social capital (the structural background of each individual's community and relationships affects their health);[10] the embodiment hypothesis (akin to the life course perspective in which exposure at a young age to economic stress and increased adversity reduces health);[11] psychosocial pathways (psychosocial stress and adversity directly affects health at short term, mid-term and long term).[12,13] On the other hand, health or social selection theories suggest that disease leads to a social drift by hampering the affected individual's efforts to attain educational and professional achievements and that upward social mobility selects individuals more prone to have good health but also with better health behaviours generally close to personality traits.[14] Both causal pathways function bilaterally although they are not equivalent across diseases or causes of mortality.[15]

Health status can be approached using several indicators, which affect health inequalities description: for example, inequalities in health status are greater when health is measured by a perceived health indicator than when it is measured by the clinical presence of chronic disease or functional limitations.[16,17] National health data systems have the advantage of applying relatively objective measures of the health status of individuals such as cause of death or treatment or diagnostic received along the healthcare pathway.[18] During the past decades, valuable insights have been gained in the study of inequalities of mortality, covering important elements regarding their determinants, such as, smoking, being overweight and alcohol use.[19–21] Because mortality data are often exhaustive, relatively well documented and nationwide, it is easier and more robust to use it for social inequalities studies. It is far more complicated to obtain unbiased data on incidence and prevalence of diseases according to individual SES. These epidemiological indicators are usually derived from voluntary population samples included in transverse surveys or in cohorts that might be affected by a lack of representativeness.[22,23] To counterbalance these limits, incidence and prevalence estimates are increasingly extracted from national health insurances or services databases.[24–26] Such data sources can be comprehensive at either national or regional level, partially ruling out selection bias. They have the disadvantage of not including people who do not use health services and often lack accurate individual socio-economic data.[27,28]

In France, non-communicable diseases such as cardiovascular diseases, cancers, diabetes and respiratory diseases, including asthma and chronic obstructive pulmonary disease, are responsible for 84% of disability-adjusted life-years and 87% of deaths.[29,30] Social disparities in mortality have been clearly identified in the general population thanks to the main longitudinal population data set sample (*Échantillon Démographique* Permanent [EDP]), which comprises approximately 4% of the population living in France but is representative of the population as a whole.[31–33] Until recently, however, it was not possible to study health status from this important sample. Conversely, while the French national health data system (*Système National des Données de Santé* [SNDS]) has been successfully used for over a decade as an epidemiological tool for conducting nationwide cohort, case-control and observational studies (e.g. ref[34–36]), this administrative database lacks information on some determinants of health, most notably patient SES. Pairing the SNDS with the EDP was therefore an important step in the French system for statistical data retrieval.[37] This has led to the creation of EDP-Santé, a database providing a representative cohort of the population for targeted research into health conditions, healthcare use and causes of mortality, including individual socio-economic data.[38,39]

Based on these healthcare data, the objective of this study was to identify the incidence and prevalence of seven major groups of chronic diseases by disposable income and socio-economic categories.

Methods

Design

This study is a descriptive retrospective cohort study on administrative databases of health insurance, income taxes and annual census surveys.

Data

The EDP-Santé is an administrative database matching the permanent longitudinal population sample (EDP) and the national health data system (SNDS).[37,39,40] SNDS contains information regarding individual healthcare consumption covered by universal health insurance: it includes outpatient and inpatient consultations with medical and paramedical professionals, prescription medicines obtained from city pharmacies, laboratory examinations and tests, and any information or diagnostics given during a hospitalisation. Suffering from specific severe chronic diseases allows a 100% coverage of all medical costs related to them, which is also registered in the SNDS.

The EDP is an ongoing socio-demographic panel that combines information from different administrative sources. Only individuals born on a fixed list of days are systematically included in the sample each year.[41]

The two databases have recently been paired through each resident's unique social security number. 98% of EDP individuals alive in 2008 have been matched in the SNDS,[37] constituting a

sample panel of around 3.4 million individuals weighted to be representative of the population living in France. However, some data in the EDP are only available for a subsample of the individuals. Indeed, whereas tax registers and civil status come from all-inclusive administrative data available for all EDP individuals, census data, including socioprofessional groups, are only available for the fraction of the EDP individuals belonging to the annual census survey sample. Therefore, the analyses presented in this article were carried out on two distinct sets of data, each with its own weights. First, analyses performed on standard of living are based on the weighted sample of all those born on the inclusion days of the EDP matched with data from the SNDS. The sample weights are computed to take into account the process according to which individuals enter the EDP and auxiliary information about the French population. Second, analyses performed on socioprofessional groups are based on a weighted sample of the respondents to the annual survey of the French rolling census, the weights take into account the annual census survey's sampling design.

Study population

The population includes all individuals on the EDP-Santé database living in France, but not in the overseas department of Mayotte, for which there is insufficient data. This population of 3.4 million individuals was studied between 2015 and 2017.

Measures

Chronic diseases

Several chronic diseases have been identified using algorithms developed by the National Health Insurance organisation with the objective of mapping the attribution of reimbursed expenditures to various health conditions; as such, the algorithms were not designed to estimate incidence and prevalence of diseases but to identify populations with treated diseases, chronic treatments and frequent, serious, or expensive care episodes.[42,43]

These algorithms are based on the following elements: long-term conditions (ALD: *Affection de longues durée* - Long-term illness); diagnoses related to hospitalisations; drugs that are specific to certain diseases; and, for several diseases, laboratory tests and medical procedures.[42]

This study focused on seven main categories of diseases: cardiovascular, diabetes, cancers, psychiatric, neurological or degenerative, chronic respiratory and liver or pancreatic. Details regarding diagnostics involved in these categories are presented in Appendix 1.

Socio-economic measures

The standard of living is equal to the disposable income of the household divided by the number of consumer units weighted in consideration of their age.[44] The standard of living is therefore the same for all the individuals in a given household. Study population was divided into deciles based on standard of living.

An average for the standard of living was established for the 2011–2013 period in current euros. When the standard of living was missing for this period (10%), the oldest information was used from the 2014–2017 period, so that eventually there was no missing standard of living.

Census data provide socioprofessional groups for individuals; they are determined by the first level of the French nomenclature of occupations and socioprofessional categories (PCS): 1/farmers; 2/artisans and business owners; 3/executives and higher intellectual professions (e.g. senior civil servants, judges, engineers, medical doctors, lawyers, artists, chief redactors); 4/intermediate professions (e.g. teachers, nurses, intermediate administrative occupations in the civil service and private sector, technical staff); 5/employees (e.g. auxiliary nurses, policemen, secretaries, receptionists, office workers, in-store salespersons, home helpers); 6/manual workers (e.g. blue-collar workers, gardeners, lorry drivers, bakers, plumbers). For retirees and unemployed, the socioprofessional group is determined by the last professional activity.

Analysis

Measures of prevalence and incidence of chronic diseases

Prevalence from the 3.4 million individuals of the EDP-Santé was computed annually over the period 2016–2017. Yearly incidence of the development of chronic disease was considered when it was detected in 2016 or 2017 healthcare data without being present in 2015 or 2016, respectively. Prevalence and incidence were stratified by gender.

Standardisation

The rates of incidence and prevalence of each group of diseases have been standardised by 10-year age classes and by gender with a direct standardisation method and displayed by deciles of living standard.[45] Direct standardisation is justified because young people and women were over-represented in the lowest living standard deciles. Direct standardisation uses age-specific incidence and prevalence rates in the compared populations, applied to a reference population age structure, here the French population. Standardised rates are therefore the rates that would be observed if the overall French population experienced the same age-specific incidence and prevalence as in the compared subpopulations. Unstandardised rates are available online in the open data published alongside the study.[46]

Ethics

The EDP was set up and authorised by French government decree n°84-393 dated 23 May 1984,[47] and its condition of use is under regulation.[48] French law n°2016-41 dated 26 January 2016 created the SNDS database,[49] and the security of its use is under regulation.[50] Matching the two databases to facilitate new research projects was declared to the French National Council for Statistical Information (No 138/H030, 5 December 2017) and French National Commission on Data privacy (No 918335, 26 September 2018). A dedicated website is open to the public for information about the project and gives guidance on personal rights as defined by the European General Data Protection Regulation n° UE 2016/679 dated 27 April 2016.[37,51] Open results data and codes have been published with the study and are available online.[46]

Role of the funding source

The funder of the study had no role in data collection, data analysis, data interpretation, writing of the manuscript, or the decision to submit for publication.

Results

Pooling 2016 and 2017 data, 5.5 million observations were available in EDP-Santé (Table 1), comprising 3.4 million separate individuals. The sample accounts for 4.1% of the 2016–2017 French population.

Table 1
Characteristics of the EDP-Santé fiscal sample, incidence and prevalence of disease categories.

Indicators		All		Gender				Age (years)															
				Females		Males		<30		30–39		40–49		50–59		60–69		70–79		80–89		≥90	
N observations[a]	All		5,488,524	51%	2,810,142	49%	2,678,382	32%	1,772,009	14%	746,582	14%	792,420	14%	760,775	12%	685,715	7%	403,039	5%	264,334	1%	63,650
N (weighted)			132,885,997	52%	68,592,728	48%	64,293,269	36%	47,731,712	12%	16,399,641	13%	17,728,548	13%	17,486,548	12%	15,994,858	7%	9,636,649	5%	6,344,330	1%	1,563,711
Weighted 1-year incidence for 2016 and 2017	Cancers	0.8%	42,859	0.8%	21,550	0.9%	21,309	0.1%	1623	0.3%	2050	0.5%	3416	0.9%	6535	1.8%	11,265	2.7%	9188	3.3%	7182	3.0%	1600
	Cardio vascular diseases	1.3%	64,991	1.2%	30,752	1.4%	34,239	0.1%	1159	0.2%	1440	0.5%	3829	1.2%	8437	2.4%	14,489	4.7%	14 676	9.6%	15,945	14.6%	5016
	Chronic respiratory diseases	1.6%	80,747	1.7%	42,369	1.6%	38,378	1.3%	20,416	1.0%	7226	1.3%	9354	1.7%	12,185	2.2%	13,802	2.5%	9128	3.0%	6881	3.2%	1755
	Diabetes	0.4%	21,038	0.4%	9276	0.5%	11,762	0.0%	627	0.2%	1258	0.4%	2696	0.8%	5274	1.0%	6110	1.0%	3184	0.7%	1612	0.5%	277
	Liver or pancreatic diseases	0.3%	14,463	0.2%	6263	0.3%	8200	0.0%	724	0.2%	1110	0.2%	1804	0.4%	2992	0.5%	3478	0.6%	2304	0.7%	1725	0.5%	326
	Neurological or degenerative diseases	0.5%	24,204	0.5%	14,037	0.4%	10,167	0.1%	1210	0.1%	712	0.1%	969	0.2%	1510	0.4%	2385	1.2%	4499	4.0%	9139	7.8%	3780
	Psychiatric diseases	0.8%	40,342	0.9%	23,046	0.7%	17,296	0.4%	6049	0.5%	3695	0.8%	5578	0.9%	6227	0.8%	5373	1.3%	4914	2.7%	6484	3.6%	2022
Weighted 1-year prevalence for 2016 and 2017	Cancers	4.8%	272,350	5.0%	144,827	4.6%	127,523	0.4%	7837	1.4%	10,032	2.5%	19,802	5.1%	38,529	10.2%	70,083	16.2%	65,565	18.9%	50,044	16.4%	10,458
	Cardio vascular diseases	7.3%	410,230	5.9%	167,110	8.8%	243,120	0.4%	6957	0.8%	6038	2.3%	18,360	6.3%	47,937	13.6%	93,794	24.6%	99,516	40.1%	106,174	49.4%	31,454
	Chronic respiratory diseases	5.3%	295,546	5.2%	148,504	5.5%	147,042	3.7%	66,277	2.7%	20,434	3.6%	28,838	5.6%	42,357	8.0%	55,131	10.4%	41,850	12.5%	33,037	11.9%	7622
	Diabetes	5.6%	314,389	4.9%	141,261	6.3%	173,128	0.3%	5158	1.0%	7681	2.7%	21,189	7.2%	54,508	14.0%	95,861	18.6%	74,849	18.0%	47,598	11.8%	7545
	Liver or pancreatic diseases	0.8%	47,502	0.7%	20,007	1.0%	27,495	0.1%	2303	0.5%	3491	0.8%	6538	1.5%	11,276	1.7%	11,659	1.8%	7093	1.6%	4353	1.2%	789
	Neurological or degenerative diseases	2.5%	136,412	2.8%	79,552	2.1%	56,860	0.6%	10,601	0.8%	6246	1.1%	9020	1.6%	11,952	2.3%	16,049	5.7%	22,992	16.1%	42,463	26.9%	17,089
	Psychiatric diseases	4.1%	229,816	4.6%	133,488	3.5%	96,328	1.5%	27,061	2.8%	20,806	4.5%	35,744	5.9%	44,672	5.9%	40,694	6.7%	26,888	9.9%	26,156	12.3%	7,795

Note: The incidence and prevalence rates are weighted. The observation numbers next to them are unweighted to indicate sample size. To compute incidence, the denominator is the part of the population which was not ill the previous year. Therefore, each disease category has its own denominator.
Interpretation: Females have a risk of developing diabetes of 0.4%. This risk is calculated on the basis of 9276 cases of women developing diabetes during the selected period.
Scope: 2016–2017, France (excluding Mayotte).
Source: EDP-Santé 2017.
[a] Correspond to the times every unique individual (3.4 million) appears during the 2 years considered, some appearing in only one of the 2 years.

Incidences

Except for cancers, the risk of developing one of the diseases gradually increased when the standard of living decreased: each decile of the population, ordered by standard of living, had a slightly lower risk than the previous poorest decile, except for cardiovascular diseases for which the second decile had a higher incidence than the first(Fig. 1). With comparable age and gender, the risk ratio between the poorest 10% and the wealthiest 10% were 0.9, 1.4, 1.5, 1.6, 1.9, 2.2 and 2.8, for, respectively, cancers, cardiovascular, neurological or degenerative, chronic respiratory, psychiatric liver and pancreatic diseases and diabetes. Incidence ratios were close in men and women for all disease categories except for diabetes: 3.6 for women vs 2.3 for men; and psychiatric diseases: 1.7 for women vs 2.3 for men (Table 2).

There were also differences in the incidence of chronic diseases among socioprofessional groups (Fig. 2). Manual workers were more likely than executives and higher intellectual professionals to develop a psychiatric disease (risk multiplied by 2.0), diabetes (1.9), a neurological or degenerative disease (1.5), a liver or pancreatic disease (1.5), a chronic respiratory disease (1.4) or a cardiovascular disease (1.3). The ratios of incidence for manual workers and executives showed no major differences between men or women (Table 3).

Cancers were differentiated by their atypical pattern of incidence. With comparable age and gender, wealthier subjects had a risk of cancer occurring 1.1 times higher than those who were less well-off. Furthermore, these differences were not graduated, as the risk for people from the tenth decile of standard of living was equal to the median decile. No significant differences related to socioprofessional group were found in the risk of developing a cancer.

Prevalence

Social gradient in disease prevalence, whereby wealthier people are advantaged, was evident for all categories but cancers. Prevalence risk ratio between the poorest 10% and the wealthiest 10% varied from 2.8 for the psychiatric to 1.3 for the cardiovascular diseases. Cancer, with a risk ratio of 0.8, was the only category with a ratio lower than one. Risk gradient according to standard of living was regular and gradual except for psychiatric, respiratory and cardiovascular diseases, for which the second decile had a higher prevalence than the first (Fig. 3).

The analysis of the prevalence of chronic diseases categorised by standard of living and by gender indicated that social inequalities were greater for women than men with regard to diabetes (risk ratio of 3.5 between the poorest and wealthiest vs 1.9 for men) and cardiovascular diseases (risk ratio of 1.5 vs 1.2 for men; Table 2), but they were more frequent for men for psychiatric diseases (3.5 vs 2.4 for women), liver or pancreatic diseases (2.8 vs 2.4 for women) and neurological or degenerative diseases (1.6 vs 1.4 for women).

The risk of living with a chronic disease also varied according to the socioprofessional group (Table 4). At comparable ages and sex, the risk was greater for manual workers and employees than executives, except for cancers. As in the analyses related to the standard of living, the risk ratio in prevalence of psychiatric diseases according to socioprofessional category was greater among men. For diabetes, this risk ratio was higher among women (Table 3). In addition, cancer was more prevalent for women only in executive roles compared with artisans, traders and company heads, employees and manual workers.

Discussion

Main results

Both incidence and prevalence of chronic diseases are linked to standard of living and socioprofessional group. Except for cancer, the risk ratio of developing a chronic disease follows a proprosperous gradient. Professional class is also significant; manual

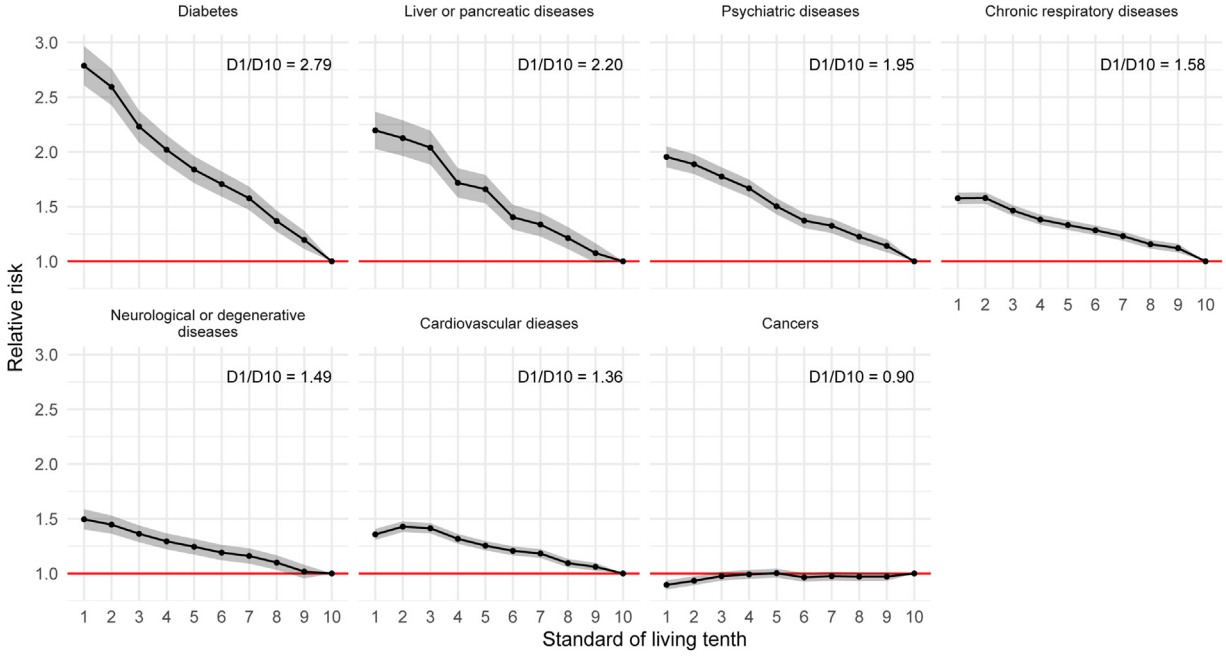

Fig. 1. Standardised risk of developing a chronic disease (incidence) depending on standard of living and disease category.
Note> The 95% confidence interval is indicated by the strip that surrounds the values. The value given at the top right of each image corresponds to the relative risk for lower-income individuals (lower tenth) compared to wealthier individuals (top tenth). Interpretation > The poorest 10% have a risk of developing a chronic respiratory disease that is 1,58 times higher than for the wealthiest 10%. Scope>2016-2017, France (excluding Mayotte). Scope>EDP-Sante 2017.

Table 2
Prevalence and incidence ratios between the poorest decile and the wealthiest one, according to sex and category of disease.

	Prevalence		Incidence	
Disease category	Women	Men	Women	Men
Cancers	**0.74** [0.72; 0.76]	**0.82** [0.80; 0.84]	**0.85** [0.79; 0.91]	0.95 [0.89; 1.01]
Diabetes	**3.46** [3.37; 3.56]	**1.90** [1.86; 1.93]	**3.62** [3.24; 4.00]	**2.28** [2.10; 2.47]
Cardiovascular diseases	**1.50** [1.47; 1.54]	**1.23** [1.21; 1.25]	**1.43** [1.35; 1.51]	**1.29** [1.23; 1.36]
Liver or pancreatic diseases	**2.43** [2.27; 2.60]	**2.82** [2.67; 2.98]	**2.34** [2.06; 2.62]	**2.08** [1.87; 2.29]
Neurological or degenerative diseases	**1.42** [1.37; 1.47]	**1.63** [1.57; 1.69]	**1.41** [1.30; 1.53]	**1.63** [1.48; 1.78]
Psychiatric diseases	**2.42** [2.36; 2.49]	**3.45** [3.34; 3.56]	**1.71** [1.60; 1.82]	**2.34** [2.17; 2.51]
Chronic respiratory diseases	**1.73** [1.69; 1.78]	**1.64** [1.60; 1.68]	**1.57** [1.49; 1.64]	**1.59** [1.51; 1.67]

Note: The 95% confidence interval is indicated between square brackets under the value. Interpretation: The poorest women (lowest tenth) have a risk of living with diabetes that is 3.46 times higher than for the wealthiest women (highest tenth). The real value is between 3.37 and 3.56, with a probability of 95%. Values in bold do not include 1 in their confidence interval, i.e. the situation where the actual prevalence has a 95% probability of differing from the one of the reference group. Scope: 2016–2017, France (excluding Mayotte). Source: EDP-Santé 2017.

workers are more likely than executives and higher intellectual professionals to develop a chronic disease. Diabetes is the chronic disease with the highest risk ratio in incidence between the least and the most well-off and the second highest risk ratio when considering socioprofessional groups (just after psychiatric disorders). Women are more affected by social inequalities in incidence and prevalence of diabetes, while such inequalities have a greater impact on men in cardiovascular and psychiatric diseases.

Implications

To our knowledge, this is the first study with such a large representative sample of the French population encompassing the incidence and prevalence of the main chronic conditions with individual socio-economic data. In line with comparable studies conducted in the Western world, a pronounced and regular social gradient impacts prevalence and incidence of most of these conditions with the exception of cancers.[52] This study creates a base for further in-depth and by-condition group analyses with substantial methodological improvements in comparison with the state-of-the-art: socio-economic measures are based on the individual rather than on neighbourhood, morbidity measures are more objective than self-reported ones (although they do not include people outside the healthcare system), data sources are from exhaustive administrative databases, which eliminates most of the inherent bias of observational surveys such as non-response.[53] Further work should also be conducted on the incidence and prevalence of multimorbidity on this data set, as in a Canadian study with similar results to our own.[54] Moreover, the databases studied are long term and routine, allowing their use for future comparable work and study replicability. This would be crucial to monitor the evolution of social inequality in health in France in mid-term and long term. Indeed, ratios of incidence and

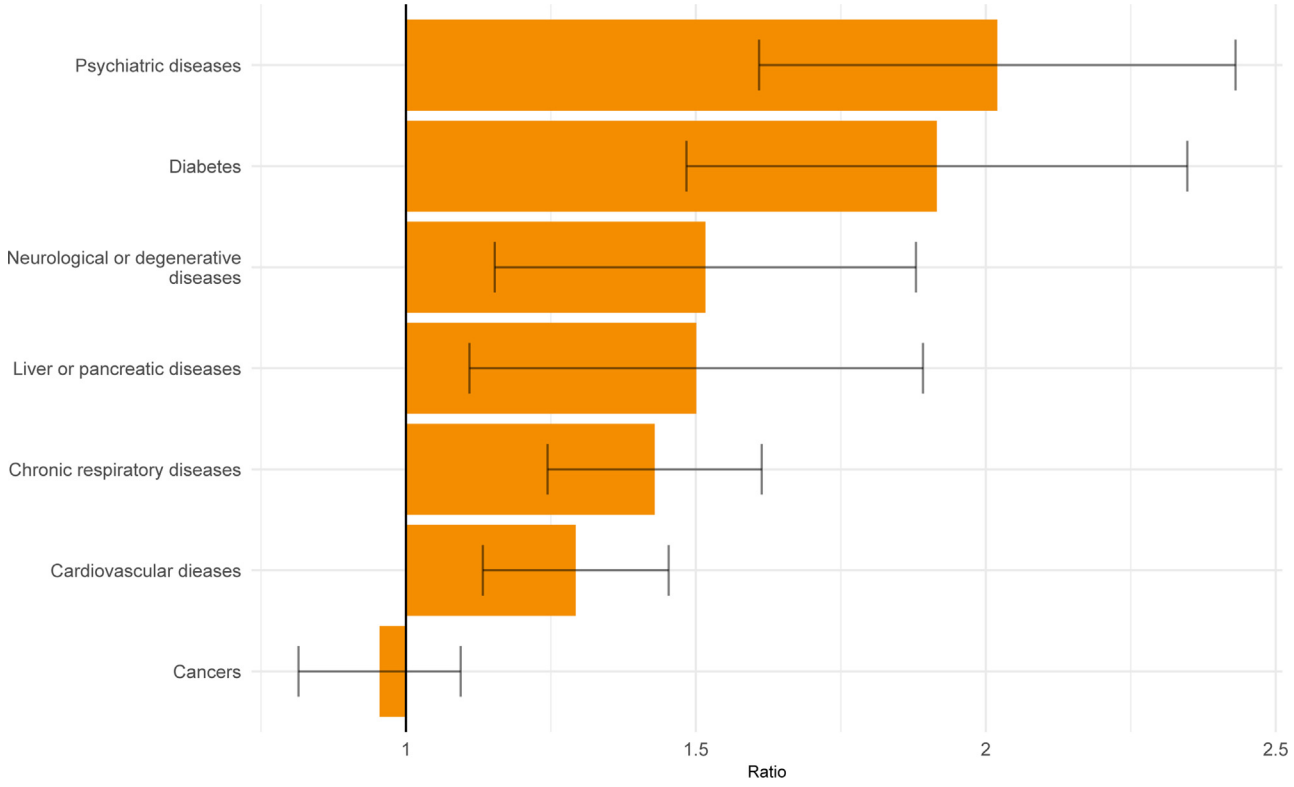

Fig. 2. Standardised incidence ratio between manual workers and executives according to the category of disease.
Note> The 95% confidence interval is indicated by the segments that surround the values. Interpretation > Manual workers have a risk of developing a liver or pancreatic disease that is 1,50 times higher than that for executives and higher intellectual occupation. Scope>2016-2017, France (excluding Mayotte). Scope>EDP-Sante 2017.

Table 3
Prevalence and incidence ratio by socioprofessional group and sex, relative to executives and higher intellectual professions.

	Category	Women					Men				
		Farm workers	Artisans, traders, company heads	Intermediate professions	Employees	Workers	Farm workers	Artisans, traders, company heads	Intermediate professions	Employees	Workers
Prevalence	Cancers	0.83 [0.59; 1.07]	**0.82** [0.73; 0.91]	0.94 [0.86; 1.02]	**0.85** [0.78; 0.91]	**0.75** [0.69; 0.82]	**0.88** [0.80; 0.95]	**0.99** [0.92; 1.06]	**1.07** [1.00; 1.13]	**1.05** [0.98; 1.12]	**1.02** [0.96; 1.07]
	Diabetes	**1.52** [1.31; 1.74]	**1.46** [1.25; 1.67]	**1.27** [1.12; 1.42]	**1.91** [1.69; 2.12]	**2.38** [2.11; 2.66]	**1.11** [1.01; 1.22]	**1.30** [1.22; 1.39]	**1.17** [1.10; 1.24]	**1.40** [1.32; 1.49]	**1.57** [1.49; 1.65]
	Cardiovascular diseases	**1.39** [1.26; 1.53]	**1.24** [1.12; 1.37]	1.09 [0.99; 1.18]	**1.24** [1.14; 1.35]	**1.41** [1.29; 1.54]	**1.06** [1.00; 1.12]	**1.19** [1.13; 1.24]	**1.12** [1.08; 1.17]	**1.18** [1.12; 1.23]	**1.25** [1.21; 1.30]
	Liver or pancreatic	0.76 [0.44; 1.08]	1.50 [0.87; 2.13]	1.28 [0.94; 1.62]	**1.46** [1.09; 1.83]	**1.72** [1.24; 2.21]	**0.72** [0.53; 0.91]	**1.11** [0.88; 1.34]	1.09 [0.90; 1.29]	**1.36** [1.11; 1.62]	**1.47** [1.23; 1.71]
	Neurological or degenerative	**1.52** [1.01; 2.02]	1.14 [0.94; 1.33]	**1.19** [1.02; 1.35]	**1.25** [1.08; 1.41]	**1.39** [1.19; 1.59]	1.34 [1.05; 1.62]	1.03 [0.89; 1.18]	**1.09** [0.96; 1.21]	**1.39** [1.22; 1.55]	**1.37** [1.24; 1.51]
	Psychiatric	1.12 [0.94; 1.31]	**1.42** [1.17; 1.67]	**1.34** [1.19; 1.50]	**1.77** [1.57; 1.97]	**1.98** [1.74; 2.23]	1.11 [0.88; 1.35]	**1.22** [1.00; 1.44]	**1.50** [1.31; 1.68]	**2.03** [1.79; 2.28]	**2.25** [2.00; 2.49]
	Chronic respiratory	1.03 [0.77; 1.30]	**1.26** [1.06; 1.46]	1.09 [0.98; 1.20]	**1.31** [1.19; 1.43]	**1.39** [1.24; 1.54]	**1.35** [1.14; 1.56]	**1.18** [1.05; 1.31]	**1.20** [1.09; 1.30]	**1.35** [1.23; 1.47]	**1.55** [1.43; 1.67]
Incidence	Cancers	1.65 [0.26; 3.03]	1.00 [0.68; 1.31]	1.00 [0.77; 1.22]	0.89 [0.70; 1.08]	0.80 [0.61; 1.00]	1.07 [0.89; 1.26]	1.00 [1.00; 1.00]	1.15 [0.95; 1.34]	1.14 [0.98; 1.30]	1.07 [0.89; 1.26]
	Diabetes	0.87 [0.32; 1.42]	1.19 [0.59; 1.79]	0.99 [0.57; 1.40]	1.37 [0.84; 1.91]	**2.05** [1.19; 2.91]	1.30 [0.87; 1.73]	**1.43** [1.01; 1.86]	**1.38** [1.04; 1.71]	**1.65** [1.23; 2.07]	**1.80** [1.42; 2.19]
	Cardiovascular diseases	1.29 [0.98; 1.61]	1.07 [0.80; 1.33]	1.00 [0.78; 1.21]	1.09 [0.87; 1.31]	1.25 [0.97; 1.52]	**1.22** [1.02; 1.42]	**1.28** [1.09; 1.47]	**1.17** [1.02; 1.32]	**1.24** [1.06; 1.42]	**1.34** [1.18; 1.50]
	Liver or pancreatic	0.93 [0.25; 1.61]	0.76 [0.25; 1.27]	1.16 [0.59; 1.74]	1.48 [0.79; 2.16]	1.48 [0.74; 2.23]	0.73 [0.40; 1.06]	1.13 [0.68; 1.59]	1.00 [0.68; 1.33]	1.17 [0.76; 1.57]	**1.51** [1.08; 1.94]
	Neurological or degenerative	2.79 [0.02; 5.57]	1.61 [0.78; 2.44]	1.49 [0.90; 2.09]	1.50 [0.92; 2.07]	1.62 [0.97; 2.26]	1.23 [0.87; 1.59]	1.02 [0.73; 1.31]	1.01 [0.74; 1.29]	1.17 [0.84; 1.50]	**1.40** [1.08; 1.73]
	Psychiatric	0.98 [0.62; 1.33]	**1.75** [1.04; 2.46]	**1.51** [1.08; 1.93]	**1.94** [1.42; 2.46]	**1.84** [1.28; 2.39]	1.21 [0.67; 1.75]	**1.74** [1.08; 2.40]	**1.43** [1.07; 1.80]	**2.35** [1.74; 2.95]	**2.31** [1.78; 2.84]
	Chronic respiratory	**0.72** [0.48; 0.95]	1.19 [0.85; 1.52]	1.06 [0.86; 1.25]	**1.25** [1.03; 1.46]	**1.42** [1.14; 1.70]	1.15 [0.78; 1.52]	1.26 [0.95; 1.56]	1.19 [0.99; 1.38]	**1.32** [1.09; 1.55]	**1.44** [1.22; 1.66]

Note: The 95% confidence interval is indicated between square brackets under after the value.
Interpretation: Female employees have a risk of developing diabetes that is 1.91 times higher than for female executives and higher intellectual professions. The real value is between 1.69 and 2.12, with a probability of 95%.
Values in bold do not include 1 in their confidence interval, i.e. the situation where the actual prevalence or incidence hava a 95% probability of differing from the one of the reference group.
Scope: 2016–2017, France (excluding Mayotte).
Source: EDP-Santé 2017.

prevalence between the first and last deciles of standard of living could become outcome measures of policies targeting health inequalities.

Scientifically, our study contributes to the health selection vs causation pathways debate. The progress and prognosis of a chronic disease differ depending on SES. Indeed, the risk of developing a chronic disease is higher among the most disadvantaged individuals whilst they also suffer from a worse prognosis and a shorter life expectancy.[55–57] It logically reduces the difference in prevalence, which is a 'stock', compared to the difference in incidence, which is a 'flow', as those who are wealthier have a disease for longer while the less affluent die earlier. This reduced difference might be greater for a disease with the highest short-term mortality (e.g. cancers) and for diseases where SES strongly affects the prognosis (e.g. diabetes). This last hypothesis could explain the surprisingly higher inequality ratio in incidence compared with prevalence in diabetes: the poorest have a higher probability of getting diabetes and would die earlier than the richer after they get it.

Conversely, the health selection pathway should lead to a higher inequality ratio of prevalence compared with that for incidence. This is particularly pronounced for psychiatric diseases, which is consistent with clinical observations and research publications: psychiatric diseases – especially the most severe ones that appear early in life – reduce opportunities for studying or having a job, which then negatively impacts the standard of living.[58] More precise research on the different psychiatric diseases included would seek to find the contrast between severe disorders, which are more prone to be included in the health selection pathway, and more frequent ones, which tend to the psychosocial theory of social inequalities in health.

The case of cancers

Regarding cancers, counter-intuitive deficit and reverse social gradient in incidence were found, which are not completely in line with most of the literature on cancer mortality and incidence.[59–61] This is explained by several factors. The first is related to the quality of the cancer detection in the data: those with cancer, including cancers under surveillance, can receive unspecific treatment (e.g. palliative care at home, ambulatory care) that is not used in the detection algorithm. This underdetection should be compensated for using the ALD (Long-term illness) code 'cancer', allowing full coverage. Patients with a cancer diagnosis are usually swiftly coded as such. Hence, an important part of cancer incidence and prevalence relies on the ALD code. However, low-income residents are entitled to Universal Health Coverage so patients with this allowance are not systematically labelled ALD because their health care is already comprehensive. Because of this bureaucratic loophole, this study certainly underestimates the incidence and prevalence of cancers in the 8.2% of the poorest French population who benefited from this coverage in 2017.

Another factor is that early cancer detection is related to better SES. When the cancer is detected in a timely manner, targeted health care for survival – rather than palliative care only – is possible. As the former is more determinant in the detection algorithm than the latter, it is probable that this study missed numerous cancers detected 'too late to be cured', which are more frequent in people with low SES.[62–64] Eventually, due to the competitive risk of other diseases, people with low SES might not survive to an age where a cancer develops and is detected, whilst those surviving to such an age might be selected as low SES but with excellent living conditions and/or health behaviours, resulting in a low rate of cancer incidence in those who are oldest and disadvantaged.

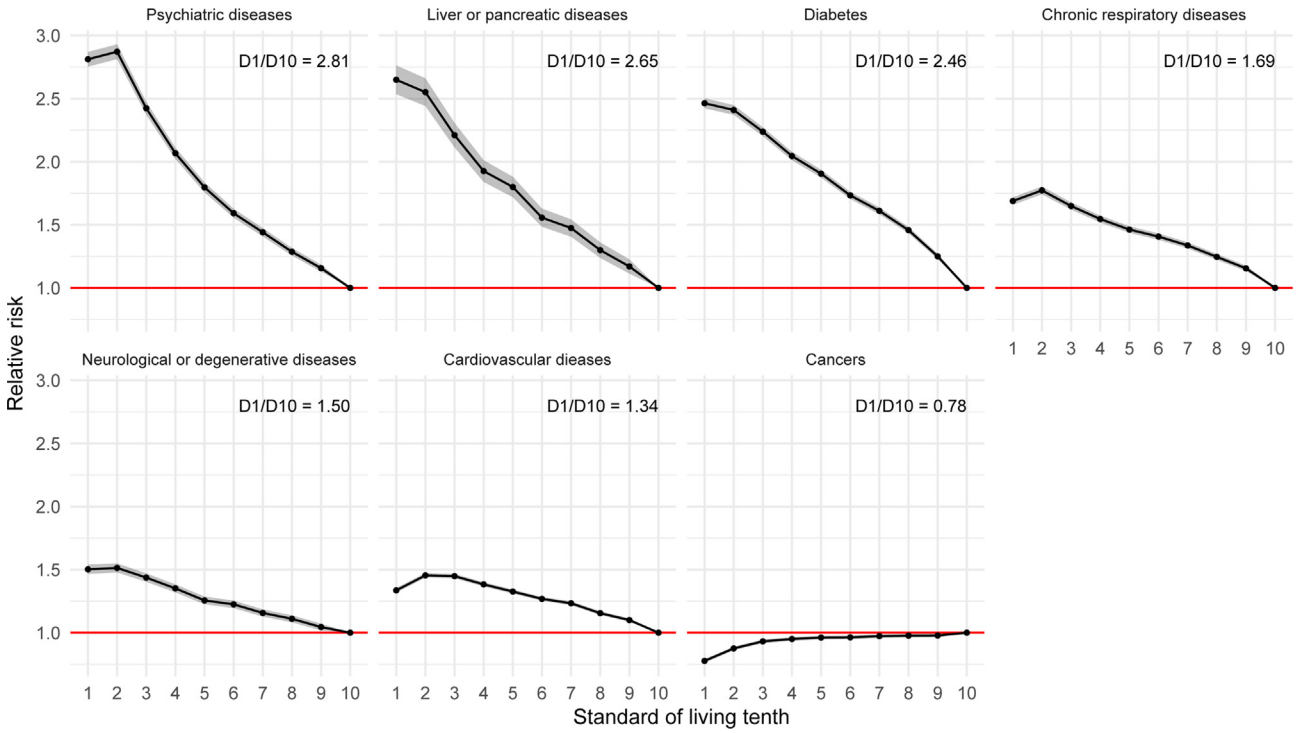

Fig. 3. Standardised risk of living with a chronic disease (prevalence) according to standard of living and disease category.
Note> The 95% confidence interval is indicated by the strip that surrounds the values. The value given at the top right of each image corresponds to the relative risk for lower-income individuals (lower tenth) compared to wealthier individuals (top tenth). Interpretation > The poorest 10% have a risk of living with a chronic respiratory disease that is 1,69 times higher than for the wealthiest 10%. Scope>2016-2017, France (excluding Mayotte). Scope>EDP-Sante 2017.

This screening inequality and selection mechanism partially explains important reverse inequalities of some cancer incidences: prostate, skin and breast cancers are more frequent among people with a high SES.[52,65,66] With a 25% incidence of all cancers in men due to prostate and 33% due to breast cancer in women, these cancers marked by reverse inequality incidence are by far the most frequent in France.[67] Consequently, pooling all cancer diagnoses flattened the curves of incidence and prevalence according to SES indicators, which masks diverse pro-poor or pro-rich inequalities according to site-specific cancers. Follow-up analysis of the study data by site-specific cancers would take the current research forward to establish how the diverse social gradients found earlier evolved in the 2010s.[68,69]

Limitations

In this study, prevalence and incidence figures rely on administrative health data, which are not equivalent to a medical diagnosis. The main purpose of those data is financial accountability and not epidemiological research. Because we are dealing with diseases that continue over time or have an important effect on health, all the linked expenditures are normally covered, at least partially. However, individuals who are not treated within the formal French health system are not considered as affected by the chronic conditions studied here. It is unlikely but not impossible that such individuals would not be treated for these conditions and the data cannot therefore estimate what percentage they represent.

By computing the incidence of each of the condition categories in 2015–2017 while using a 2011–2013 average for the standard of living, we tried to isolate the health selection pathway. However, it is not possible to fully cancel out this effect for reasons mentioned before and also because an individual's health can slowly deteriorate and affect their SES well before they access appropriate treatment.

Table 4
Prevalence of categories of disease by socioprofessional group, relatively to executives.

Category	Farm workers	Artisans, traders, company heads	Executives and higher intellectual professions	Intermediate professions	Employees	Workers
Cancers	**0.85** [0.70; 0.99]	**0.89** [0.83; 0.95]	1.00	**0.99** [0.94; 1.05]	**0.93** [0.88; 0.98]	**0.86** [0.82; 0.91]
Diabetes	**1.27** [1.17; 1.37]	**1.36** [1.27; 1.46]	1.00	**1.21** [1.14; 1.28]	**1.59** [1.50; 1.68]	**1.88** [1.78; 1.98]
Cardiovascular diseases	**1.19** [1.13; 1.25]	**1.21** [1.15; 1.27]	1.00	**1.11** [1.06; 1.16]	**1.20** [1.15; 1.26]	**1.32** [1.26; 1.37]
Liver or pancreatic diseases	**0.73** [0.56; 0.90]	**1.26** [0.98; 1.54]	1.00	**1.17** [0.99; 1.34]	**1.40** [1.19; 1.61]	**1.57** [1.33; 1.80]
Neurological or degenerative diseases	**1.44** [1.12; 1.77]	**1.10** [0.97; 1.22]	1.00	**1.15** [1.03; 1.26]	**1.30** [1.18; 1.43]	**1.38** [1.25; 1.52]
Psychiatric diseases	**1.12** [0.97; 1.26]	**1.35** [1.17; 1.52]	1.00	**1.40** [1.28; 1.52]	**1.87** [1.71; 2.03]	**2.08** [1.90; 2.26]
Chronic respiratory diseases	**1.18** [1.00; 1.35]	**1.22** [1.10; 1.35]	1.00	**1.14** [1.06; 1.22]	**1.33** [1.24; 1.41]	**1.46** [1.36; 1.56]

Note: The 95% confidence interval is indicated between square brackets under the value. Interpretation: Employees have a risk of living with diabetes that is 1.59 times higher than for executives and higher intellectual professions. The real value is between 1.50 and 1.68, with a probability of 95%. Values in bold do not include 1 in their confidence interval, i.e. the situation where the actual prevalence has a 95% probability of differing from the one of the reference group. Scope: 2016–2017, France (excluding Mayotte). Source: EDP-Santé 2017.

Although justified by the sample size, the 10-year classes of age used for standardisation are probably too large to completely eliminate the structure effects, with young people and women over-represented in the lowest deciles of living standards. The ratios in prevalence and incidence at exact “equal age” between the least well-off and the most affluent would be greater than those presented.

Conclusion

Despite these limitations, these results are important to determine and monitor social gradients affecting chronic conditions. They show that administrative health data can and should be used to further investigate SES inequalities. Additional work is necessary as soon as more recent data – and greater detail for each of the condition categories – become available.

Author statements

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Ethical approval

Please refer to 'Ethics' section in the main text.

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Competing interests

The authors declare no competing interests.

Author contributions

S.A. and V.C. conceived the study, with discussion with J.B.H. and D.N. S.A. wrote the initial draft. D.N., T.D. and J.B.H. reviewed, commented on and revised further drafts. Data analysis was conducted by S.A. with the help of T.D. All authors had full access to the data in the study and were responsible for the decision to submit for publication.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2023.12.022.

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