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The Economic Burden of Disease in France From the National Health Insurance Perspective

The Healthcare Expenditures and Conditions Mapping Used to Prepare the French Social Security Funding Act and the Public Health Act

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Background: Identifying the most frequently treated and the costliest health conditions is essential for prioritizing actions to improve the resilience of health systems.

Objectives: Healthcare Expenditures and Conditions Mapping describes the annual economic burden of 58 health conditions to prepare the French Social Security Funding Act and the Public Health Act.

Design: Annual cross-sectional study (2015–2019) based on the French national health database.

Subjects: National health insurance beneficiaries (97% of the French residents).

Measures: All individual health care expenditures reimbursed by the national health insurance were attributed to 58 health conditions (treated diseases, chronic treatments, and episodes of care) identified by using algorithms based on available medical information (diagnosis coded during hospital stays, long-term diseases, and specific drugs).

Results: In 2019, €167.0 billion were reimbursed to 66.3 million people (52% women, median age: 42 y). The most prevalent treated diseases were diabetes (6.0%), chronic respiratory diseases (5.5%), and coronary diseases (3.2%). Coronary diseases accounted for 4.6%

of expenditures, neurotic and mood disorders 3.7%, psychotic disorders 2.8%, and breast cancer 2.1%. Between 2015 and 2019, the expenditures increased primarily for diabetes (+€906 million) and neurotic and mood disorders (+€861 million) due to the growing number of patients. "Active lung cancer" (+€797 million) represented the highest relative increase (+54%) due to expenditures for the expensive drugs and medical devices delivered at hospital.

Conclusions: These results have provided policy-makers, evaluators, and public health specialists with key insights into identifying health priorities and a better understanding of trends in health care expenditures in France.

Key Words: health expenditure, cost-of-illness, burden of disease, national health data system

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Addressing the challenges resulting from the longer life expectancy[1] in high-income countries requires that we reinforce the resilience of health systems.[2] In the context of increasing financial constraints, the identification of the most frequently treated and costliest health conditions is essential for prioritizing actions to improve resilience, such as preventive actions or the reorganization of care, and a better understanding of the mechanisms underlying health care expenditures.[3]

Over the last decade, national claims data used for health care billing have been increasingly used to describe the morbidity[1,4] and expenditures by health condition.[5–11] However, the study population is often not representative of the general population if health insurance is not universal. In addition, the lack of individual information sometimes requires the modeling or the grouping of diseases into large categories. Thus, only very few countries have simultaneously described the prevalence of health conditions and the resulting expenditures for their management.[12]

In France, the National Health Data System ("*Système National des Données de Santé, SNDS*") contains extensive individual information for almost the entire population, as public health insurance coverage is mandatory.[13] Thus, the SNDS has

been increasingly used for research in recent years[13] and the development of Healthcare Expenditures and Conditions Mapping (HECM). The objective of this standardized tool is to describe the national annual prevalence of 58 health conditions among health care users and the expenditures reimbursed by the national health insurance for the care of each health condition. Here, 'health conditions' refers to treated diseases, chronic treatments (without a specific diagnosis identified), and episodes of care (such as maternity). We present the methodology of the HECM, its main results for 2019, and how they varied between 2015 and 2019 to provide a first overview of the economic burden of disease in France, a country that aims to offer free and universal access to health care.

METHODS

Design

The HECM is equivalent to an annually repeated cross-sectional population-based study, without sampling, as all eligible individuals are included. The study has been repeated for all years studied with the release of each new version. The study using the present version was conducted for the years 2015–2019.

Population

The HECM includes all health care users (French residents with at least 1 reimbursement for health care delivery during the year studied). In 2019, they represented ~66.3 million people (97% of French residents).

Data Source: The French National Health Data System

Individual data from administrative forms and reimbursement claims have been prospectively recorded in a common data warehouse, the SNDS, since 2005.[13] SNDS contains sociodemographic data, including health care reimbursements covered by complementary universal health insurance, which is free supplemental health insurance that provides free access to health care to low-income earners and was used to measure social precarity. SNDS also contains exhaustive information on pharmacy claims and the type of outpatient services or procedures reimbursed (without their results). In outpatient settings, physician-reported diagnoses are available only for beneficiaries with the "*Affection de Longue Durée*" status, which waives copayments related to the treatment of specific long-term diseases. SNDS also includes the French Hospital Discharge Database, containing inpatient diagnoses and procedures, from 2006 to 2019 at the time of this study.

All SNDS data are anonymous and individually linkable. Access to data is subject to prior training and authorization and requires approval by the independent French data protection authority ("*Commission Nationale Informatique et Libertés*"). Our public institution has permanent access to these data in application of the provisions of articles R. 1461-12 et seq. of the French Public Health Code. Therefore, ethics board approval was not required.

Health Conditions

Algorithms have been developed to identify 58 health conditions (grouped into 15 categories) from the medical information available in SNDS using a lookback period of up to 5 years (Supplemental Digital Contents 1, http://links.lww.com/MLR/C491 , and 2, http://links.lww.com/MLR/C492).[14]

Several health conditions can be identified in the same patient. "Hospitalisations for other reasons" concerned people with at least 1 short stay for a reason other than those considered for the health conditions otherwise identified. In particular, this reason may be related to infection (pneumonia), trauma, surgery (hip prosthesis and appendicectomy), exploratory examinations (colonoscopy), or ill-defined symptoms or conditions.[15] For cardiovascular diseases (CVDs), cancer, and end stage renal disease, exclusive algorithms identified different states of the same disease to distinguish expenditures related to active treatment or acute care or to long-term follow-up and chronicity. Finally, several health conditions aimed to attribute expenditures to individuals receiving chronic treatment when they had no specific diagnosis coded as anlong-term disease or during a hospital stay.

The first version of the algorithms was developed in 2012 by AFC, with the help of a coding expert, an epidemiologist, and a health insurance physician and exchanges with other experts. All algorithms were submitted to review by clinicians, epidemiologists, and coding experts, conducted by an independent research team[14] and subsequently adapted. Their continuing improvement has also benefited from the work conducted by a network of SNDS expert users who record and compare algorithms.[16]

Individual Expenditures

All reimbursed individual expenditures directly related to personal health care administered during a given year were calculated by expenditure item for each individual from a national health insurance perspective. Expenditures related to collective services (prevention, public health services, and health administration) and lump-sum financing were not included in HECM. The expenditure items and sources of data are listed in Table 1.

Attribution of Expenditures to Health Conditions

Overall annual reimbursed expenditures were distributed between the 58 identified conditions, with no possibility of double counting. The sum of expenditures attributed to a health condition across all expenditure items constituted its estimated economic burden. On the basis of a comprehensive and standardized methodology rather than multiple disease-specific cost-of-illness studies, which tend to overestimate the total expenditure, this general cost-of-illness approach has been considered conceptually more relevant for a political objective.[17]

Two methods were used for attribution according to the expenditure item (Table 1). For items for which diagnoses are systematically recorded (eg, hospital stays), we used this information to directly attribute expenditures to a single health condition (Supplemental Digital Content 3, http://links.lww.com/MLR/C493). This approach is similar to a "bottom-up" method, as individual-level expenditures are summed to

TABLE 1. List of Expenditure Items, Sources of Data, Methods to Attribute Expenditures to Health Conditions, and Whether "Usual Care" Were Considered

Category of Expenditure	Expenditure Item	Sources of Data	Attribution to Health Conditions	Expenditure Attributed to Usual Care
Ambulatory care	General practitioners	Derived directly from individual SNDS reimbursement data	Indirect	Yes
	Specialists			
	Dental care			
	Nursing care			
	Physiotherapists			
	Other paramedical care			
	Drugs			
	Medical devices and associated care			
	Laboratory tests			
	Other ambulatory care			
	Midwifery			No (not related to usual care)
	Transportation			
Hospital care	Public hospital outpatient care	Hospital discharge database	Indirect	
	Short-stay hospitalization (DRG)		Direct	
	Drugs and medical devices out of DRG*			
	Hospitalization in rehabilitation care			
	Hospitalization in psychiatry			
	Hospital at home		Indirect	
Cash benefits	Maternity leave[†]	Derived directly from individual SNDS reimbursement data	Direct (maternity)	
	Disability pension[‡]		Indirect	
	Sick leave[†]		Indirect	Yes

*Within health care institutions, the "supplementary list" ("*liste en sus*") allows the payment of pharmaceutical specialties by the health insurance system, for some of their therapeutic indications, in addition to the costs related to the hospital stay derived from DRG, when these indications are innovative. This list is set by order of the minister responsible for health and social security and specifies the indications concerned, in accordance with Article L. 162-22-6 of the Social Security Code.
[†]Daily allowances paid by national health insurance in case of work stoppage due to disease or maternity. Also comprise compensation for work accidents or occupational disease.
[‡]Compensation of loss of salary as a result of disability.
DRG indicates diagnosis-related group; SNDS, Système national des données de santé (French national health database).

obtain a population-level condition-specific estimation.[18] Short-stay hospitalization expenditures not attributable to a specific health condition were attributed to hospitalizations for other reasons.

For items not associated with information based on a diagnosis, we used an indirect attribution approach, similar to a "top-down" method, as portions of resource aggregates were assigned to specific health conditions.[18] The indirect method was applied for each concerned item and observed combination of health conditions in the study population (~450,000 combinations). When only 1 health condition was identified for the year, expenditures were attributed exclusively to this condition. For other combinations, the total expenditure was assigned to the constituent conditions pro rata to the mean expenditure previously calculated in groups with only 1 of these conditions. For example, the mean drug expenditures for people with diabetes (A) or epilepsy (B) as unique identified conditions were used to calculate the proportions for distributing drug expenditures for people with these 2 conditions [A/(A+B) for diabetes and B/(A+B) for epilepsy]. The indirect method was applied for each individual after subtracting expenditures for so-called "usual" care. For concerned items, this amount corresponded to the second decile of expenditures for people of the same age and sex who had used this type of care but had no health condition identified other than hospitalizations for other reasons.

Statistical Analyses

Sociodemographic characteristics of the study population and the prevalence of each health condition were described for 2019. Annual expenditures (in current euros) and mean expenditures (in current euros per patient) attributed to the various health conditions were calculated, globally and by expenditure item. The mean annual growth rates of expenditures and the number of patients were calculated for the 2015–2019 period. As the analyses were not performed on a random sample of the population, no confidence interval was estimated. Statistical analyses were performed using SAS Enterprise Guide 4.3 software (SAS Institute Inc., Cary, NC).

RESULTS

Population Characteristics and Health Conditions in 2019

In 2019, the HECM comprised 66.3 million people, including 52% women and 21% people aged 65 years or older, with a median age of 42 years (interquartile range: 21–61). Social precarity concerned 9.1% of the population. People with no health condition identified (55%) were younger than the general population (median age: 29 y, interquartile range: 14–46), and 9.5% of them were in a socially precarious situation. Sociodemographic characteristics by health condition are presented in Supplemental Digital Content 4, http://links.lww.com/MLR/C494.

The most prevalent categories of health conditions were "CVD and chronic treatments" (21%), and "psychiatric diseases and chronic treatments" (12%) (Table 2). The most prevalent health conditions were hospitalization for other reasons (14%) and chronic treatments without a specific diagnosis identified, in particular antihypertensive treatment (11%). Diabetes (6.0%) and chronic respiratory disease (5.5%) were the most frequent diseases, followed by coronary disease (3.0% for chronic coronary disease without an acute event, 3.2% when combined with acute coronary syndrome).

Social precarity was more frequent among people with addictive disorders (19%), psychiatric disorders that began in childhood (24%), maternity (18%), and chronic analgesic or non-steroidal anti-inflammatory (NSAI) treatment (24%) than those with no health condition identified (9.5%). Nevertheless, it was less frequent among people receiving care for CVD (3.9%), cancer (3.3%, in particular in long-term follow-up), diabetes (6.7%), dementia (1.2%), and Parkinson disease (1.7%).

Expenditures Attributed to Health Conditions in 2019

In 2019, €167.0 billion was reimbursed by the national health insurance for the entire population (Table 2). Hospitalizations for other reasons accounted for the highest expenditure (22% of total expenditures), followed by CVD and treatments (14%), psychiatric diseases and treatments (14%), and cancer (12%). At a more detailed level, expenditures attributed to the management of these categories of health conditions were primarily related to neurotic and mood disorders (3.7% of total expenditures), psychotic disorders (2.8%), chronic coronary heart disease (2.0%), and "other cancers during the active treatment phase" (5.7%). Among the 4 specific cancer sites (breast, lung, colorectal, and prostate), breast cancer was associated with the highest expenditure (2.1% of total expenditures, 1.8% when considering only cancer in the active treatment phase). In addition, at this detailed level, diabetes seemed to be the third most expensive health condition (5.1% of total expenditures).

Furthermore, the predominant component of expenditures differed according to health condition (Fig. 1). As mentioned above, CVD and psychiatric diseases were the most frequent health conditions, but the mean expenditures per patient were low (1334 and 2125 €/patient, respectively) relative to other health conditions, including cancer (5656 €/patient). By contrast, the highest mean expenditures concerned, by far, end stage renal disease (41,701 €/patient,

n = 98,427; not shown in Fig. 1), mostly related to chronic dialysis (60,557 €/patient, n = 54,566).

Finally, the expenditures were mostly related to hospital care for acute CVD, valvular heart diseases, cancer in the active treatment phase (except prostate cancer), and psychiatric diseases (Supplemental Digital Content 5, http://links.lww.com/MLR/C495). By contrast, expenditures were mostly related to ambulatory care for chronic CVD, follow-up for cancer, diabetes, HIV infection, and rare diseases. Finally, cash benefits represented an important proportion of expenditures for maternity (5.5%), chronic analgesic and NSAI treatment, and chronic psychiatric treatments.

Evolution of Expenditures Between 2015 and 2019

Between 2015 and 2019, health care expenditures increased by €14.5 billion (+9.5%, +2.3%/y on average). The growth in expenditures was the highest for cancer (+€3.8 billion, +5.3%/y) (Fig. 2). Apart from the heterogeneous group of other cancers during the active treatment phase (+€1.7 billion), lung cancer during the active treatment phase was the specific cancer site associated with the highest increase in expenditures (+€797 million; +11.4%/y) during the study period. Except in 2016, the largest share of this increase can be attributed to the mean expenditure per patient (Fig. 3), which sharply increased by 13% in 2017 and continued to increase during the following years due to drugs and medical devices out of the diagnosis-related group of the stay, for which the expenditures increased dramatically from 1351 €/patient in 2015 to 5161 €/patient in 2019 (+282%) (Supplemental Digital Content 6, http://links.lww.com/MLR/C496).

In addition, the expenditures increased substantially for diabetes (+€906 million, +2.8%/y on average), heart arrhythmia or conduction disorders (+€612 million, +6.8%/y), and neurotic and mood disorders (+€861 million, +3.8%/y), to which antidepressant or mood regulating treatment without a specific diagnosis identified (+€342 million, +3.2%/y) can be added (Fig. 2). These increases were mainly due to growth in the number of patients for diabetes (+9%) and neurotic and mood disorders (+11%) (Fig. 3). Heart-arrhythmia or conduction-disorder–related expenditures increased due to the growth in both the number of patients (+15%) and the mean expenditure per patient (+13%), the mean expenditure increasing mainly because of drugs (+€215 million, +16%/y on average).

Expenditure growth was essentially due to an increase in the number of patients for chronic inflammatory diseases (+17%), end stage renal disease (+12%), chronic heart failure without acute event (+16%), valvular heart diseases (+15%), acute coronary syndrome (+10%), peripheral vascular diseases (+11%), and psychiatric disorders that began in childhood (+23%) (Fig. 2).

Although expenditures increased for most health conditions, they decreased for liver or pancreas diseases (−€507 million, −6.5%/y on average, despite a temporary increase in 2017), HIV infection (−€288 million, −5.1%/y), lipid-lowering treatment (−€338 million, −5.4%/y), hypnotic treatment (−€220 million, −5.0%/y), and "other psychiatric disorders" (−€115 million, −1.7%/y) (Fig. 2). These decreases were due to a decrease in the mean expenditure per patient,

TABLE 2. Frequency, Prevalence, and Distribution of Total Expenditures by Health Condition in 2019

Health Condition	n	Prevalence* (%)	Expenditures	
			In Billion €	Proportion of Total (%)
Whole population	66,266,685	100	166.97	100
No health condition identified	36,194,044	55	11.14	6.7
Cardiovascular diseases and chronic treatments	13,605,415	21	23.54	14
Acute coronary syndrome	103,648	0.16	1.03	0.62
Chronic coronary disease without acute event	1,983,957	3.0	3.40	2.0
Acute stroke	124,733	0.19	1.55	0.93
Sequelae of stroke	833,164	1.3	2.24	1.3
Acute heart failure	197,856	0.30	1.59	0.95
Chronic heart failure without acute event	662,875	1.0	1.50	0.90
Peripheral vascular diseases	714,256	1.1	1.87	1.1
Heart arrhythmia or conduction disorders	1,785,941	2.7	2.65	1.6
Valvular heart diseases	461,016	0.70	1.28	0.77
Pulmonary embolism	44,805	0.068	0.23	0.14
Other cardiovascular diseases	351,056	0.53	0.59	0.35
Antihypertensive treatments[†]	7,329,506	11	4.26	2.6
Lipid-lowering treatments[†]	3,056,830	4.6	1.34	0.80
Diabetes	3,964,561	6.0	8.58	5.1
Cancers	3,297,155	5.0	20.10	12
Active female breast cancer	228,165	0.66	2.92	1.8
Follow-up for female breast cancer	495,965	1.43	0.58	0.35
Active colorectal cancer	150,434	0.23	1.67	1.0
Follow-up for colorectal cancer	220,811	0.33	0.22	0.13
Active lung cancer	98,603	0.15	2.28	1.4
Follow-up for lung cancer	54,018	0.082	0.09	0.057
Active prostate cancer	220,797	0.70	1.54	0.92
Follow-up for prostate cancer	314,728	0.99	0.25	0.15
Other active cancers	836,056	1.3	9.59	5.7
Follow-up for other cancers	934,542	1.4	0.95	0.57
Psychiatric diseases and chronic treatments	8,103,919	12	22.73	14
Psychotic disorders	475,244	0.72	4.76	2.8
Neurotic and mood disorders	1,405,133	2.1	6.21	3.7
Mental impairment	132,039	0.20	0.56	0.34
Addictive disorders	440,883	0.67	1.59	0.95
Psychiatric disorders having begun in childhood	172,358	0.26	1.30	0.78
Other psychiatric disorders	427,305	0.64	1.67	1.0
Antidepressant or mood-regulating treatments[‡]	2,994,072	4.5	2.88	1.7
Neuroleptic treatments[‡]	325,742	0.49	0.28	0.17
Anxiolytic treatments[‡]	3,077,668	4.6	2.53	1.5
Hypnotic treatments[‡]	1,244,966	1.9	0.95	0.57
Neurological diseases	1,673,904	2.5	7.66	4.6
Dementia (including Alzheimer disease)	760,673	1.1	2.57	1.5
Parkinson disease	271,583	0.41	1.09	0.65
Multiple sclerosis	115,498	0.17	1.20	0.72
Paraplegia	97,635	0.15	1.12	0.67
Myopathy or myasthenia	48,334	0.073	0.26	0.15
Epilepsy	342,385	0.52	0.61	0.36
Other neurological conditions	175,486	0.26	0.82	0.49
Chronic respiratory diseases[§]	3,656,804	5.5	3.49	2.1
Chronic inflammatory diseases	964,753	1.5	3.36	2.0
Inflammatory bowel diseases	273,098	0.41	0.99	0.59
Rheumatoid arthritis and related diseases	299,918	0.45	0.96	0.58
Ankylosing spondylitis and related diseases	228,949	0.35	0.94	0.56
Other chronic inflammatory diseases	215,598	0.33	0.47	0.28
Rare diseases	180,599	0.27	1.52	0.91
Hereditary metabolic diseases or amyloidosis	120,196	0.18	0.64	0.38
Cystic fibrosis	8796	0.013	0.32	0.19
Hemophilia or severe hemostasis disorders	52,021	0.079	0.57	0.34
HIV infection	151,346	0.23	1.22	0.73
End stage renal disease	98,427	0.15	4.10	2.5
Chronic dialysis	54,566	0.082	3.30	2.0
Kidney transplant	3514	0.0053	0.24	0.14
Follow-up for kidney transplant	40,347	0.061	0.56	0.34
Liver or pancreas diseases[§]	604,162	0.91	1.54	0.92
Other long-term diseases	1,975,489	3.0	4.30	2.6

(Continued)

TABLE 2. Frequency, Prevalence, and Distribution of Total Expenditures by Health Condition in 2019 (*continued*)

Health Condition	n	Prevalence* (%)	Expenditures	
			In Billion €	Proportion of Total (%)
Maternity	1,265,621	3.7	8.48	5.1
Hospitalization for other reasons	9,417,185	14	37.41	22
Analgesic or NSAI treatment[‖]	1,308,126	2.0	1.52	0.91
Usual care[¶]	NA	NA	6.28	3.8

*Among men or women only when appropriate.
[†]Without a diagnosis of cardiovascular disease, diabetes, or end stage renal disease.
[‡]Without a diagnosis of mental illness.
[§]Excluding cystic fibrosis.
[‖]Excluding diseases, treatments, maternity care, or hospitalization.
[¶]Prevalence not reported because it is not a group of people, only aggregated expenditures.
NA indicates not applicable; NSAI, nonsteroidal anti-inflammatory.

particularly drug expenditures for liver or pancreas diseases (−30%) and HIV infection (−27%) and the number of patients for the 3 other health conditions (lipid-lowering treatment: −19%, hypnotic treatment: −26%, and other psychiatric disorders: −8%) (Fig. 3).

Finally, expenditures attributed to chronic analgesic or NSAI treatment were stable, with a decrease in the number of patients (−16%) and a corresponding increase in the mean expenditure per patient (+16%).

The evolution of the expenditure items that varied the most between 2015 and 2019 are presented by health condition in Supplemental Digital Content 7, http://links.lww.com/MLR/C497.

DISCUSSION

For the first time in France, HECM has offered the opportunity to describe the economic burden of disease and its trend over 5 years. CVDs, diabetes, cancer, and mental diseases were among the most frequent and costliest health conditions, consistent with the results from most other European countries.[6,11,19] In Switzerland, CVDs and mental and substance use disorders were among the 3 costliest diseases, along with musculoskeletal disorders, whereas cancer only ranked seventh.[7]

In 2019, CVDs and their treatment concerned 21% of the population and represented 14% of expenditures. Coronary disease was the most frequent and costly CVD. Diabetes was the third most expensive health condition and showed the greatest increase in expenditures between 2015 and 2019, not considering grouped health conditions, such as "other active cancers". The growth of expenditures for most CVDs, diabetes, and end stage renal disease was regular and essentially related to the growing number of patients, which suggests that it was mostly due to ageing of the population and an increase in the prevalence of risk factors, such as obesity. The increase in drug expenditures for heart arrhythmia or conduction disorders probably resulted from the growing use of non–vitamin K antagonist oral anticoagulants.[20] Finally, the large decrease in the number of patients receiving lipid-lowering treatment (with no specific diagnosis identified) (−19%) was likely related to controversy concerning the indications of statins in primary prevention since 2013, which have been particularly publicised in France.[21,22]

Cancer represented a higher proportion of expenditures (12%) than in most other countries that conducted such estimations (from 5.5% in the United States to 10% in the Czech Republic), but it was very similar in Finland (12%), Hungary (13%), and Greece (13%).[6,7,9] Furthermore, cancer was characterized by strong dynamics in expenditures, often associated with very costly therapeutic innovations. This is illustrated by the sharp increase in expenditures for drugs and medical devices out of the diagnosis-related group for the treatment of lung cancer in 2017, which most likely resulted from the arrival of specific immunotherapies (nivolumab and pembrolizumab).

The economic burden of psychiatric diseases and chronic treatments was also large (prevalence among health care users: 12%, 14% of expenditures), in particular, neurotic and mood disorders. The increase in the number of individuals with psychiatric disorders that began in childhood likely resulted from the increase in the prevalence of autism spectrum disorders.[23,24] The decrease in the prevalence and expenditure for treatment with chronic hypnotics was likely related to implementation of a requirement that zolpidem prescriptions be obtained by secured forms.[25]

Moreover, we observed other notable trends. The fact that the number of patients with chronic analgesic or NSAI treatment decreased, whereas the mean expenditure increased, may be related to actions implemented by health authorities to reduce the misuse of codeine among young people. The decrease in the mean expenditures for the management of HIV infection was concomitant with drug price reductions. Finally, the decrease in the mean expenditures for the management of liver or pancreas diseases was probably related to the successful treatment of chronic hepatitis C, the temporary increase in 2017 coinciding with the generalization of new direct-acting antiviral indications.[26]

HECM is based on a rich database, with a coverage of 97% of the population and the completeness of individual expenditures reimbursed by the national health insurance. Universal health insurance provides nations with a robust dataset usable for both policy and clinical research without some of the limitations of datasets that only cover a portion of a population.[27] Nevertheless, several methodological issues merit discussion. First, although we identified a greater number of health conditions than in many previous studies,[6–8,10,11] the information available was insufficient to
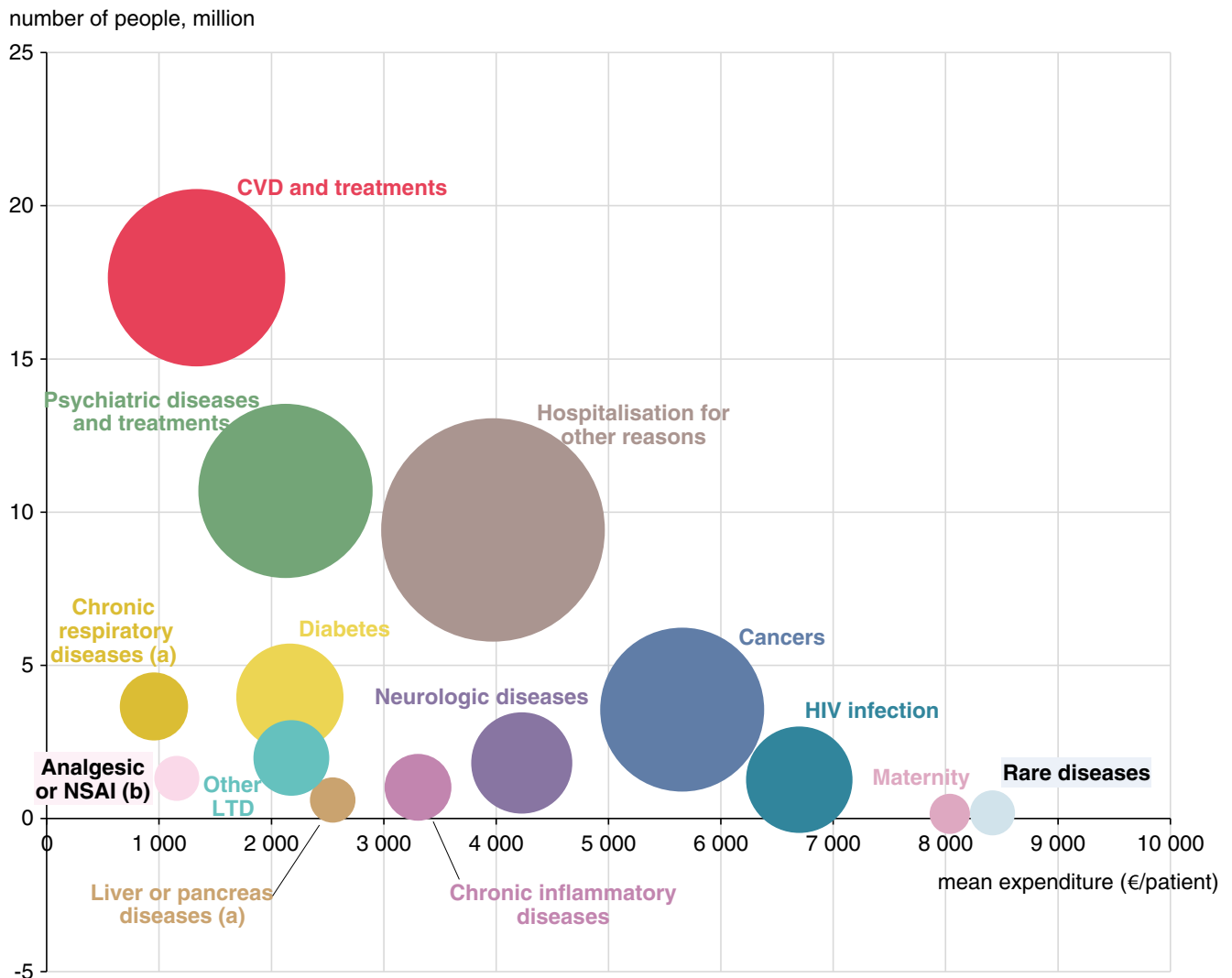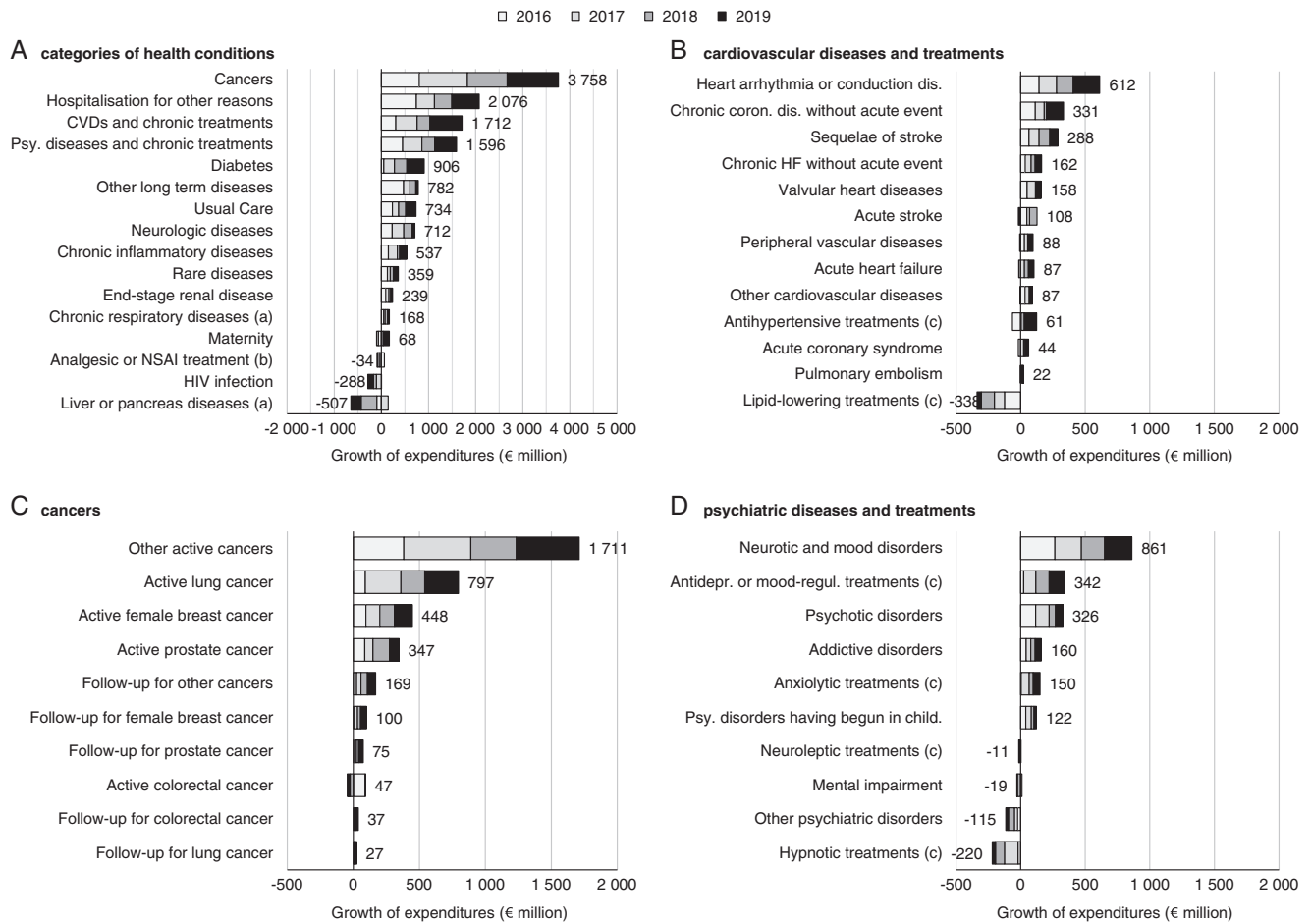
FIGURE 1. Expenditures by health condition category in 2019 and their components: number of patients and mean expenditure per patient. Excluding cystic fibrosis. Excluding diseases, treatments, and maternity care or hospitalization. The size of the bubbles is proportional to the expenditure. Bubbles for end stage renal disease (n = 98,427, 41,701 €/patient), people with no identified health condition (n = 36 million, 308 €/patient), and usual care were not represented because of the very high mean expenditure or very large number of people. CVD indicates cardiovascular diseases; LTD, long-term disease; NSAI, nonsteroidal anti-inflammatory. [full color online]

distinguish between certain health conditions, for example, chronic obstructive pulmonary disease and asthma, and to identify certain health conditions, for example, osteoarthritis. In addition, we previously reported that "orthopaedics and traumatology" accounted for 1.4 million hospital admissions and ~4 billion euros (13% of the total expenditures) in 2017.[15] The addition of algorithms to identify trauma is among the future improvements of HECM.

Second, as in all studies based on administrative data, the performance of the health condition identification algorithms largely depends on coding practices. The performance of such algorithms has been rarely studied due to the lack of gold standards. One study showed that our diabetes identification algorithm, as others, performed very well in identifying treated diabetes.[28] Population-based cohorts could be

used more systematically in the future to evaluate such algorithms.

Finally, the data available in SNDS allowed approximately half of health care expenditures to be directly attributed to health conditions at the individual level. This has rarely been the case in other studies because this requires detailed diagnostic data.[18] Furthermore, the indirect method used for the remaining half of the expenditures, contrary to classic top-down studies, was based on individual data to identify health conditions and was performed by combining health conditions, thus accounting for multimorbidity, that is, interactions between health conditions towards expenditures. However, basing the pro rata attribution of expenditures on people with several health conditions on mean expenditures of those with only 1 condition could have insufficiently

FIGURE 2. Annual growth of total reimbursed expenditures between 2015 and 2019 by health condition category and health conditions from the 3 categories with the highest expenditures. Excluding cystic fibrosis. Excluding diseases, other chronic treatments, and maternity care or hospitalization, without a specific diagnosis identified. CVD indicates cardiovascular diseases; NSAI, nonsteroidal anti-inflammatory.
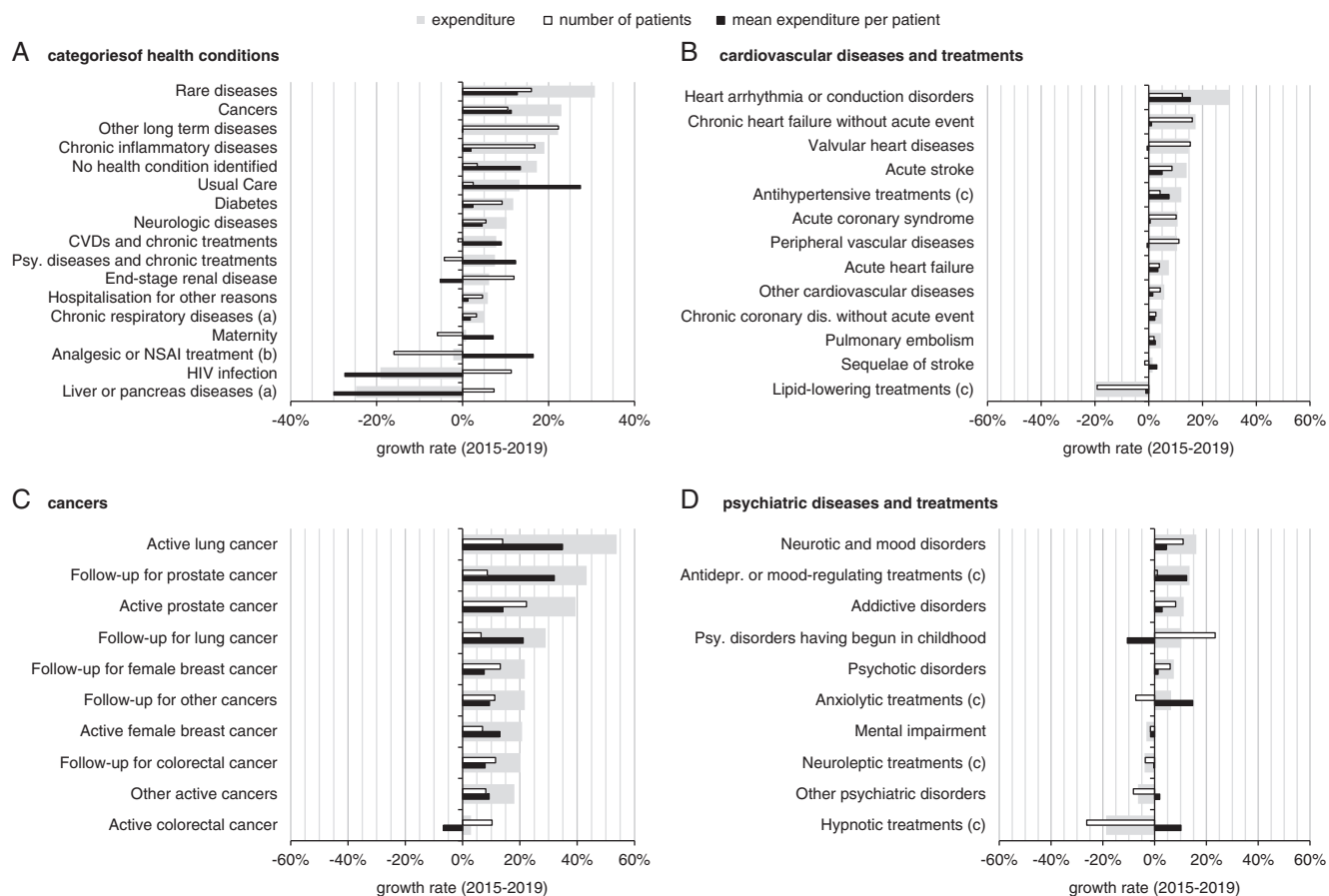
accounted for multimorbidity for the concerned expenditure items. The feasibility of expenditure modeling, which could more accurately account for such interactions[8,29] and other individual characteristics, is yet to be assessed in the context of a large number of health conditions.

The HECM results have been published in an annual report to the parliament and Ministry of Health. Its results provide these bodies with a better understanding of the impact of aging of the population, therapeutic innovations, the evolution of medical practice, and public health interventions, as mentioned above through examples. It also provides them with insightful information to prepare the Social Security Funding Act and the Public Health Act, in particular, to identify priority public health actions to improve the resilience of the health system, which includes preventive actions. In addition, data used to identify health conditions and individual calculated expenditures are accessible through SNDS to a large number of health system actors and researchers, which can facilitate territorial diagnoses, research on health services and care pathways, and health economics studies.[30] At the international level, these methods could be applied, or

adapted according to data availability, in other countries with large-scale individual data on health care spending. Our results are also useful for international comparisons of the economic burden of disease in various populations and health systems.

Finally, to set priorities for public health actions, it is necessary to consider the human burden, in addition to the economic burden, of disease. Our algorithms have not been designed to estimate the prevalence of diseases in the general population, but rather the prevalence of treated diseases among health care users, which is relevant when considering our objective to describe expenditures by health condition within the health system. Although this measure is likely a correct approximation of the disease prevalence in the general population when almost all cases are treated, other estimations of disease prevalence (and incidence) based on representative epidemiological studies are needed. In addition, economic indicators must and will be completed by morbidity and mortality indicators,[1] which will enrich the national and territorial diagnoses and provide a complete picture of the burden of disease.

■ expenditure □ number of patients ■ mean expenditure per patient

A categoriesof health conditions

B cardiovascular diseases and treatments

C cancers

D psychiatric diseases and treatments

FIGURE 3. Growth rate of expenditures by health condition between 2015 and 2019 and their components: number of patients and mean expenditure per patient. Excluding cystic fibrosis. Excluding diseases, other chronic treatments, and maternity care or hospitalization, without a specific diagnosis identified. CVD indicates cardiovascular diseases; NSAI, nonsteroidal anti-inflammatory.

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