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CLINICAL RESEARCH

Prevalence and economic burden of cardiovascular diseases in France in 2013 according to the national health insurance scheme database



Prévalence des maladies cardiovasculaires prises en charge en France et montants remboursés (2013) : analyse de la base nationale de l'assurance maladie

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KEYWORDS

Cardiovascular diseases;
Prevalence;
Comorbidities;
Costs;
SNIIRAM

Summary

Background. — Cardiovascular diseases (CVDs) constitute the second leading cause of death in France. The *Système national d'information interrégimes de l'assurance maladie* (SNIIRAM; national health insurance information system) can be used to estimate the national medical and economic burden of CVDs.

Objectives. — To describe the rates, characteristics and expenditure of people reimbursed for CVDs in 2013.

Abbreviations: AD, significant associated diagnoses; CMU-C, *Couverture maladie universelle-complémentaire*; CVD, cardiovascular disease; HF, heart failure; ICD, International classification of diseases; LTD, long-term disease status; PAD, peripheral artery disease; PD, principal diagnosis; RD, related diagnosis; SNIIRAM, *Système national d'information inter-régimes de l'assurance maladie*.

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Methods. – Among 57 million general health scheme beneficiaries (86% of the French population), people managed for CVDs were identified using algorithms based on hospital diagnoses either during the current year (acute phase) or over the previous 5 years (chronic phase) and long-term diseases. The reimbursed costs attributable to CVDs were estimated.

Results. – A total of 3.5 million people (mean age, 71 years; 42% women) were reimbursed by the general health scheme for CVDs (standardized rate, 6.5%; coronary heart disease, 2.7%; arrhythmias/conduction disorders, 2.1%; stroke, 1.1%; heart failure, 1.1%). These frequencies increased with age and social deprivation, and were higher in Northern and Eastern France and Réunion Island. The total sum reimbursed by all schemes for CVDs was € 15.1 billion (50% for hospital care and 43% for outpatient care [including 15% for drugs and 12% for nurses/physiotherapists]); coronary heart disease accounted for € 4 billion, stroke for € 3.5 billion and heart failure for € 2.5 billion (i.e. 10% of the total expenditure reimbursed by all national health insurance schemes for all conditions).

Conclusion. – CVDs constitute the leading group in terms of numbers of patients reimbursed and total reimbursed expenditure, despite a probable underestimation of both numbers and expenditure.

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MOTS CLÉS

Maladies cardiovasculaires ;
Prévalence ;
Comorbidités ;
Coûts ;
Sniiram

Résumé

Contexte. – Les maladies cardiovasculaires (MCV) constituent la seconde cause de décès en France. Le Système national d'information inter-régime de l'assurance maladie (Sniiram) permet d'en estimer le poids médical et économique au niveau national.

Objectifs. – Décrire les taux, caractéristiques et dépenses des personnes prises en charge pour MCV en 2013.

Méthodes. – Parmi 57 millions d'assurés du régime général (86% de la population française), les personnes prises en charge pour les MCV ont été repérées à l'aide d'algorithmes basés sur les diagnostics hospitaliers soit sur l'année en cours (phase aiguë), soit sur les cinq dernières années (phase chronique) et les affections de longue durée. Les coûts remboursés attribuables aux MCV ont été estimés.

Résultats. – On dénombrait 3,5 millions de personnes (âge moyen, 71 ans ; femmes 42%) prises en charge par le régime général pour une ou des MCV (taux standardisé, 6,5% ; maladie coronarienne, 2,7% ; troubles du rythme/conduction, 2,1% ; AVC, 1,1% ; insuffisance cardiaque, 1,1%). Ces taux augmentaient avec l'âge et le désavantage social et étaient plus élevées dans le Nord et l'Est et aussi à la Réunion. Le montant remboursé tous régimes pour les MCV était de 15,1 milliards d'euros (hôpital 50%, soins de ville 43% dont médicaments 15% et infirmiers/kinésithérapeutes 12%) dont la maladie coronarienne : 4 milliards d'euros, AVC : 3,5 milliards, insuffisance cardiaque : 2,5 milliards, soit au total 10% des remboursements versés à toute la population.

Conclusion. – Les MCV constituent le premier groupe en termes d'effectifs de personnes prises en charge et de dépenses affectées, malgré une sous-estimation probable à la fois des effectifs et des dépenses.

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Background

Cardiovascular diseases (CVDs) constitute the second leading cause of death in France, accounting for 27% of the 535,000 deaths in 2011 (i.e. a standardized rate of 216/100,000) [1]. More precisely, ischaemic heart disease accounted for 7% of deaths (standardized death rate of 55/100,000) and cerebrovascular disease accounted for 6% of deaths (standardized death rate of 48/100,000); the male/female ratios for these last two causes of death were

2.4 and 1.3, respectively. However, age-standardized death rates decreased by one-half between 1990 and 2009: by 55% for ischaemic heart disease and by 48% for cerebrovascular disease [1]. In 2012, the crude hospitalization rates were 339/100,000 for ischaemic heart disease, 188/100,000 for acute coronary syndromes, 94/100,000 for myocardial infarction, 224/100,000 for cerebrovascular disease and 239/100,000 for heart failure (HF) [2]. Standardized hospitalization rates for each of these diseases also decreased between 2002 and 2012 for both sexes, but with different

amplitudes. However, standardized hospitalization rates for stroke in subjects aged <65 years increased over the same period (+13.3% for men and +16.3% for women). The observed variations can be attributed to lifestyle changes and improvements in primary/secondary prevention and management of patients at the acute phase, and to an increased prevalence of certain risk factors among younger subjects.

Despite the importance of these diseases, and apart from disease registries, few large-scale prevalence studies and cost estimates have been performed in France. Self-reporting Handicap-Santé (health and disability) surveys conducted on samples of households and institutionalized subjects (2008–2009) have reported a prevalence of 3.7% for ischaemic heart disease, 2.3% for HF and 2% for stroke, including 0.8% for stroke with sequelae, in the adult population [3,4].

The objective of this study was to estimate, on the basis of algorithms using data derived from the *Système national d'information interrégimes de l'assurance maladie* (SNI-IRAM; national health insurance information system), the prevalence rates of the most common CVDs among people covered by the main French national health insurance scheme (86% of the population), as well as their variations according to region and social deprivation index, associated comorbidities and the expenditure reimbursed by national health insurance specifically related to these diseases.

Methods

Population and information system

The national health insurance general health scheme covered about 76% of the 66 million inhabitants of France in 2014, as well as various population groups covered by local mutualist sections for students, civil servants, etc. (i.e. 86% of the French population). The Mutualité Sociale Agricole (agricultural workers' health insurance fund) and the Régime Social des Indépendants (self-employed health insurance fund) each cover 5% of the population, and the remaining 4% is covered by other schemes. The population of the present study was therefore composed of general health scheme beneficiaries, including local mutualist sections, after exclusion of those individuals for whom no hospital or outpatient expenditure was reimbursed during the year, representing about 4–5% of the population, varying according to age and sex.

The SNIIRAM database comprehensively and individually records all outpatient prescriptions and health care procedures reimbursed to beneficiaries of the various health schemes [5], but does not comprise any clinical information concerning results related to consultations, prescriptions or examinations. However, attribution of long-term disease (LTD) status, validated by a national health insurance physician at the request of the attending physician, allowing exemption of copayment, can provide information about the nature of the diseases treated. An anonymous and unique identification number for each beneficiary allows this information to be linked to the data collected by the *Programme de médicalisation des systèmes d'information* (PMSI; a the French national hospital discharge database) during hospital

stays in the various types of health care institutions. Hospital diagnoses are coded according to the International Classification of Diseases 10th Edition (ICD-10), in the same way as the diagnoses allowing attribution of LTD status.

Methodology

The *Caisse nationale d'assurance maladie* (CNAM) general health scheme fund has developed a tool designed to identify beneficiaries reimbursed for chronic diseases and common, serious or expensive diseases and treatments, in order to study these diseases in terms of numbers, prevalence rates, expenditure and annual growth [6]. This tool, based on SNIIRAM data, uses algorithms to distribute beneficiaries into 56 non-exclusive groups of patients, pooled into 13 main categories. The details of these algorithms are available and updated annually, and have been subjected to expert review [7]. The algorithms used are based on principal diagnosis (PD), related diagnosis (RD) or significant associated diagnoses (AD) for short-stay and psychiatric hospital stays; diagnoses eligible for LTD cover; dispensing of specific drugs, identified by their *Code identifiant de présentation* (pack identification codes; the products and services reimbursed to the patient as medical device according to the *liste des produits et prestations* [LPP]); and specific procedures identified by their code according to the *Classification commune des actes médicaux* (French medical classification for clinical procedures).

Schematically, for some CVDs (coronary heart disease, stroke, HF), the term "acute" refers to a hospital stay during the year corresponding to the appropriate codes (with or without LTD), while the chronic phase is defined by the presence of LTD cover during the year and/or a hospital stay with a specific code during the previous 5 years. The acute episode always takes precedence over a chronic phase, and these two groups are mutually exclusive for a given disease, and are sometimes combined in statistical analyses. PDs were investigated in the various ward summaries when the stay comprised transfers to different wards.

The following CVD algorithms were used: for coronary heart disease, acute coronary syndrome (codes = I21 to I24 for a PD for a hospital stay in year N) and chronic ischaemic heart disease (codes = I20 to I25 for an LTD in year N; or codes I20 to I25 for PD/RD for hospital stays in years N to N-4 or for AD for hospital stays in year N); for stroke, acute stroke (codes I60 to I64 for a PD for a hospital stay in year N) and sequelae of stroke (codes = I60 to I64 or I67 to I69 for an LTD in year N; or codes = I60 to I64 or I67 to I69 for PD/RD for hospital stays in years N to N-4 or for AD for hospital stays in year N); for HF, acute phase (hospital stays with PD = I50 or AD/RD = I50 with PD = I11.0, I13.0, I13.2, I13.9, K76.1, J81 in year N) and chronic phase (LTD = I50, I11, I13 in year N; or hospital stays with PD/RD = I50 or AD = I50 and PD/RD = I11.0, I13.0, I13.2, I13.9, K76.1, J81 in years N to N-4; or hospital stay with AD = I50 with no restrictions concerning the PD/RD in year N); peripheral artery disease (PAD) (LTD = I70, I73, I74 in year N; or hospital stay with PD/RD = I70.2, I73.9 in years N to N-4; or hospital stay with AD = I70.2 or I73.9 in year N); arrhythmias/conduction disorders (LTD = I44 to I49 in year N; or hospital stay with PD/RD = I44 to I49 in years N to N-4; or hospital stay with AD = I44 to I49 in year N); valvular heart disease (LTD = I05 to I08 or I34 to I39 in year N; or

hospital stay with PD/RD=I05 to I08 or I34 to I39 in years N to N-4; or stay with AD=I05 to I08 or I34 to I39 in year N, with the exception of congenital valvular heart disease); pulmonary embolism (hospital stay with PD=I26 in year N). The other CVDs corresponded to patients with LTD cover for other CVDs, i.e. a disease with an ICD-10 code corresponding to the CVD section, but not described above (I codes, especially myocarditis, endocarditis, pericarditis, occlusion and stenosis of cerebral arteries, not resulting in cerebral infarction, and cerebral aneurysm) or congenital cardiovascular malformations (Q codes) or cardiovascular disorders originating in the perinatal period (P29), vascular disorders of the intestine (K55), abnormalities of heart beat (R00), complications of cardiac and vascular prosthetic devices, implants and grafts (T82) or the presence of cardiac and vascular implants and grafts (Z95). Patient groups treated with antihypertensives were defined by the presence of at least three reimbursements for specific drugs at different dates in year N. Finally, the identification of patients reimbursed for other diseases (diabetes; cancers; neurological or degenerative diseases; chronic lung diseases; inflammatory or rare diseases or human immunodeficiency virus/acquired immunodeficiency syndrome; end-stage renal disease; or liver and pancreatic diseases) or patients treated with psychotropic drugs is described elsewhere [6]. Only expenditure directly attributed to individual patients was considered for calculation of the costs of disease [6], corresponding to health care (mandatory health scheme) provided in 2013 and reimbursed up until 30 June 2014 for all types of insurance (disease; maternity; work accident/occupational disease; invalidity). Expenditure was classified into three main categories: outpatient care; hospital care; and cash payments. Outpatient care included visits to doctors, dentists, physiotherapists, nurses, laboratory examinations, drugs/other health products and transport costs. Hospital care included hospital stays in public and private hospitals, in short-stay, psychiatry, post-acute and rehabilitation hospital. Cash payments included sick leave, work accident and occupational disease allowances, maternity leave and invalidity pensions.

Except for hospital short-stay, allocation of reimbursed expenditure to a specific disease is based on a "top down" methodology. This methodology [6] permits us—for people with several diseases in particular—to split their expenditure between each of their diseases on a pro rata basis, thus avoiding double counting. Furthermore, to avoid overestimating the expenditure attributed to a disease, a sum of expenses corresponding to "usual care" consumption was deducted for each individual, according to age and sex, and according to the various types of ambulatory care considered. So, for beneficiaries with only one of the 56 chronic diseases identified through our algorithms, all of their expenditures (excluding "usual care") were attributed to the disease. For beneficiaries with several of the 56 identified diseases, their expenditures (excluding "basic care") were distributed between each of their diseases using, as pro rata coefficient, the mean expenditure by disease as observed for beneficiaries with only one disease. Hospital (short-stay) expenditures were attributed directly to diseases according to short-stay PD or RD, using the same ICD codes as those used by the CVD algorithms. Thus, the total expenditure attributed to each CVD disease corresponds to the sum of: the expenditure of beneficiaries presenting

only one CVD, the proportion of expenditure attributable to each CVD disease for patients with several diseases and hospital expenditures for each CVD short-stay. All expenditures, initially extracted for the study population (general health insurance scheme), were extrapolated to the entire French population (i.e. the population of all health insurance schemes) and matched to the main aggregates (or subtargets) of the maximum national ceiling for statutory health insurance expenditure (ONDAM), which is voted on each year by parliament [8].

Statistical analysis

The social deprivation index used, expressed in deciles, was constructed according to the communes (the smallest administrative units in France, 30,500 units) of residence by using four factors derived from *Institut national de la statistique et des études économiques* (national institute of statistics and economic studies) data: mean household income, percentage of high-school graduates among inhabitants aged ≥ 15 years, percentage of labourers in the employed population and unemployment rate [9]. This index does not include overseas departments. Another marker of individual deprivation was used: the presence or absence of *Couverture maladie universelle-complémentaire* (CMU-C; complementary universal medical cover), a means-tested benefit granted for 1 year. In 2014, the means test limit was an annual income of about €8,645 for a single person, and increased according to the number of people in the household. This means limit is lower than the poverty limit, defined as 50% of the median income. CMU-C covers the share of expenditure not reimbursed by national health insurance, and allows beneficiaries to access health care by waiving prepayment and top-up fees. However, over the age of 60 years, other aids are also available, such as the *Allocation de solidarité aux personnes âgées* (solidarity allowance for the elderly), which is higher than the means test limit for CMU-C. Analysis of CMU-C beneficiaries was therefore limited to people aged < 60 years.

The numbers and rate of general health scheme beneficiaries reimbursed for CVD in 2013 are reported in the "Results" section, together with the prevalence rates of the main comorbidities and other health states available in the health care tool [6]. The reference French population at 01/01/2014 published by National Institute of Statistics and Economic Studies was used to establish sex- and age-standardized rates, and to perform regional comparisons. All analyses were performed with SAS Enterprise Guide software (version 4.3; SAS Institute Inc., Cary, NC, USA).

Results

In 2013, the SNIIRAM database comprised more than 3.5 million general health scheme beneficiaries (mean age, 71 years; 42% women) who were reimbursed for care associated with one or more CVD (i.e. almost 4.3 million people extrapolated to all of France; Table 1). The standardized rate for the overall population of all ages was 6.5% (8.1% in men; 5.2% in women) and the standardized rate for subjects aged ≥ 20 years was 8.5% (10.8% in men; 6.7% in women). The two most common groups of CVD identified, for all

Table 1 Characteristics of individuals who received care for cardiovascular diseases and prevalence rates in 2013 among general health scheme beneficiaries, by sex and age, with extrapolation to the whole French population.

Diseases	N ^a	Mean age (years)	Women (%)	Rates (%)						N ^a for France	
				Crude	Standardized, all ages			Standardized, age ≥ 20 years			
					All	Men	Women	All	Men		Women
<i>Coronary heart disease</i>	1467.3	71.2	34.3	2.59	2.71	3.93	1.67	3.59	5.31	2.17	1783.3
Acute	59.9	67.7	32.1	0.11	0.11	0.16	0.07	0.15	0.22	0.09	72.6
Chronic	1407.4	71.3	32.4	2.48	2.60	3.77	1.60	3.45	5.09	2.08	1710.8
<i>Stroke</i>	624.6	70.2	49.4	1.10	1.15	1.25	1.07	1.51	1.67	1.38	757.8
Acute	93.2	72.4	50.7	0.16	0.17	0.18	0.17	0.23	0.24	0.21	113.4
Sequelae	531.4	69.8	49.1	0.94	0.98	1.07	0.91	1.28	1.43	1.17	644.4
<i>Heart failure</i>	578.5	77.6	51.6	1.02	1.07	1.12	1.05	1.42	1.50	1.36	706.4
Acute	136.0	79.6	52.4	0.24	0.25	0.26	0.25	0.33	0.35	0.33	166.6
Chronic	442.5	76.9	51.3	0.78	0.82	0.86	0.80	1.08	1.15	1.03	539.9
<i>Peripheral artery disease</i>	541.3	71.9	32.5	0.96	1.00	1.45	0.61	1.33	1.96	0.80	658.1
<i>Arrhythmias/conduction disorders</i>	1124.7	74.2	47.7	1.98	2.09	2.34	1.88	2.74	3.13	2.43	1372.5
<i>Valvular heart disease</i>	0.30	72.9	49.8	0.54	0.57	0.61	0.53	0.74	0.82	0.69	372.3
<i>Pulmonary embolism</i>	0.32	68.0	56.0	0.06	0.06	0.06	0.06	0.08	0.08	0.08	39.1
<i>Other diseases</i>	0.22	61.3	40.2	0.39	0.40	0.52	0.31	0.48	0.64	0.35	265.7
<i>All CVDs</i>	3526.2	70.6	42.2	6.22	6.51	8.08	5.19	8.52	10.80	6.68	4280.5

CVD: cardiovascular disease.
^a Thousands.

subjects aged ≥ 20 years, were coronary heart disease (3.6%) and arrhythmias/conduction disorders (2.7%), followed by stroke (1.5%), HF (1.4%) and PAD (1.3%). More specifically, in terms of acute episodes, identified exclusively by a hospital stay during the year, standardized rates in subjects aged ≥ 20 years were 0.15% for acute coronary syndrome, 0.23% for stroke and 0.33% for HF. Hospitalization rates for coronary heart disease and PAD were two-fold higher among men compared with women. A slightly smaller difference was observed for arrhythmias/conduction disorders and valvular heart disease, as well as HF and stroke. In contrast, the hospitalization rate for pulmonary embolism was similar for men and women.

The prevalence of the various CVDs increased markedly with age (Table 2), especially in men: 43% of men aged ≥ 75 years had at least one identified reimbursement for CVD versus 29% of women in the same age group. The CVDs most commonly observed after the age of 75 years were arrhythmias/conduction disorders (17% in men and 12% in women), followed by coronary heart disease (20 and 9%, respectively). The prevalence of HF was 9% for men and 8% for women.

The standardized rates for individuals receiving a reimbursement for at least one CVD varied according to the various French regions between 1.6 and 7.7% (Fig. 1). The highest rates were observed in Northern and Eastern regions

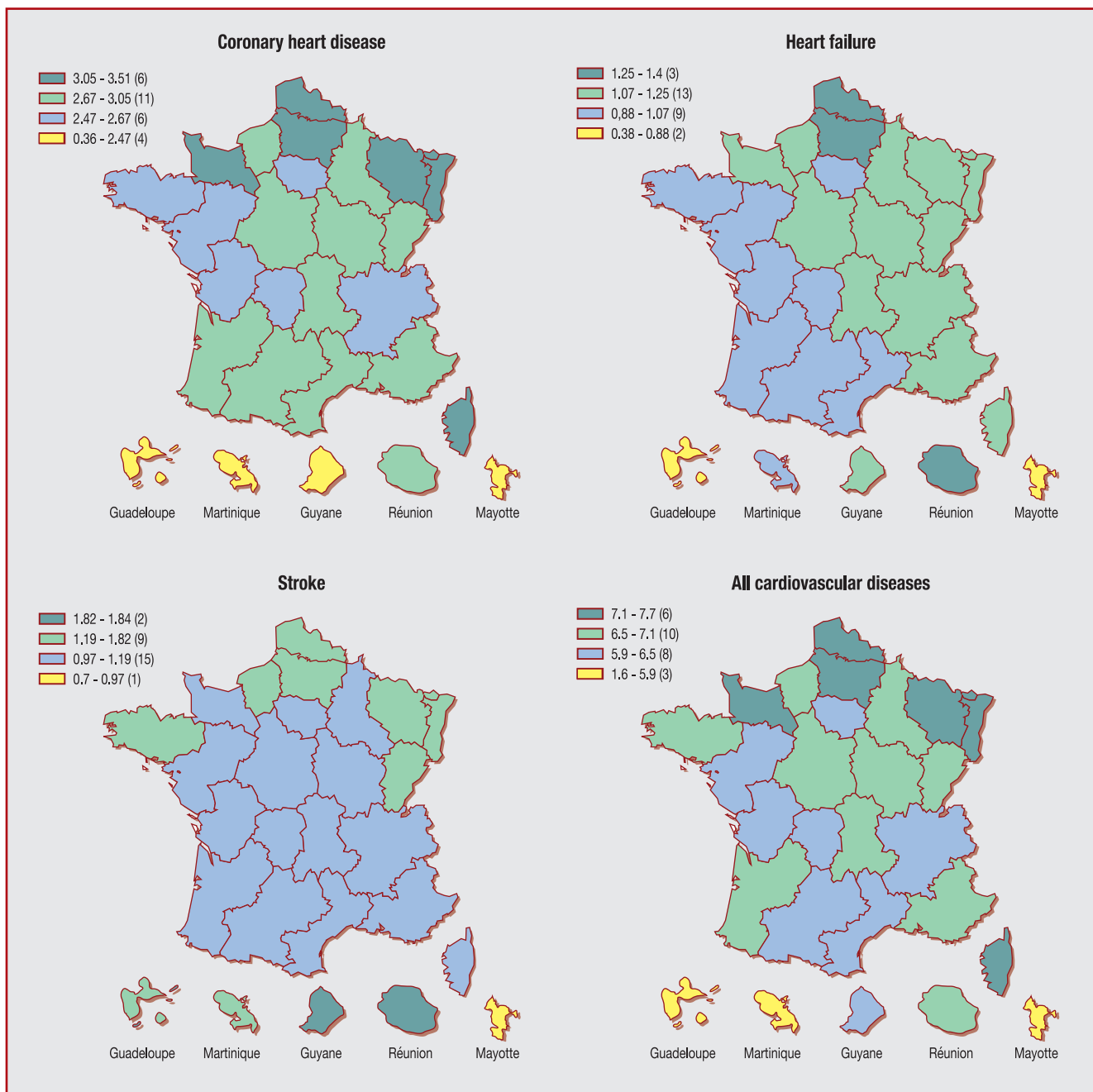


Figure 1. Standardized (age and sex) rates (%) of individuals who received care for cardiovascular diseases among general health scheme beneficiaries, by French region, in 2014.

Table 2 Rates of individuals who received care for cardiovascular diseases in 2013 among general health scheme beneficiaries, by sex and age.

	Age 0–14 years	Age 15–34 years	Age 35–54 years	Age 55–64 years	Age 65–74 years	Age ≥ 75 years
<i>Males</i>						
Coronary heart disease	0.01	0.05	1.70	7.41	12.74	20.12
Acute	0.00	0.01	0.14	0.32	0.42	0.63
Chronic	0.01	0.05	1.56	7.08	12.33	19.49
Stroke	0.06	0.13	0.60	1.92	3.43	7.17
Acute	0.00	0.02	0.09	0.26	0.47	1.13
Sequelae	0.06	0.11	0.52	1.66	2.96	6.04
Heart failure	0.02	0.03	0.27	1.26	2.71	8.99
Acute	0.00	0.00	0.05	0.23	0.56	2.36
Chronic	0.02	0.03	0.23	1.03	2.15	6.63
Peripheral artery disease	0.00	0.01	0.46	2.86	4.83	7.69
Arrhythmias/conduction disorders	0.06	0.18	0.66	2.68	6.47	17.02
Valvular heart disease	0.02	0.04	0.22	0.78	1.72	4.09
Pulmonary embolism	0.00	0.01	0.04	0.09	0.15	0.26
Other diseases	0.18	0.12	0.24	0.78	1.42	2.38
All cardiovascular diseases	0.32	0.52	3.52	13.91	24.47	43.30
<i>Women</i>						
Coronary heart disease	0.00	0.02	0.42	1.64	3.46	9.39
Acute	0.00	0.00	0.03	0.07	0.12	0.36
Chronic	0.00	0.02	0.39	1.57	3.34	9.03
Stroke	0.05	0.11	0.48	1.01	1.83	5.63
Acute	0.00	0.01	0.06	0.11	0.25	1.01
Sequelae	0.04	0.10	0.42	0.90	1.59	4.62
Heart failure	0.02	0.02	0.13	0.49	1.31	7.61
Acute	0.00	0.00	0.02	0.08	0.26	1.94
Chronic	0.02	0.02	0.11	0.40	1.05	5.67
Peripheral artery disease	0.00	0.01	0.16	0.62	1.13	3.55
Arrhythmias/conduction disorders	0.05	0.15	0.37	1.14	3.18	11.95
Valvular heart disease	0.01	0.03	0.14	0.44	1.04	3.07
Pulmonary embolism	0.00	0.01	0.03	0.05	0.12	0.31
Other diseases	0.16	0.09	0.15	0.31	0.53	1.17
All cardiovascular diseases	0.28	0.41	1.62	4.70	9.77	28.62
<i>Total</i>						
Coronary heart disease	0.01	0.04	1.01	4.27	7.68	13.30
Acute	0.00	0.00	0.08	0.19	0.26	0.46
Chronic	0.01	0.03	0.93	4.09	7.43	12.84
Stroke	0.05	0.12	0.54	1.43	2.56	6.19
Acute	0.00	0.01	0.07	0.18	0.35	1.05
Sequelae	0.05	0.10	0.47	1.24	2.21	5.14
Heart failure	0.02	0.03	0.19	0.84	1.95	8.11
Acute	0.00	0.00	0.03	0.15	0.40	2.09
Chronic	0.02	0.02	0.16	0.69	1.55	6.02
Peripheral artery disease	0.00	0.01	0.30	1.64	2.82	5.06
Arrhythmias/conduction disorders	0.06	0.17	0.50	1.84	4.68	13.80
Valvular heart disease	0.01	0.04	0.17	0.60	1.35	3.45
Pulmonary embolism	0.00	0.01	0.03	0.07	0.13	0.29
Other diseases	0.17	0.10	0.19	0.52	0.93	1.61
All cardiovascular diseases	0.30	0.46	2.50	8.90	16.46	33.98

Data are expressed as percentages.

Table 3 Prevalence of cardiovascular diseases according to deciles of a geographical social deprivation index in Metropolitan France (all ages), and prevalence of complementary universal medical cover beneficiaries aged < 60 years in 2013.

	Deciles of social deprivation index ^a										CMU-C (age < 60 years)
	1	2	3	4	5	6	7	8	9	10	
Age (mean)	40.5	40.5	40.3	40.7	40.6	41.4	41.3	41.2	41.4	40.0	24.2
Men (%)	44.9	45.5	45.4	45.2	45.1	45.1	45.3	45.2	45.3	45.8	45.2
Coronary heart disease	7.5	8.2	8.3	8.8	8.9	9.4	9.6	9.8	10.3	10.2	16.4
Acute	6.5	7.5	7.7	8.4	8.5	9.1	9.3	9.8	10.2	10.8	16.8
Chronic	7.6	8.3	8.4	8.9	9.0	9.5	9.6	9.8	10.3	10.2	16.3
Stroke	7.8	8.0	8.0	8.5	9.0	9.2	9.4	9.6	9.9	9.8	16.6
Acute	7.5	7.8	7.6	8.3	8.6	8.9	8.9	9.5	9.6	9.7	21.4
Sequelae	7.8	8.0	8.1	8.5	9.1	9.2	9.4	9.6	9.9	9.8	15.9
Heart failure	6.8	7.4	7.7	8.3	9.1	9.4	9.6	10.1	10.9	10.7	27.0
Acute	6.8	7.0	7.5	8.0	8.8	9.3	9.5	10.1	11.1	11.1	36.0
Chronic	6.8	7.5	7.8	8.4	9.1	9.5	9.7	10.0	10.9	10.6	25.3
Peripheral artery disease	6.1	7.6	8.0	8.7	9.4	9.7	10.1	10.1	10.7	10.9	20.1
Arrhythmias/conduction disorders	7.5	8.0	8.3	8.7	9.0	9.5	9.7	9.7	10.4	10.0	16.2
Valvular heart disease	7.5	8.3	8.6	8.8	9.1	9.3	9.7	9.5	10.1	9.9	17.2
Pulmonary embolism	8.6	7.9	8.2	8.4	9.2	8.8	9.0	9.0	9.5	9.6	15.7
Other diseases	6.6	8.1	8.3	8.7	8.9	9.8	10.2	9.8	10.5	10.2	14.0
All cardiovascular diseases	7.3	8.1	8.2	8.7	9.0	9.5	9.7	9.7	10.2	10.1	16.1

Data are expressed as percentages. CMU-C: *Couverture maladie universelle-complémentaire* (complementary universal medical cover).

^a 1 = least deprived decile; 10 = most deprived decile.

of France. Standardized rates were low in the French West Indies and high in Réunion Island. Higher rates were observed for HF in North, Eastern and South-Eastern regions (0.38 to 1.4%). A similar distribution was observed for coronary heart disease between regions, but with relatively higher rates in the South of France and Réunion Island (0.4 to 3.5%). The distribution of stroke (0.7 to 1.8%) presented regional differences, with higher rates in Northern and North-Eastern regions, Brittany and especially overseas departments.

Standardized rates for the various CVDs identified increased with deciles of social deprivation, especially for PAD, the prevalence of which increased from 6.1 to 10.9% between the most favourable and least favourable deciles, followed by coronary heart disease (7.5 to 10.2%) and HF (6.8 to 10.7%) (Table 3). A globally high proportion of CMU-C beneficiaries (16%) was observed among subjects aged < 60 years with at least one reimbursement for CVD, but even higher proportions were observed for HF (27%), stroke (17%) and PAD (20%). The proportion of CMU-C beneficiaries among patients with stroke and HF was higher during the acute phase (21 and 36%) than during so-called chronic management (16 and 25%).

Patients frequently presented concomitant CVDs (Table 4). One-third of subjects receiving at least one reimbursement for coronary heart disease also received a reimbursement for HF, almost 30% received a reimbursement for PAD and valvular heart disease, and almost one quarter received a reimbursement for arrhythmias/conduction disorders. The CVDs most commonly identified among the subjects receiving at least one reimbursement for stroke (around 10% of cases for each diagnosis) were

HF, arrhythmias/conduction disorders and valvular heart disease. About 30% of individuals receiving at least one reimbursement for HF also received a reimbursement for valvular heart disease, and 24% received a reimbursement for arrhythmias/conduction disorders. Individuals receiving at least one reimbursement for arrhythmias/conduction disorders also received a reimbursement for HF in 46% of cases, valvular heart disease in 38% of cases and pulmonary embolism in 22% of cases. Another cardiac disease was less commonly identified among patients treated for pulmonary embolism.

The presence of CVD was also frequently associated with other diseases or treatments. Diabetes was identified in 20–28% of patients, depending on the type of CVD. Cancer was identified in 15–20% of patients, but with a rate as high as 29% among patients hospitalized for pulmonary embolism during the year. The frequency of psychiatric illness ranged from 5 to 9%. Chronic lung disease was also very common, ranging between 12 and 24%, according to the type of CVD. Patients with HF, who were generally older, had particularly high rates of chronic lung disease (24%), cancer (19%), liver and pancreatic disease (5%), treated end-stage renal disease (2%) and psychotropic drug treatments (40%) compared with the other groups. The comorbidities most commonly identified among patients with stroke were neurological or degenerative diseases (17%), including dementias.

Health care expenditure reimbursed by the general health scheme, extrapolated to all health schemes, for the management of CVD was € 15.1 billion in 2013, with 50% for hospital care and 43% for outpatient care (including 15% for drugs and 12% for nursing care and physiotherapy)

Table 4 Frequencies of comorbidities among individuals managed for cardiovascular diseases in 2013.

Comorbidities	Individuals managed in 2013 for						
	Coronary heart disease	Stroke	Heart failure	PAD	Arrhythmias/conduction disorders	Valvular heart disease	Pulmonary embolism
Coronary heart disease	—	6.3	13.5	10.7	17.9	5.7	0.3
Stroke	14.7	—	9.4	7.9	19.3	4.4	0.4
Heart failure	34.4	10.2	—	11.0	46.4	15.6	0.7
PAD	29.1	9.1	11.8	—	16.3	4.7	0.4
Arrhythmias/conduction disorders	23.4	10.7	23.9	7.8	—	10.3	0.6
Valvular heart disease	27.4	8.9	29.5	8.4	38.0	—	0.5
Pulmonary embolism	12.6	7.2	13.2	6.2	21.5	5.0	—
Other cardiovascular diseases	14.0	8.1	13.3	6.8	18.5	6.1	0.3
Diabetes	27.6	20.2	25.7	27.9	20.9	19.3	14.1
Cancer	15.9	15.3	18.9	19.2	19.5	17.5	28.6
Psychiatric illness	5.1	8.2	6.3	6.1	5.8	5.3	9.4
Psychotropic drug treatments	32.2	39.4	40.4	35.1	35.3	34.7	38.1
Neurological or degenerative diseases	7.4	17.3	13.2	8.4	12.0	9.2	12.7
Chronic lung disease (excluding cystic fibrosis)	15.3	12.1	24.3	19.7	17.6	17.3	21.3
Inflammatory or rare diseases or HIV or AIDS	3.5	3.6	4.1	4.0	3.8	4.5	5.9
End-stage renal disease	1.1	0.8	2.2	1.8	1.1	1.3	0.5
Liver and pancreatic disease (excluding cystic fibrosis)	2.8	3.1	4.6	4.0	3.6	4.1	5.0

Data are expressed as percentages. AIDS: acquired immunodeficiency syndrome; CVD: cardiovascular disease; HIV: human immunodeficiency virus; PAD: peripheral artery disease.

(Table 5). Coronary heart disease accounted for 27% of this sum (€ 4 billion), stroke represented 23% (€ 3.5 billion), HF represented 16% (€ 2.5 billion) and arrhythmias/conduction disorders and PAD each represented 11.2% (€ 1.7 billion). Hospital management constituted a large share of the cost of acute diseases, estimated between 80 and 90% of total expenditure for these CVDs. Inversely, chronic diseases were predominantly treated on an outpatient basis, with 56% for coronary heart disease, 58% for stroke and 79% for HF. More detailed analysis revealed variations according to the type of CVD: drugs represented 30% of expenditure for chronic coronary heart disease, while nursing care and physiotherapy represented 24% of expenditure for sequelae of stroke and 35% of expenditure for chronic HF. Transport costs accounted for 8.4% of total expenditure for stroke with sequelae. Post-acute care and rehabilitation accounted for 37% of the cost of acute stroke, 24% of the cost of stroke with sequelae, 15% of the cost of acute coronary syndromes and about 16% of the cost of HF.

Discussion

This study, conducted on the basis of reimbursed health care consumption data, reveals that 6.5% of general health scheme beneficiaries (86% of the French population; i.e. 3.5 million people) presented recent markers for

reimbursement of care for one or several CVDs in 2013: coronary heart disease (2.7%), arrhythmias/conduction disorders (2.1%), stroke (1.1%), HF (1.1%) and PAD (1.0%). These prevalences increased with age and geographical social deprivation index, and were higher in the Northern and Eastern regions of France and, for some CVDs, in Réunion Island. The annual amount reimbursed for all of these CVDs was estimated to be € 15.1 billion (i.e. more than 10% of the total expenditure reimbursed by all national health insurance schemes for all conditions).

Acute CVDs

The algorithms used in this case were exclusively based on the PD indicated at the time of the hospital stay. The rates observed can therefore be considered to be hospitalization rates for acute episodes of disease that are essentially managed in hospital. Standardized hospitalization rates in 2012 have been previously reported to be 0.10% for myocardial infarction vs 0.11% in our study in 2013, 0.24% for HF vs 0.25% and 0.16% for stroke vs 0.17%. This rate was 0.06% vs 0.09% for pulmonary embolism, but RDs were included in the 2012 study, while we only adopted PDs indicated on hospital claims (i.e. only part of the RDs) [2]. These rates are therefore similar between studies, apart from a few variations that may be caused by characteristics or health care use specific to the beneficiaries of other schemes (14% of

Table 5 Total amounts reimbursed by national health insurance in 2013 according to the various cardiovascular diseases and the main types of expenditure (all of France).

	Outpatient care (%)							Total
	Physicians	Nurses and physiotherapists	Other health care professionals	Clinical pathology	Drugs	Other health products (LPP)	Transport	
<i>Coronary heart disease</i>	8.4	5.4	0.0	1.8	26.0	2.9	1.9	47.5
Acute	2.4	0.4	0.0	0.3	5.0	0.3	2.6	11.3
Chronic	9.8	6.5	0.0	2.1	30.8	3.4	1.8	55.8
<i>Stroke</i>	2.7	15.4	1.5	0.7	7.4	3.9	6.1	38.4
Acute	0.9	2.7	0.5	0.2	1.5	0.8	2.8	9.5
Sequelae	4.0	24.1	2.5	1.1	11.5	6.0	8.4	58.3
<i>Heart failure</i>	2.7	21.7	2.7	2.1	11.7	6.4	2.9	48.8
Acute	1.5	9.6	0.0	0.9	3.5	3.1	2.5	21.1
Chronic	6.1	35.2	0.1	3.4	20.8	10.2	3.3	79.4
<i>Peripheral artery disease</i>	7.1	12.2	0.0	1.5	20.1	6.0	3.0	50.8
<i>Arrhythmia/conduction disorders</i>	5.8	10.1	0.1	3.4	11.4	3.7	2.6	41.4
<i>Valvular heart disease</i>	5.2	3.5	0.1	2.7	4.7	1.4	1.8	20.0
<i>Acute pulmonary embolism</i>	3.5	2.8	0.0	1.7	4.6	2.0	1.4	16.2
<i>Other diseases</i>	6.3	3.4	0.7	1.2	16.7	4.4	4.9	38.2
<i>All cardiovascular diseases</i>	5.9	11.5	0.5	1.8	15.1	4.1	3.3	42.9
	Hospital care (%)				Cash payments (%)	Total (million €s)		
	DRG hospitalization stays	Additional payment for expensive drugs	Post-acute care, rehabilitation	Total				
<i>Coronary heart disease</i>	29.6	4.2	7.8	43.4	9.1	4132		
Acute	59.4	8.3	14.5	83.0	5.7	770		
Chronic	22.8	3.3	6.2	34.3	9.9	3362		
<i>Stroke</i>	21.9	0.9	29.1	52.9	8.8	3502		
Acute	49.3	1.3	36.8	88.1	2.4	1430		
Sequelae	3.0	0.6	23.7	28.6	13.1	2072		
<i>Heart failure</i>	30.4	1.5	16.0	48.9	2.4	2500		
Acute	57.1	2.8	18.1	78.5	0.4	1314		
Chronic	0.9	0.1	13.8	16.1	4.5	1186		
<i>Peripheral artery disease</i>	27.8	3.9	7.9	40.9	8.3	1668		
<i>Arrhythmia/conduction disorders</i>	22.4	10.1	10.0	55.2	3.4	1710		
<i>Valvular heart disease</i>	54.0	8.6	11.4	75.3	4.7	909		
<i>Acute pulmonary embolism</i>	67.4	0.6	8.6	78.7	5.1	201		
<i>Other diseases</i>	40.5	5.7	5.5	54.8	6.9	468		
<i>All cardiovascular diseases</i>	30.4	3.9	14.5	50.3	6.8	15,090		

DRG: diagnosis-related group; LPP: *liste des produits et prestations*. The shares of total outpatient care or hospital stays are higher than the sum of the shares of the various types of expenditure included in the table because only the main expenditures were reported.

the population), differences in the years considered (2013 vs 2012), but also possible minor variations in inclusion criteria (at least overnight hospital stays or not, early deaths, etc.).

Chronic CVDs

In France, the prevalence of ischaemic heart disease has been previously estimated to be 3.7% in the overall population aged ≥ 18 years (men, 5.1%; women, 2.4%) according to the self-reported Handicap-Santé (health and disability) survey conducted in 2008 among people at home or in an institution [3]. These prevalences are very similar to the 3.4% estimated by our study for subjects aged ≥ 20 years (men, 5.1%; women, 2.1%). Nevertheless, age-adjusted self-reported prevalences were always higher for the main age groups (e.g. 55–64 years: 4.7% vs 4.1%), which can be explained by survey reporting errors or, more probably, by underestimation in medical administrative databases because of chronic diseases managed in hospital more than 5 years ago or managed exclusively on an outpatient basis with no specific marker for health care consumption (in particular, absence of LTD). In comparison with other countries, the prevalences observed in France, either in self-reported surveys or in the present study, are lower than those reported by a self-reported population survey in England (5.7% for men and 3.5% for women aged > 16 years in 2011) and also by a self-reported survey in the USA (5.4% among subjects aged ≥ 20 years; 6.5% in men and 4.4% in women in 2011/12) [10,11]. These differences are consistent with the findings of the MONICA project concerning the lower incidence of myocardial infarction and coronary death in France [12].

The prevalence of HF classically ranges between 1 and 3% in industrialized countries, and increases considerably with age [13]. However, our study revealed a much lower prevalence (1.4%) than that observed in the Handicap-Santé survey, which indicated a self-reported prevalence of 2.3% in adults, a prevalence that is also similar to the national estimate of 2.2% established in 2002 in a cohort of general practice patients from a sentinel network [14]. The Handicap-Santé survey reported a prevalence of about 4% between the ages of 65 and 74 years, 9% between the ages of 75 and 84 years and 16% after the age of 85 years, while our study demonstrated lower prevalences: 1.9% between the ages of 65 and 74 years and 8% for subjects aged ≥ 75 years. Like the Handicap-Santé survey, the prevalence of HF was also higher among men in our study. Once again, these observed differences could be explained by exclusive outpatient management, without LTD status for HF (or for another disease, particularly another CVD).

According to the Handicap-Santé survey, the estimated self-reported prevalence of stroke was 1.6% in the French population [4]. Sequelae were reported in almost two-thirds of cases, corresponding to a prevalence of sequelae close to 1.1%. In our study, the prevalence of sequelae was slightly higher (1.3%), but the algorithm may also have included cases without sequelae or long-term disability. The patient may have been hospitalized 5 years before, and LTD status may have been requested at the time of the acute phase despite the absence of any long-term sequelae, as LTD status is renewed every 5 years. The Handicap-Santé survey indicated a self-reported prevalence of stroke (with and

without sequelae) of 2.9% between the ages of 65 and 74 years, 6.1% between the ages of 75 and 84 years and 9.5% after the age of 85 years (i.e. higher prevalences than those observed in this non-self-reported study: 2.2% between the ages of 65 and 74 years and 5.1% over the age of 75 years). An even higher prevalence of 2.8% was reported in the USA for individuals aged > 20 years, with major geographical disparities [11].

To our knowledge, no prevalence studies are available in France for the other CVDs studied. The prevalences reported in this study were also lower than those reported in studies from other countries comprising clinical examination, because they were based on health care use algorithms, mainly hospital management over the previous 5 years, or medical recognition of severe chronic disease by LTD status. However, most importantly, the prevalences of the risk factors associated with these diseases vary considerably from one country to another. The prevalence of PAD in individuals aged > 40 years (1.9%) was much lower than the prevalence of 5.8% observed in the general population based on clinical examination in the USA, but where the prevalences of obesity and diabetes are much higher than in France [15]. The overall prevalence of valvular heart disease, excluding congenital malformations, for individuals aged ≥ 20 years was 0.74% in our study. A North American general population echocardiography study demonstrated a prevalence of 2.5% in subjects aged ≥ 18 years and, especially, a prevalence of 13% in subjects aged ≥ 75 years versus 3.4% in our study [16]. The prevalence of arrhythmias/conduction disorders in our study was 2.1% (i.e. about 1 million people).

Some CVDs are more often associated with other CVDs, which can be explained by the natural history of these diseases, but the present study was unable to determine which disease occurred first. Nevertheless, a number of classical associations have been described, such as coronary heart disease with HF and with PAD; HF with arrhythmias/conduction disorders and valvular heart disease; and stroke with arrhythmias/conduction disorders and valvular heart disease. However, the prevalences of these associations are exclusively based on CVDs identified for the patient by the algorithms used.

Geographical variations in the observed prevalence for stroke, HF and coronary heart disease correspond to geographical variations in vascular risk factors, as indicated by surrogate markers (i.e. prevalence of antihypertensive, antidiabetic and lipid-lowering drug treatments). An exception concerns the South-Eastern region of France, where the prevalences of these treatments were lower, while higher prevalences were observed in overseas departments [17,18]. Similar trends have also been observed for obesity and being overweight in population-based studies [19]. The present study demonstrated a particularly high prevalence of diabetes for patients with various CVDs, while the overall prevalence of diabetes in France was 4.6% in 2012 [20].

Social deprivation

Many studies have reported an increasing prevalence of certain CVDs and cardiovascular risk factors with increasing social deprivation, based on both individual indicators and

geographical indicators [21–25]. In France, this trend has been reported with the same geographical indicator of social deprivation as that used in this study, for stroke, PAD and coronary heart disease in 2010. The prevalence of antihypertensive, antidiabetic or lipid-lowering drug treatments also increased slightly with increasing level of social deprivation in this study. However, a similar trend was not observed for the prevalence of at least one annual blood glucose, glycated haemoglobin (HbA1c) or lipid assay, which remained stable according to the level of social deprivation [25]. In the present study, which also used an individual indicator of social deprivation, the proportion of CMU-C beneficiaries aged < 60 years for each of the CVDs studied was almost two- to three-fold higher than the proportion of CMU-C beneficiaries in the general population (i.e. about 8%). In 2009, CMU-C beneficiaries also presented an excess overall standardized mortality (relative risk=2.4) compared with the rest of the population, as well as a higher annual frequency of hospital stays for CVDs (relative risk=1.7) and hospital mortality (relative risk=1.3) [26]. In our study, a higher proportion of CMU-C beneficiaries received treatment for acute CVDs, while a lower proportion received treatment for the chronic phase of CVDs, in the case of stroke and HF (but not coronary heart disease). This could be related to a higher mortality rate during the acute phase or subsequently, or to the particular aetiologies of these diseases in these relatively young adults. The algorithms used in this study were based on health care consumption. Low-income earners, such as CMU-C beneficiaries, may forego or limit their health care consumption for economic reasons, but also for sociocultural or geographical reasons. However, CMU-C beneficiaries have access to health care without prepayment of expenses and without excess fees. There is also a possibility that LTD status is declared less frequently among CMU-C beneficiaries, because CMU-C cover provides an equivalent level of reimbursement. The prevalences of chronic diseases using LTD status as the marker could therefore be underestimated in this population.

Expenditure attributed to CVDs

The amounts reported in this study correspond to the expenditure reimbursed by the general health scheme extrapolated to all health schemes. The costs of primary prevention drug treatments for certain cardiovascular risk factors, estimated by another study to be, in 2010, € 1417 million for antihypertensive drugs, € 761 million for lipid-lowering drugs and € 749 million for antidiabetic drugs, can also be added to this reimbursed expenditure [25]. Other costs were not taken into account, such as out-of-pocket expenses for patients and the social cost of these diseases. Two specific economic studies have been conducted previously in France, one on stroke, which revealed attributable expenditure of € 5.3 billion in 2007, 92% of which corresponded to costs reimbursed by national health insurance, with € 2.8 billion of medicosocial expenditure [27]. The present study revealed a lower cost of € 3.5 billion to national health insurance. However, in the method used in this study, costs related to stroke were more specific, resulting in minimization of the costs related to other concomitant diseases.

Strengths and limitations

The main strength of this study concerns the use of the SNI-IRAM database, comprising data for more than 86% of the French population in 2013, and the mapping tool allowing identification of 56 groups of diseases, health states or treatments by means of predefined algorithms. These definitions were submitted to sensitivity analyses concerning the numbers of subjects and the expenditure incurred, and a critical review was conducted by an independent partner, allowing improvement of these algorithms [7]. To date, validation studies in France have exclusively concerned identification of various diseases in hospital databases [28–30]. An extension or creation of algorithms in cardiology is currently under consideration, which would include the reimbursement of certain drugs, procedures or equipment. These markers could be used alone or in combination over a time frame that has yet to be defined.

The algorithms used in this study were constructed from health care consumption data and cannot take into account subjects with undiagnosed, asymptomatic disease and, in the particular case of CVDs, not managed by a hospital stay or a specific LTD. Nevertheless, hospital stays are investigated with a follow-up of 5 years. Diseases leading to a hospital stay or attribution of LTD status are therefore more likely to be considered than minor forms, which are treated on an outpatient basis or for which a hospital stay is uncommon, such as certain forms of coronary insufficiency, HF, arrhythmias and PAD. The diseases studied here are not mutually exclusive. The presence of multiple CVDs raises the problem of which disease occurred first. For example, if LTD status was initially attributed for coronary heart disease, a second LTD for HF may not be requested. Furthermore, granting LTD status may be dependent on the patient's medicosocial setting, such as a patient requiring home care or an institutionalized patient, particularly in the case of HF or sequelae of stroke, which occur after another CVD and in elderly patients or in CMU-C beneficiaries, as discussed above.

Conclusion

The mapping developed by the *Caisse nationale d'assurance maladie des travailleurs salariés* (CNAM-TS) constitutes a useful tool for epidemiological and economic analyses, which usefully completes population studies, whether self-reported or accompanied by clinical or laboratory examinations. The algorithms developed by the CNAM-TS, however, need to be refined and adapted to the study of specific diseases. This tool can be used to estimate the burden of CVDs both for the population and for the health system, but also to study certain time courses without any additional development costs. This tool can also be used to establish regional snapshots or to focus on specific populations, as a result of its high statistical power; it can therefore be used to guide national and regional public health policies.

Disclosure of interest

The authors declare that they have no competing interest.

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