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## CLINICAL RESEARCH

# Cardiovascular research in France: Evolution of scientific activities and production over the last decade



*La recherche cardiovasculaire en France : évolution des activités et de la production scientifique au cours de la dernière décennie*

Claire Bouleti<sup>a</sup>, Nicolas Danchin<sup>c</sup>, Bernard Iung<sup>a,b,\*</sup>,  
Claude Daubert<sup>d</sup>

<sup>a</sup> Inserm U1148, Department of Cardiology, hôpital Bichat, AP–HP, 6, rue Henri-Huchard, 75018 Paris, France

<sup>b</sup> DHU FIRE Paris-Diderot University, Sorbonne Paris Cité, 75013 Paris, France

<sup>c</sup> Department of Cardiology, Paris-Descartes University, hôpital Européen Georges-Pompidou, AP–HP, 75015 Paris, France

<sup>d</sup> U1099, LTSI-Inserm, université de Rennes, 35043 Rennes, France

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### KEYWORDS

Cardiovascular  
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### Summary

**Background.** — Cardiovascular disease (CVD) is a major cause of death worldwide, and fruitful research is needed for future advances in this field.

**Aims.** — To analyse the scientific production and vitality of French cardiovascular clinical research, and its evolution over the last decade.

**Methods.** — We first used Lab Times online data obtained through the Web of Science (Thomson-Reuters, Toronto, ON, Canada), then the PubMed database (National Center for Biotechnology Information [NCBI], Bethesda, MD, USA), for studies published between 2005 and 2015 in the multidisciplinary and cardiology journals with the highest impact factors. French abstracts submitted and accepted at the European Society of Cardiology (ESC) congress were provided directly by the ESC. The number of cardiovascular projects was analysed through the <http://www.ClinicalTrials.gov> database and the French site for government-funded projects, over the decade from 2008 to 2017.

**Abbreviations:** CVD, Cardiovascular Disease; EHJ, European Heart Journal; HPCR, Hospital Programme of Clinical Research; IF, Impact Factor; JACC, Journal of the American College of Cardiology; JAMA, Journal of the American Medical Association; NEJM, New England Journal of Medicine.

\* Corresponding author. Inserm U1148, Department of Cardiology, hôpital Bichat, AP–HP, 6, rue Henri-Huchard, 75018 Paris, France.  
E-mail address: [bernard.iung@aphp.fr](mailto:bernard.iung@aphp.fr) (B. Iung).

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**Results.** — Overall, France was ranked fifth in Europe and eighth worldwide for CVD publications. During the 10-year period from 2005 to 2015, French publications accounted for 0.2–0.3% of articles in top multidisciplinary journals and 2% of articles in top cardiology journals. We observed a steady decrease in French abstract submissions at the ESC congress (from 5% to 3.5% in 10 years), and in 2017, France was ranked eighth in Europe. Across European countries, France has been ranked first for declared cardiovascular research on <http://www.ClinicalTrials.gov> over the last 3 years, for both interventional and observational studies. Regarding the Hospital Programme of Clinical Research, heart ranked second after neurosciences.

**Conclusions.** — France is very well represented in terms of new CVD projects, but actual French scientific production scores poorly. Investing in CVD research is a priority to increase the level of publication and to compete with other leading countries.

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## MOTS CLÉS

Recherche  
cardiovasculaire ;  
Publications ;  
Bibliométrie

## Résumé

**Objectif.** — Les pathologies cardiovasculaires demeurent une cause majeure de mortalité, ce qui justifie la poursuite de la recherche dans ce domaine. Le but de ce travail est d'analyser la production scientifique et la vitalité de la recherche cardiovasculaire française et son évolution au cours de la dernière décennie.

**Méthode.** — Nous avons utilisé les données de labtimes.org du site Web of sciences (Thomson-Reuters), puis la base de données pubmed.ncbi pour les études publiées entre 2005 et 2015 dans les revues multidisciplinaires et cardiologiques ayant les facteurs d'impact les plus élevés. Les abstracts français soumis et acceptés au congrès de la Société Européenne de Cardiologie (ESC) ont été obtenus directement après de l'ESC. Le nombre de projets en recherche cardiovasculaire a été analysé à partir du site <http://www.clinicaltrials.gov> et du site français des Projets Hospitaliers de Recherche Clinique (PHRC) entre 2008 et 2017.

**Résultats.** — La France se classe au 5<sup>e</sup> rang en Europe et au 8<sup>e</sup> rang dans le monde en ce qui concerne les publications en recherche cardiovasculaire. Parmi les revues multidisciplinaires les plus renommées, les publications françaises représentaient 0,2–0,3 % durant la dernière décennie et 2 % parmi les revues cardiologiques. Les soumissions d'abstracts au congrès de l'ESC ont diminué de 5 % à 3,5 % en 10 ans et la France se classe au 8<sup>e</sup> rang en Europe. La France était classée au premier rang en Europe pour les projets de recherche cardiovasculaire déclarés sur <http://www.clinicaltrials.gov> durant les 3 dernières années, tant pour les études interventionnelles qu'observationnelles. En ce qui concerne les PHRC, la recherche cardiovasculaire était classée au 2<sup>e</sup> rang après les neurosciences.

**Conclusion.** — La France est très bien représentée en ce qui concerne les nouveaux projets de recherche soumis en pathologie cardiovasculaire, mais la production scientifique française demeure mal classée. L'investissement dans la recherche cardiovasculaire est une priorité afin d'améliorer le niveau des publications et d'être compétitive avec les autres pays en tête de la recherche.

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## Background

In France, as in most countries, cardiovascular disease (CVD) is a leading cause of death, along with cancer, and is responsible for more than 1 in 4 deaths (approximately 140,000 deaths per year) [1,2].

Cardiovascular research, diagnostic tool refinement and prevention have improved survival in Europe [3] and the USA, with CVD deaths decreasing from 771,169 in 1985 to 596,577 in 2011, whereas the number of deaths from cancer has nearly tripled over the last 60 years [4]. This decrease in CVD mortality has led to a need for clinical trials with

very large sample sizes and longer periods of follow-up to demonstrate any further improvement in survival [5–7].

In parallel, financial investment in cardiovascular research, particularly funding by industry, has declined because of the many challenges involved, including regulatory requirements, extensive clinical trial management bureaucracy and the complexity of the healthcare system [8].

The aim of this paper was to analyse scientific production and vitality in France, and its evolution over the last decade. We focused mainly on clinical research, as the fundamental aspects of CVD research have already been addressed

in a recent paper [9], although some barriers are common between basic and clinical research.

## Methods

For global analysis, we used Lab Times online data (labtimes.org) obtained through the Web of Science (Thomson-Reuters, Toronto, ON, Canada) for articles published from 2007 to 2013 (quoted from 2009 to 2015) to analyse original articles. This analysis dealt with the 352 specialty or subspecialty journals listed in the database of the *SCImago Journal & Country Rank* portal. However, these data do not take into account cardiovascular studies published in multidisciplinary medical journals or the precise rank of the authors. To overcome these limitations, we further analysed all the studies published between 2005 and 2015 in cardiovascular or multidisciplinary journals with high impact factors (IFs). This analysis was restricted to the three multidisciplinary journals with the highest IFs (*New England Journal of Medicine* [NEJM], *The Lancet* and *Journal of the American Medical Association* [JAMA]) and the three cardiology journals with the highest IFs (*Circulation*, *Journal of the American College of Cardiology* [JACC] and *European Heart Journal* [EHJ]). We also analysed the four main cardiology subspecialty (interventional cardiology, cardiovascular imaging, electrophysiology and heart failure) journals derived from the three cardiology journals with the highest IFs. The 12 subspecialty journals are listed in [supplementary material](#).

The publication list was obtained from the PubMed database (National Center for Biotechnology Information [NCBI], Bethesda, MD, USA) by requesting ((*Circulation* [Journal]) and journal article [Publication Type]) and (2005/01/01 [Date – Publication]: 2005/12/31 [Date – Publication]). Only original articles, reviews, recommendations and consensus or position papers in the CVD field were included. The articles were considered as French only if the first or last author had a French affiliation.

European Society of Cardiology (ESC) congress abstract publications were evaluated. Data on the number of French abstracts submitted and accepted were obtained directly from the ESC.

The number of cardiovascular clinical research projects was analysed by using the <http://www.ClinicalTrials.gov> database and the French healthcare site for government-funded projects (<https://solidarites-sante.gouv.fr/systeme-de-sante-et-medico-social/recherche-et-innovation/l-innovation-et-la-recherche-sclinique/appels-a-projets/article/les-appels-a-projets-de-la-dgos-les-projets-retenus>). For the <http://www.ClinicalTrials.gov> site, the projects list was obtained by requesting: (Aortic disease or Heart disease or Cardiac disease or Cardiovascular disease or Valvular disease) between 01 January 2008 and 31 December 2017, for each country of interest.

For the government-funded projects, all data between 2008 and 2017 were obtained via the dedicated website. All projects were classified by the research topic, with 19 topic categories identified ([supplementary material](#)). In case of doubt regarding the best category for classification of a project (frontiers form between two specialties), the evaluation was performed by two reviewers (B. I. and C. B.), and the final classification was reached by consensus.

## Results

### French publications in the CVD field

#### Rank in Europe and worldwide

Based on the Lab Times evaluation obtained through the Web of Science portal, France was ranked fifth in Europe for articles in the CVD field published between 2007 and 2013 (citations from 2009 to 2015), as illustrated in [Table 1](#).

According to the worldwide ranking, France was ranked eighth for articles in the CVD field, just after Japan and Canada ([Table 2](#)).

#### Evolution of French publications in the journals with the highest IFs, from 2005 to 2015

##### *Multidisciplinary journals*

We found 52 French publications during the 10-year period between 2005 and 2015 in the *NEJM*, *Lancet* and *JAMA*; an average of 5 publications per year. These French

**Table 1** Ranking of the top 10 European countries according to the number of citations and published articles in cardiovascular disease field.

Europe	Number of citations	Number of articles
	1,136,157	80,984
European ranking		
1. Germany	279,208	14,980
2. UK	237,984	12,397
3. Italy	222,467	13,165
4. Netherlands	187,910	9369
5. France	153,515	8369
6. Spain	81,769	5052
7. Sweden	77,444	4050
8. Switzerland	73,760	3883
9. Belgium	72,213	3266
10. Denmark	49,396	2583

**Table 2** Ranking of the top 10 countries worldwide according to the number of citations and published articles in the cardiovascular disease field.

Europe	Number of citations 1,136,157	Number of articles 80,984
World ranking		
1. USA	1,049,838	59,915
2. Germany	279,208	14,980
3. UK	237,984	12,397
4. Italy	222,467	13,165
5. Netherlands	187,910	9369
6. Canada	167,114	8640
7. Japan	160,840	13,981
8. France	153,515	8369
9. Australia	85,306	4963
10. Spain	81,769	5052

**Table 3** French cardiovascular disease publications in major multidisciplinary and cardiology journals between 2005 and 2015.

Journals	IF	Number	%	Number/year	%/year	Trend
Major multidisciplinary journals						
<i>NEJM</i>	79.3	21	0.3	1–4	0.1–0.6	Stable
<i>Lancet</i>	53.2	17	0.2	0–4	0–0.4	↗
<i>JAMA</i>	47.7	14	0.3	0–3	0–0.4	↗
Major cardiology journals						
<i>Circulation</i>	18.9	103	1.2	4–13	0.5–2	Stable
<i>JACC</i>	16.8	118	1.9	4–16	0.9–2.7	↘
<i>EHJ</i>	23.4	202	3.2	14–26	1.9–6.4	↘
Total		475	1.8			↘

*EHJ*: European Heart Journal; IF: impact factor; *JACC*: Journal of the American College of Cardiology; *JAMA*: Journal of the American Medical Association; *NEJM*: New England Journal of Medicine.

publications accounted for 0.2% of all publications in *Lancet* and 0.3% of all publications in *NEJM* or *JAMA*. Over the years, there was a trend for more publications in *Lancet* and *JAMA*, while French participation remained stable in *NEJM*. Overall, French production in these journals remains low. These results are detailed in Table 3 and Fig. 1A.

### Cardiology journals

When focusing on the top three cardiology journals (*EHJ*, *Circulation* and *JACC*), French publications accounted for about 2% of all published articles, with 423 papers. The majority of the articles were published in the *EHJ* (202 articles; 3.2%), while they accounted for <2% of publications in journals from the USA: 118 articles (1.9%) in *JACC* and 103 articles (1.2%) in *Circulation*. Over time, publication remained stable in *Circulation* and slightly decreased in *JACC*, but decreased in *EHJ*, with an average number of publications of 21 articles/year between 2005 and 2010, and 15 articles/year between 2011 and 2015. These results are illustrated in Table 3 and Fig. 1B.

### Subspecialty journals

Regarding the four main subspecialties of cardiology (interventional cardiology, electrophysiology, imaging and heart

failure), we studied the journals derived from *EHJ*, *JACC* and *Circulation*, as detailed in supplementary material. The results are detailed in Table 4 for each subspecialty.

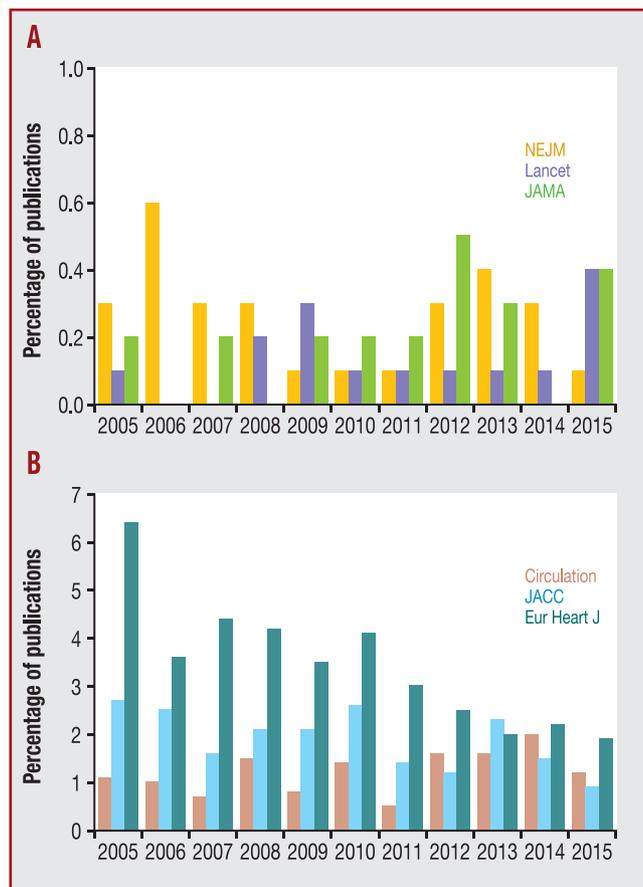
### Interventional cardiology

The evolution was not available for the whole 10-year period for *JACC Cardiovascular Interventions* and *Circulation Cardiovascular Interventions*, which were created in 2008 and 2009, respectively.

In total, 164 French articles were published between 2005 and 2015, which accounted for 3.9% of all published articles: 2.1% in *JACC Cardiovascular Interventions*, 2.9% in *Circulation Cardiovascular Interventions* and 5.6% in *Eurointervention*. Overtime, there was a trend toward increased production in *Circulation Cardiovascular Interventions*, while the number of French publications decreased in the two other journals. These results are detailed in Table 4 and Fig. 2A.

### Cardiovascular imaging

The main specialist journals on cardiovascular imaging are *EHJ Cardiovascular Imaging* (which replaced the *European*



**Figure 1.** A. Evolution of the proportion of French publications in the top three multidisciplinary journals. B. Evolution of the proportion of French publications in the top three cardiology journals. *Eur Heart J*: *European Heart Journal*; *JACC*: *Journal of the American College of Cardiology*; *JAMA*: *Journal of the American Medical Association*; *NEJM*: *New England Journal of Medicine*.

*Journal of Echocardiography* in 2013), and *JACC Cardiovascular Imaging* and *Circulation Cardiovascular Imaging*, both of which were created in 2008.

In total, 72 French articles were published between 2005/2008 and 2015, which accounts for 1.8% of all published articles: 0.9% in *JACC Cardiovascular Imaging*, 1.7% in *Circulation Cardiovascular Imaging* and 1.8% in *EHJ Cardiovascular Imaging*. Over time, there was an increase in the proportion of French papers published in *EHJ Cardiovascular Imaging*. These results are detailed in [Table 4](#) and [Fig. 2B](#).

### Electrophysiology

*Circulation Arrhythmias and Electrophysiology* was created in 2008; *JACC Clinical Electrophysiology* was created in 2015 and does not appear in the analyses. In total, 111 French articles were published between 2005 and 2015 in these journals, which accounted for 2.2% of all published articles: 1.3% in *Circulation Arrhythmias and Electrophysiology* and 2.5% in *Europace*. Over time, the proportion of French publications remained stable. These results are detailed in [Table 4](#) and [Fig. 2C](#).

### Heart failure

*Circulation Heart Failure* and *JACC Heart Failure* were both created in 2008. In total, 92 French articles were published between 2005/2008 and 2015, which accounted for 2.2% of all published articles: 3.2% in *JACC Heart Failure*, 1.3% in *Circulation Heart Failure* and 3.4% in the *European Journal of Heart Failure*, which has the highest IF of the three journals. These results are detailed in [Table 4](#) and [Fig. 2D](#).

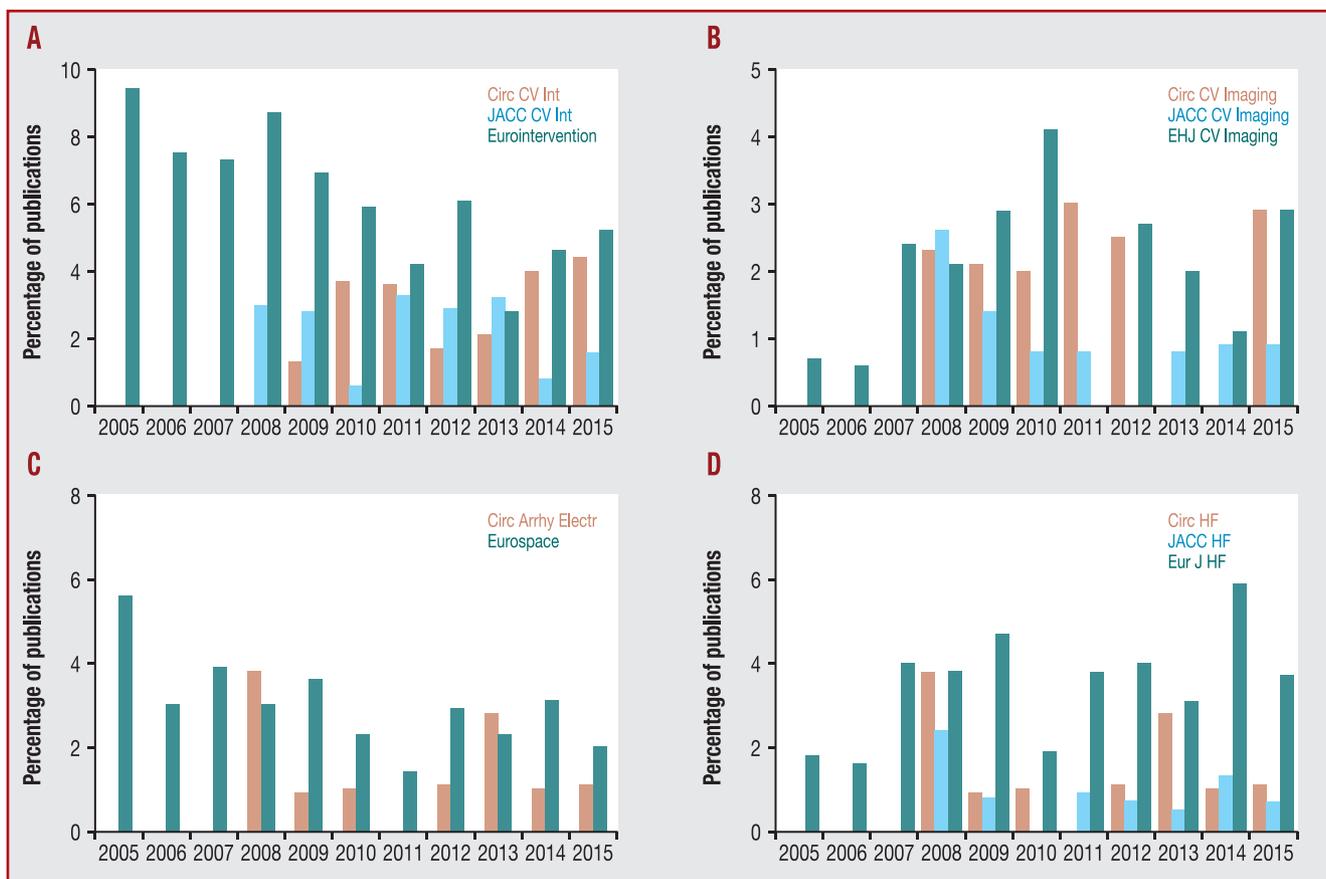
### French abstracts at the ESC congress

Participation in the ESC congress is another reflection of research activity. Over the last decade, we have observed a

**Table 4** French cardiovascular disease publications in major cardiology subspecialty journals between 2005 (or the year of the journal creation) and 2015.

Journals	IF	Number	%	Number/year	%/year	Trend
<b>Interventional cardiology</b>						
<i>Circulation Cardiovascular Interventions</i>	6.5	21	2.9	0–6	0–4.4	↗
<i>JACC Cardiovascular Interventions</i>	9.9	31	2.1	1–6	0.6–3.8	↘
<i>Eurointervention</i>	4.4	112	5.6	6–14	2.8–9.4	↘
<b>Electrophysiology</b>						
<i>Circulation Arrhythmia and Electrophysiology</i>	4.7	15	1.3	0–5	0–3.8	Stable
<i>Europace</i>	5.2	96	2.5	5–13	1.4–5.6	Stable
<b>Cardiovascular imaging</b>						
<i>Circulation Cardiovascular Imaging</i>	6.2	14	1.7	0–3	0–3	Stable
<i>JACC Cardiovascular Imaging</i>	10.2	9	0.9	0–2	0–2.6	Stable
<i>EHJ Cardiovascular Imaging</i>	8.3	49	1.8	0–9	0–4.1	↗
<b>Heart failure</b>						
<i>Circulation Heart Failure</i>	5.7	15	1.3	0–5	0–3.8	Stable
<i>JACC Heart Failure</i>	4.0	8	0.8	0–2	0–2.4	Stable
<i>European Journal of Heart Failure</i>	10.7	69	3.4	3–10	1.8–5.9	↗

*EHJ*: *European Heart Journal*; *IF*: impact factor; *JACC*: *Journal of the American College of Cardiology*.



**Figure 2.** Evolution of the proportion of French publications in subspecialty journals. A. *Interventional cardiology*. B. *Cardiovascular imaging*. C. *Electrophysiology*. D. *Heart failure*. Arrhy Electr: Arrhythmia and Electrophysiology; Circ: *Circulation*; CV Imaging: *Cardiovascular Imaging*; CV Int: *Cardiovascular Interventions*; EHJ: *European Heart Journal*; Eur J: *European Journal*; HF: *Heart Failure*; JACC: *Journal of the American College of Cardiology*.

steady decrease in submissions and acceptances of French abstracts at the ESC congress (Fig. 3). From 2009 to 2013, approximately 5% of submitted abstracts were French; this percentage was around 3.5% from 2016 to 2018. Consequently, the percentage of accepted French abstracts at the ESC congress decreased in proportion, from over 4% to 2.5%.

Regarding the position of France compared with other countries, detailed information was available for the 2017 ESC congress, and is illustrated in Fig. 4. French cardiologists submitted 274 abstracts, which placed France in eighth position in Europe, behind Germany, Italy, Spain, the UK, Portugal, Poland and Greece. The acceptance rate for French abstracts was 58% (159 accepted abstracts), which was better than the rates for Germany (52%), the UK (51%), Italy (50%), Spain (41%), Greece (36%), Poland (34%) and Portugal (32%). France therefore ranked fifth for accepted abstracts (Fig. 4A). However, France ranked thirteenth when the number of accepted abstracts was divided by the number of cardiologist members of the ESC, and fifteenth when the number of accepted abstracts was divided by the population of the country (Fig. 4B).

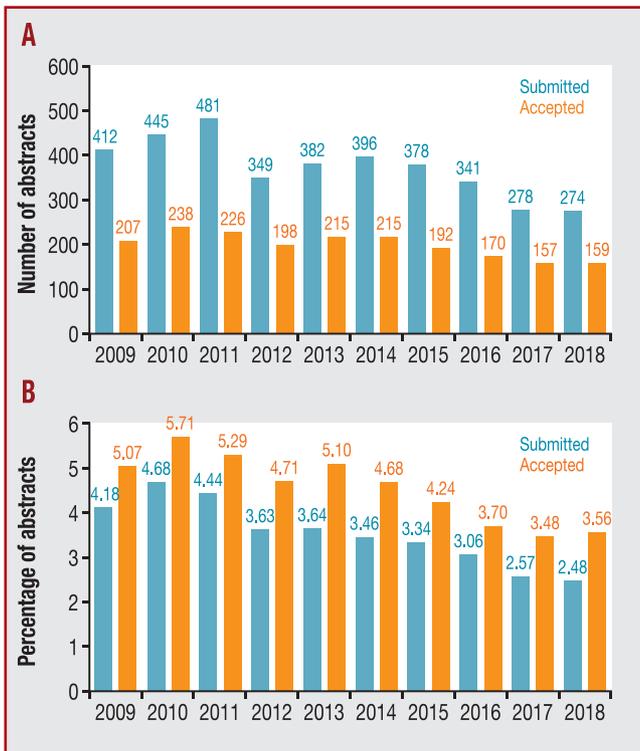
## Dynamism of French cardiovascular research regarding new projects

### Analysis of the <http://www.ClinicalTrials.gov> database

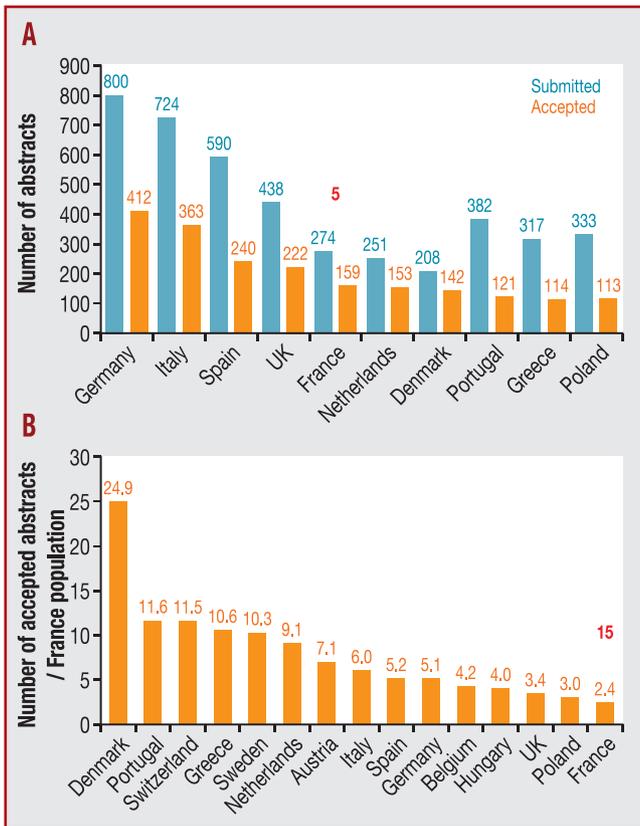
The <http://www.ClinicalTrials.gov> database lists the registries and clinical trials launched in each country. Between 2008 and 2017, there were 23,725 studies in the cardiovascular field, including both interventional and observational studies. The evolution of the number of studies submitted per year is illustrated in Fig. 5A for the world and for France.

There has been an increase in the annual number of declared studies on <http://www.ClinicalTrials.gov> over the past 10 years, from 1797 in 2008 to 2721 in 2017 worldwide; this evolution was similar for French data, with 173 studies registered in 2008 and 245 in 2017. French participation accounted for approximately 9% of cardiovascular research, with a minimal rate of 7.6% in 2012 and a maximal rate of 10.1% in 2015 (Fig. 5A).

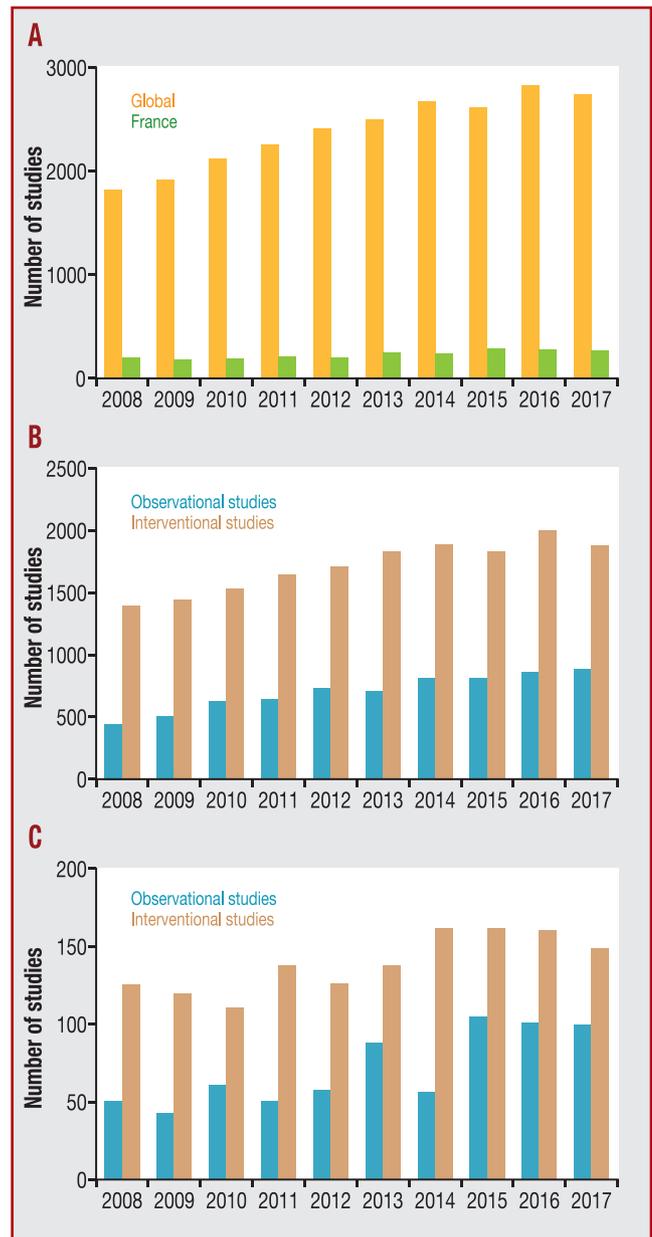
This increase was also observed for interventional studies and registries, both worldwide and for France (Fig. 5B).



**Figure 3.** French abstracts submitted to and accepted by the European Society of Cardiology congress between 2009 and 2018. A. Numbers. B. Percentages.



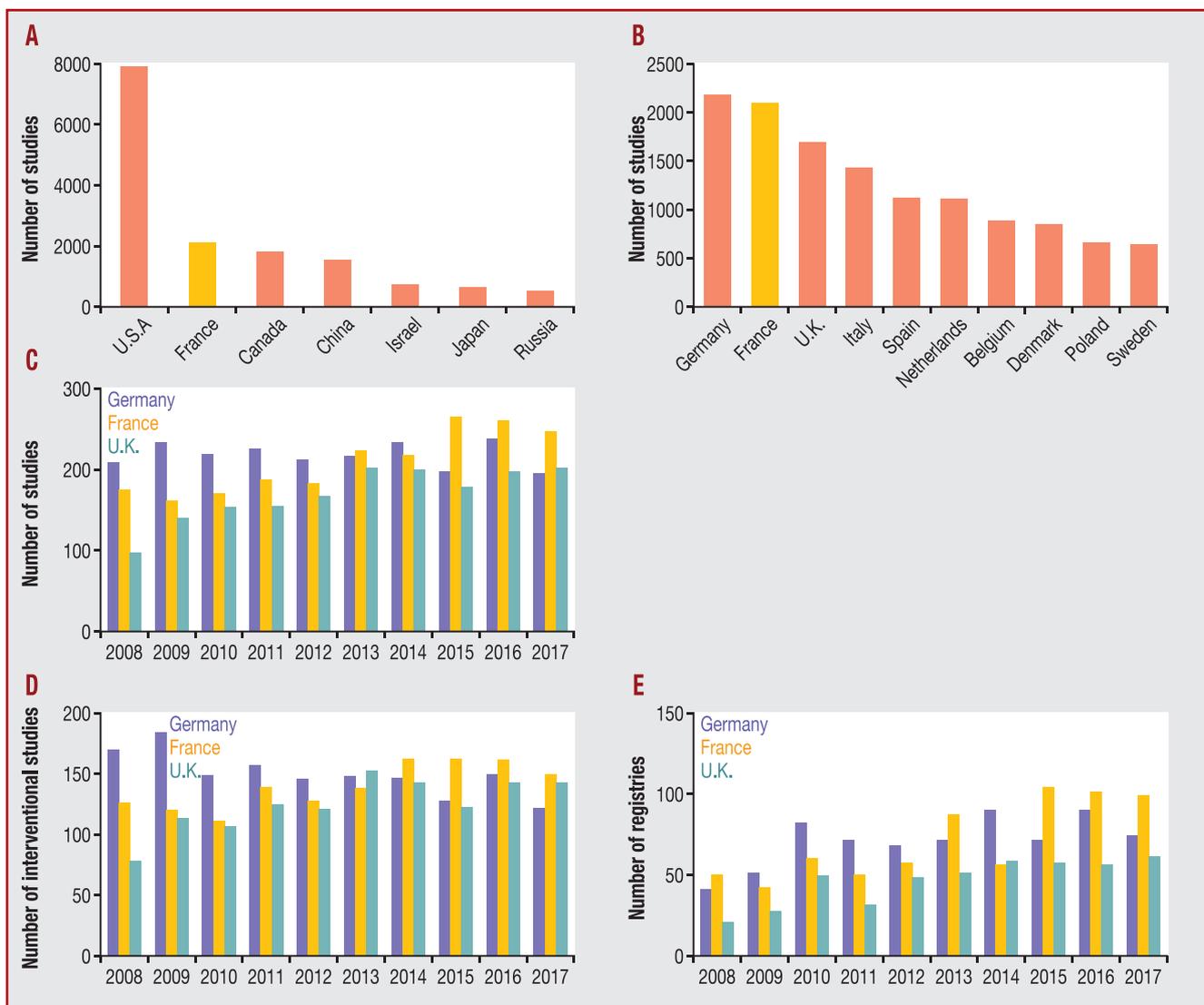
**Figure 4.** A. Abstracts submitted to and accepted by the 2017 European Society of Cardiology congress among European countries. B. Ratio of accepted abstracts to total French population.



**Figure 5.** Evolution of the number of cardiovascular studies registered on <http://www.ClinicalTrials.gov> between 2008 and 2017. A. All studies worldwide and in France. B. Interventional and observational studies worldwide. C. Interventional and observational studies in France.

and Fig. 5C, respectively). Over the last 10 years, the USA registered 1747 observational studies out of 7848 studies (22%), whereas France submitted 696 observational studies out of 2070 studies (34%). Moreover, as illustrated in Fig. 5C, the proportion of registries has actually increased in France over time, accounting for 40% of total submitted research projects over the last 3 years.

Compared with non-European countries, the results for France were good, as the country was ranked second behind the USA – the uncontested leaders, with 7848 submitted studies over the last decade. France ranked better than Canada, China and Japan (Fig. 6A).



**Figure 6.** A. Number of registered cardiovascular studies worldwide. B. Number of registered cardiovascular studies in Europe. C–E. Temporal trends over the last decade in the top three European countries. C. All studies. D. Interventional studies. E. Observational studies.

Only six European countries had > 1000 registered studies over the 10 years of interest: Germany, France, the UK, Italy, Spain and the Netherlands. With 2070 registered studies, France ranked second, just after Germany (2160 studies) and before the UK (1669 studies), Italy, Spain and the Netherlands (Fig. 6B). More importantly, the analysis of temporal trends in the number of studies registered for the top three European countries (Germany, the UK and France), showed that France has been ranked first, before Germany, in recent years (Fig. 6C). Indeed, Germany has had stable production over time (207 studies in 2008 and 193 in 2017), while France has had a steady increase in study promotion over the last decade (from 173 studies in 2008 to 245 in 2017). France was ranked first in 2013, and has remained the leader in the cardiovascular field over the last 3 years. This positive evolution of CVD research in France compared with Germany and the UK was observed for both interventional and observational studies; France has ranked first in these two categories over the last 3 years (Fig. 6D and Fig. 6E).

### Analysis of accepted French government-funded clinical research projects

The Hospital Programme of Clinical Research (HPCR) was created in 1992 in France to promote medical progress, dynamize hospital clinical research and improve patient care. Since 1993, the government has launched the HPCR project call once a year, and has provided financial support for accepted projects (total funding of €130 millions for 2016).

Between 2008 and 2017, 1231 research projects were accepted by the HPCR. The maximal number of accepted projects was reached between the years 2009 and 2011 (average of 174 projects/year), and the minimum was reached in 2013 (86 projects), which corresponded with the launch of another research programme (the medicoeconomical research programme). The number of projects per year and per pathology domain is detailed in Table 5, for the eight medical specialties with  $\geq 60$  accepted projects over the study period.

**Table 5** Evolution of number of accepted projects by medical specialty over the decade 2008–2017.

Number of accepted projects/specialty	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
All	134	174	167	174	112	86	89	103	95	97	1231
Heart	17	9	8	20	11	9	7	13	16	14	124
Digestive and liver diseases	9	14	9	10	7	8	5	6	5	15	88
Gynaecology	7	9	10	10	6	5	8	9	3	2	69
Infectious diseases	5	10	13	10	6	5	2	7	6	2	66
Clinical neurosciences	25	25	30	34	16	14	8	15	11	5	183
Respiratory diseases	1	10	13	8	8	11	8	6	9	2	76
Psychiatry	11	20	12	18	11	8	8	8	10	9	115
Kidney/urinary diseases	9	9	11	14	11	8	4	4	7	7	84
Vascular diseases	4	6	7	6	4	4	8	7	5	9	60

The number of accepted projects was highest in clinical neurosciences, with 183 projects (15%). Heart ranked second, with 124 accepted projects, followed by psychiatry, digestive and liver diseases, kidney-urinary diseases, respiratory diseases and vascular diseases.

The detailed analysis of temporal trends showed that clinical neurosciences dominated the HPCR acceptance rate, particularly during the years 2008–2011. Heart ranked second most of the time (2008, 2011, 2014, 2015 and 2017), but came first in 2016.

When considering CVD instead of heart and vascular diseases separately, CVD was ranked first over the decade, with 184 accepted projects, just before neurosciences (Fig. 7A). CVD has ranked first since 2014, and the evolution of the rate of accepted projects over the total number of projects has increased over time (Fig. 7B). Indeed, until 2013, the rate of accepted CVD projects was 0–15%, then 15–20% in 2014–2015 and 20–25% in the last 2 years.

## Discussion

Clinical research data in the CVD field over the last decade in France show contrasting results. France is very well represented in terms of new CVD projects, whether government-funded projects (HPCR) or worldwide registered projects (<http://www.ClinicalTrials.gov> database). Conversely, actual French scientific production scored poorly and has tended to decline, as illustrated by abstracts presented to the world's largest cardiovascular congress (the ESC congress), and especially by published articles in top journals. Scientific production is mainly assessed by the publication of original articles, in high-ranking international journals. Although IFs have been vigorously challenged in recent years [10], and may indeed be an imperfect metric, they remain the means by which most journals are judged [11]. In the three multidisciplinary journals and three cardiovascular journals with the highest IFs, France is now ranked fifth in Europe and eighth worldwide. On the other hand, France ranks in the top three and is often a leader in Europe, as for project submissions. These discrepancies should be further analysed to reverse the current trends. Several explanations for the current situation can be proposed.

### Too much mediatized success for cardiology in France?

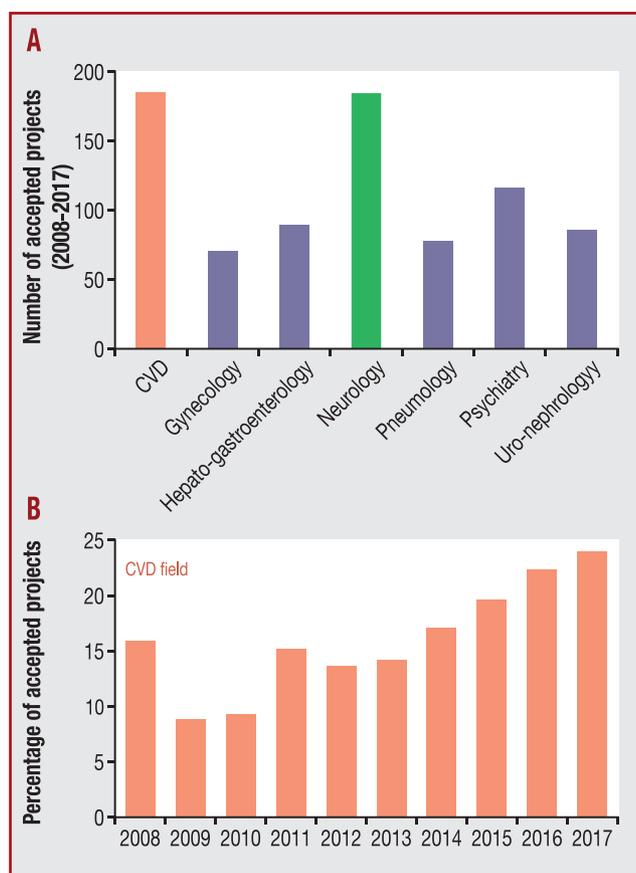
France is widely considered as an important country for medical advances in the field of CVD. Tremendous progress has been achieved in the management of coronary artery diseases, electrophysiology and heart valve diseases, with French researchers being involved or pioneers in these fields [12–20]. For example, the mortality rates for myocardial infarction have achieved their lowest level in France, with rates as low as 3% at 30 days and 5.3% at 6-month follow-up, with a further 22% reduction in standardized mortality from 2010 to 2015 [21,22]. This decrease in coronary disease mortality and the longer global average life span also rely on the validation of new therapeutic concepts supported by large trials and active research [3]. However, these advances should not overshadow the fact that CVD remains the most common cause of morbimortality worldwide [23,24].

In France, a study concerning French health insurance beneficiaries showed that the most common causes of deaths in 2013 were cardiovascular/neurovascular diseases (56%), cancers (42%) and neurological and degenerative diseases (25%) [25]. However, cancer and neurodegenerative diseases seem to be considered to be of greater concern to the general population in France, and the financial incentives from the government are much higher than those offered for CVD [9].

Perhaps CVD research is a victim of its own success and, despite major breakthroughs during the last decades, a reminder is needed of the large burden of CVD. It is indeed in the patients' interest to benefit from adequate levels of clinical research and translation into new prevention and therapeutic strategies. However, there are limitations to CVD research in France, both at the financial and institutional levels.

### Financial difficulties and an institutional brake to CVD research

As showed by Boulanger et al., the research and development budget has not increased over the past 20 years, placing France below the average Organization for Economic Cooperation and Development (OECD) countries for research



**Figure 7.** A. Number of accepted projects according to medical specialty over the decade 2008–2017. B. Evolution of cardiovascular disease (CVD) representation over the decade 2008–2017.

financial support [9]. Nonetheless, financial support is a key issue for current CVD research, particularly given the decline in cardiovascular mortality, which leads to a need for larger population studies with very large sample sizes to bring to light incremental risk reduction [5,6,8]. Larger population studies actually translate into greater budgets. Moreover, publication standards have increased over time, and publishing in top journals now requires much more data and time, thereby increasing costs [9].

In parallel to the government's financial participation, the pharmaceutical industry's willingness to invest in CVD has also declined. Advocated reasons are, in particular, increasing regulatory requirements, the bureaucracy associated with conducting clinical trials and the difficulties in guaranteeing access to newly approved medications [5,9,26]. However, despite the lower level of funding, CVD research remains active and productive in France, and still competes with research in the neurosciences field, as illustrated by the results of the HPCR proposals. Indeed, after many years of dominance by neurosciences research projects, cardiology – especially CVD research – has become the leader in HPCR-accepted projects. However, this may not be enough to translate these promising projects into high-ranking publications, given the limited funding associated with HPCR. The question is to know how long CVD researchers will maintain this high quality of research

without appropriate funding, and how to prevent a decline in competitiveness compared with other specialties and other countries that are increasing their financial support for CVD research [27].

The place of France in CVD research has been great and, with some changes in public policies, more golden years are yet to come. Indeed, as presented in this study, France has the ideas and the energy to produce high quality research, and even ranks first in Europe in terms of the number of cardiovascular projects registered online on the <http://www.ClinicalTrials.gov>.

### French culture: French language and underexploitation of databases

The vitality of CVD research, as illustrated by the number of projects launched, does not translate sufficiently enough into high-ranking publications. In addition to the funding limitations detailed in the previous section, French cardiologists do not have a culture of intensive database exploitation. Indeed, whereas large databases in the USA and Sweden, for example, lead to high numbers of publications, most French studies give rise to only one to five publications. The FAST-MI registry should be regarded as exemplary, with more than 50 publications in international

journals [22]. This approach should be taught to researchers and championed by the leaders of CVD research in France.

Lastly, in addition to the different barriers listed previously to France being better represented in global CVD research, the French face another limitation compared with other European countries: the inability to speak fluent English. The French were ranked recently as the worst English speakers in Europe, according to the Education First English Proficiency Index [28]. These results may lead to changes in public policies regarding the English teaching system in France, and to reform our dubbing industry, which provides French language on most national television channels. This may seem a minor detail, but the low involvement of French cardiologists in the ESC congress may be the result, in part, of this limitation. Once this language limitation is overcome, we can reasonably expect that French cardiologists will be more present and active at the ESC congress, especially given the good acceptance rate of French abstracts. The quality of our research is good, but incentivizing public policies are needed to overcome language and funding limitations in the years to come.

Young cardiologists are strongly involved in France, with one-third of French Society of Cardiology members aged < 40 years. This new generation of cardiovascular researchers should not be denied the possibility to improve patient care through high quality research in their field. Investing in CVD research seems therefore to be a priority, to increase the level of publication and to compete with other leading countries in Europe and worldwide.

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## Disclosure of interest

The authors declare that they have no competing interest.

## Appendix A. Supplementary material

Supplementary material associated with this article can be found in the online version available at <https://doi.org/10.1016/j.acvd.2018.11.003>.

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