International activity in cardiovascular research : trends in the output and impact of research papers from the UK, USA, Japan, Germany and France.

International Activity in

Cardiovascular Research

TRENDS IN THE OUTPUT AND IMPACT OF RESEARCH PAPERS FROM THE UK, USA, JAPAN, GERMANY AND FRANCE

This booklet summarises the findings of a study into the position of UK cardiovascular research internationally. The analysis focused on cardiovascular research published in refereed journals and covered tens of thousands of papers, in an attempt to provide a reliable broad brush picture of trends in international activity in the field.

Full details of the study are available in:

O'Driscoll M, Rogers L and Anderson J 1994. Cardiovascular research 1981-1991: international comparisons of research outputs in the United Kingdom, United States, Japan, Germany and France. PRISM report No. 8, the Wellcome Trust, London.

Rogers L A and Anderson J 1993. A new approach to defining a multidisciplinary field of research: the case of cardiovascular biology. Scientometrics Vol. 28 No. 1 61-77

Background to the analyses

Data sources

Science Citation Index (SCI): 1981-1986
This covers over 3000 journals, of which 1500 are biomedical. It is a key database for 'bibliometric' analysis, because it includes the addresses of all authors on each paper, so permitting analysis of research collaboration through international co-authorship. It is also the only database to carry citations to papers, so permitting analysis of research impact. However, at the time of this study, data suitable for analysis were only available up to 1986. The SCI was therefore only used for analysing international collaboration and citation impact during the early 1980s.

Medline: 1981-1991
This covers over 3500 biomedical journals. Its drawback is that during the 1980s it did not carry the addresses of all authors on each paper. Its strength is that it has a very detailed indexing system (Medical Subject Headings - MeSH), making it possible to identify sets of papers in specific biomedical disciplines like cardiovascular research.

Defining the field

This was an iterative process, involving the following stages:

- creating a 'filter' of MeSH index terms through which papers in Medline were screened

- consulting with an expert panel of cardiovascular researchers to check for irrelevant and missing areas

- validating the final set of terms used to define the boundary of the field, with a series of empirical tests on university publications data.

This process resulted in a definition of the cardiovascular field which captured basic and clinical research papers, drawn from a wide range of biomedical disciplines. Importantly, the definition was shown in validation tests to exclude papers outside the cardiovascular field, as well as include those which were relevant. Full details of the process of field definition are given in the paper enclosed in the back pocket of this leaflet (Rogers, L and Anderson, J *Scientometrics*, **28**, 61-77, 1993).

Having defined the field through Medline, and identified a set of tens of thousands of cardiovascular papers in this database, the set was matched to the SCI to get fuller bibliographic details (e.g. addresses) on each paper.

Fig 1

Biomedical and cardiovascular publications for all countries: 1981-1991 (Medline analysis)

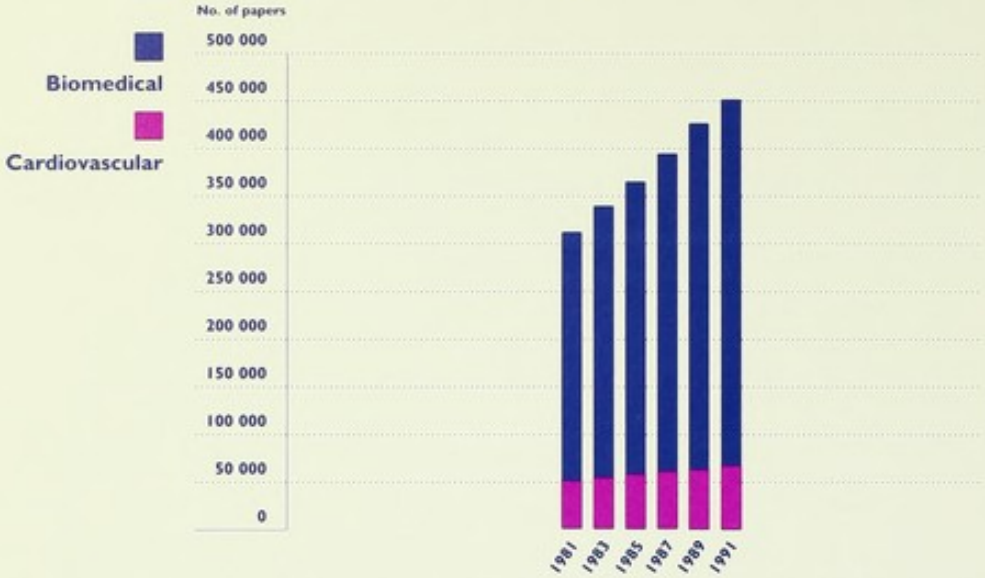


Figure 1 depicts the growth in total number of biomedical papers worldwide throughout the 1980s, and shows the proportion of these that were captured as cardiovascular research, using the MeSH definition created in this study.

Overall, cardiovascular papers accounted for 19% of biomedical papers, or an average of 65 000 papers per year, over the period studied.

Fig 2

Biomedical and cardiovascular publications in five countries: 1988-1991 (Medline analysis)

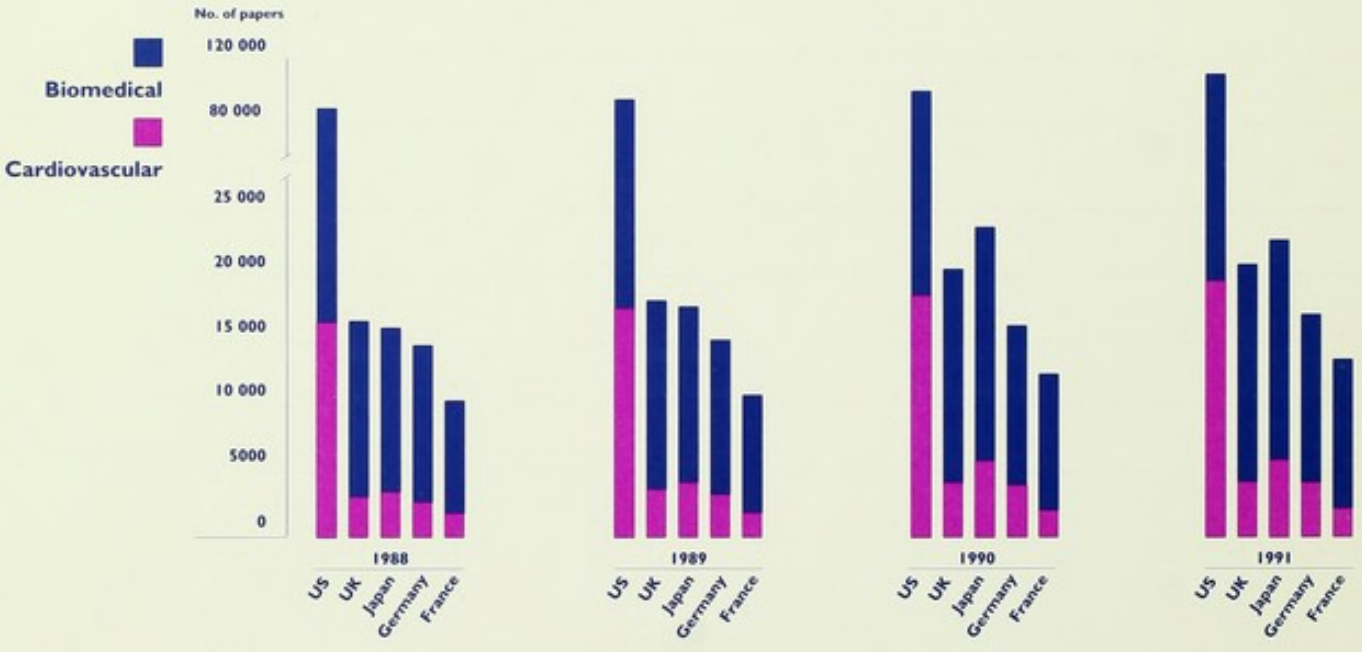
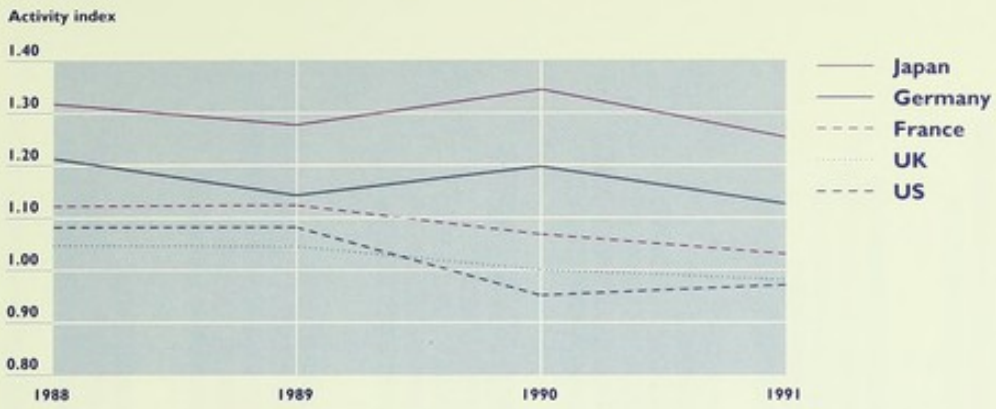


Figure 2 presents data for five countries. It reveals substantial activity in the US, which published over four times more papers than the UK. This reflects the huge output of biomedical papers by the US generally which increased from 25% of all papers in Medline in 1988 to 30% in 1991. In contrast, the UK produced only a steady 6% of the world's biomedical papers annually between 1988-1991.

In terms of the share of the world's cardiovascular papers, the US had an average of 27%, the UK 5%, Germany 5% and France 3% over the period. The only country to exhibit a clear increase in its share of the world's output of cardiovascular publications over the period was Japan (from 6% to 8%).

Fig 3

International comparison of cardiovascular publications activity indices: 1988-1991 (Medline analysis)



$$\text{Cardiovascular Research Activity Index} = \frac{\text{Number of national cardiovascular papers / Number of national biomedical papers}}{\text{Number of world cardiovascular papers / Number of world biomedical papers}}$$

Figure 3 shows the emphasis placed on cardiovascular research by different countries in relation to their overall national activity in biomedical research.

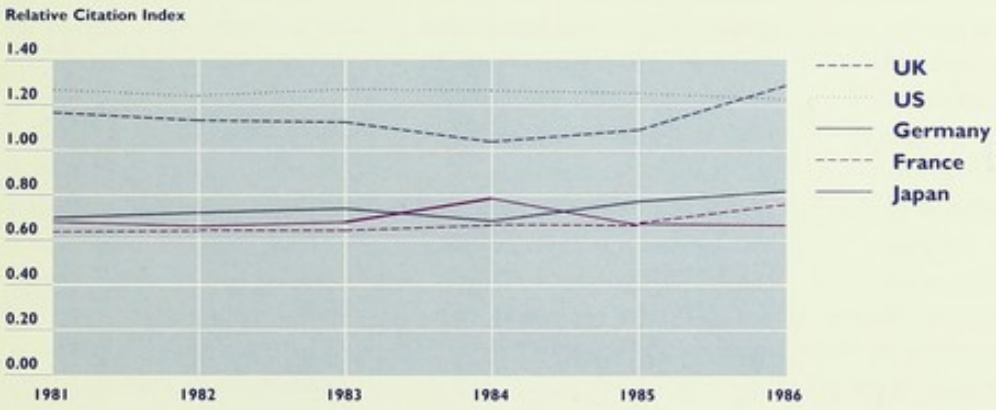
To show this clearly, it is necessary to compute a 'cardiovascular research activity index' for each country for each year, using the formula above. An index greater than 1.00 reveals a greater than expected output of cardiovascular research in relation to the world norm, whilst a value below 1.00 suggests lower than expected activity. From 1988 to 1991 Japan and Germany consistently had activity indices above 1.00, suggesting that in these countries cardiovascular science had some prominence within their national research portfolios.

In contrast, in the UK, US and France cardiovascular research had less prominence, with low, and declining activity indices. By 1991, indices for the UK and US had fallen below 1.00. Thus, while the UK and US publish large numbers of cardiovascular papers each year, it is clear that this field does not stand out in these countries, as it does in Japan and Germany.

Whilst the number of papers produced by a country gives some measure of the productivity of its cardiovascular research enterprise, the number of citations received by these papers gives some measure of the country's impact or influence in this field internationally. Figure 4 shows the results of such an analysis.

Fig 4

Citation impact of cardiovascular papers: 1981-1986 (SCI analysis)



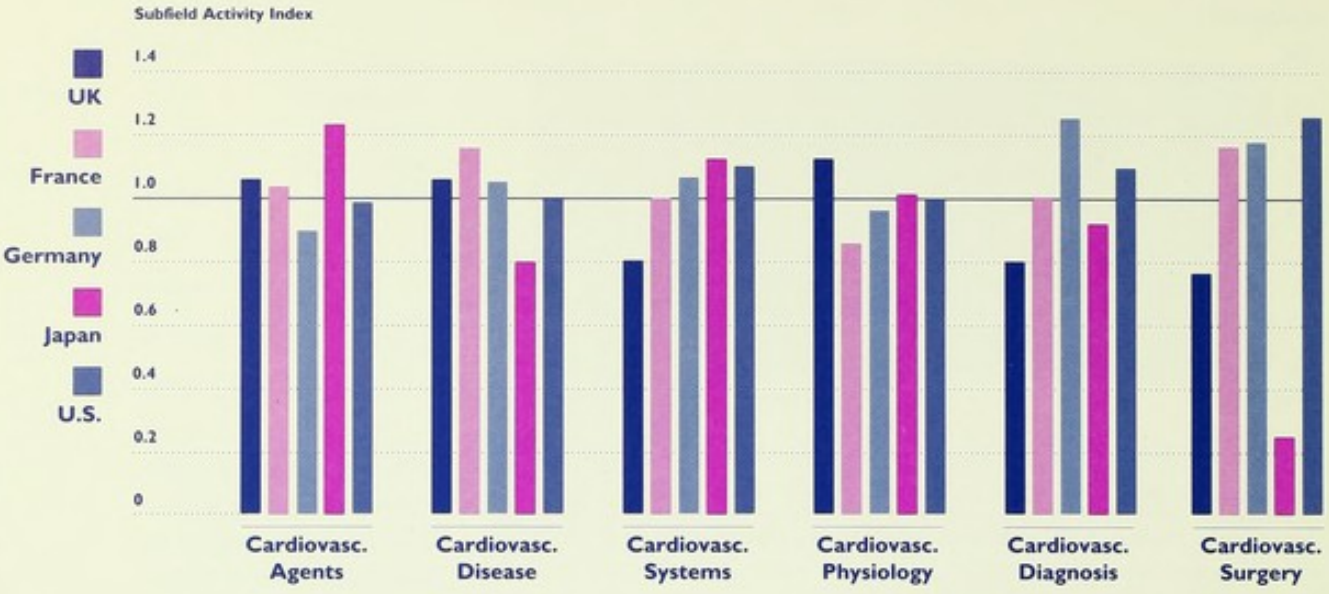
$$\text{Relative Citation Index (RCI)} = \frac{\text{Citations per paper for country A}}{\text{Citations per paper for all countries}}$$

Here the average number of citations per cardiovascular paper for a country is compared to the world average citations per cardiovascular publication, using a Relative Citation Index. Given that citation analysis could only be conducted using the SCI, the analysis is limited to the period 1981-1986. Values above 1.00 denote a citation impact higher than the world norm.

By this measure, US and UK cardiovascular research papers had above average impact internationally. In contrast, although Japan and Germany appeared in recent years to be relatively active in cardiovascular research (Fig 3), the evidence of figure 4 is that these countries were having below average citation impact in this field, at least during the first half of the 1980s.

Fig 5

International comparison of the emphasis on different subfields: 1981-1986 (SCI analysis)



$$\text{Subfield Activity Index} = \frac{\text{Number of country A's papers in subfield S / Number of country A's papers in all subfields}}{\text{Number of world's papers in subfield S / Number of world's papers in all subfields}}$$

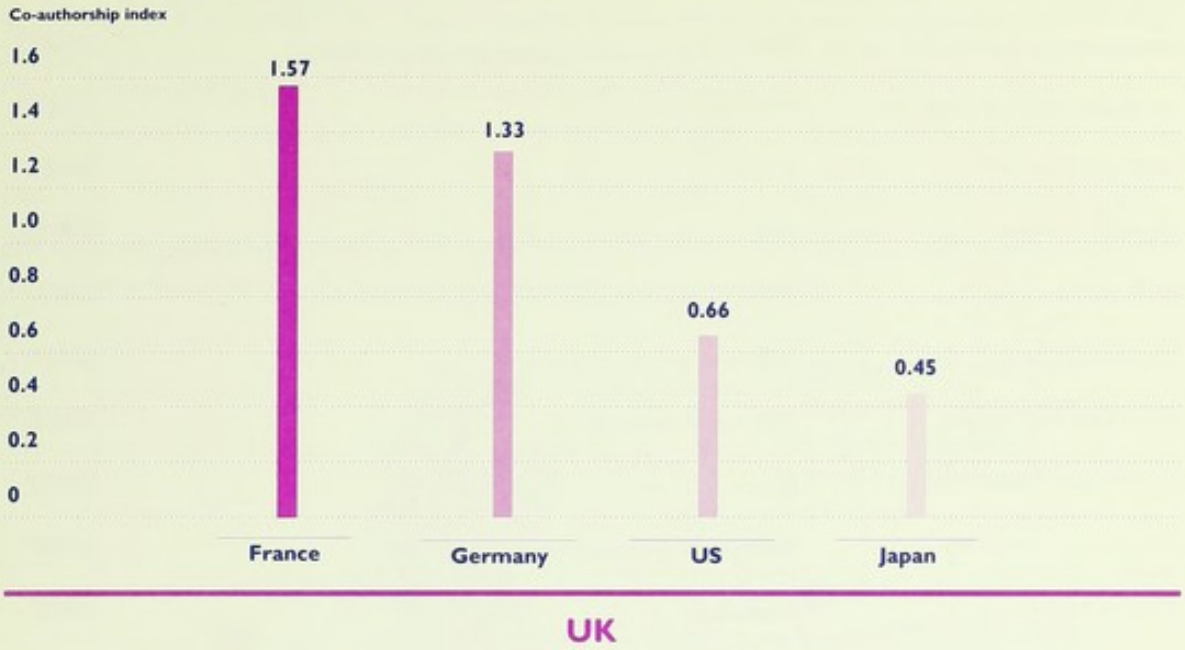
In an attempt to assess whether there were any differences between countries in their research activity within specific subfields, data were disaggregated according to the main Medline index terms making up the definition of cardiovascular research.

Each paper in Medline usually carries several index terms, denoting that its subject matter spans several subfields. Analysis of subfield activity which includes such papers will necessarily mean that they are 'counted' in two or more of the subfields. Such an analysis (Fig 5), therefore, can only show the total frequency with which different MeSH terms were used by Medline indexers to describe the subject matter of papers from a particular country. However with the large set of papers, available in this study, this kind of analysis provides a rough guide to the relative activity in different subfields in different countries.

The data were expressed as Subfield Activity Indices, using the formula above. An index greater than 1.00 suggests a concentration of effort in a particular subfield.

The most striking result, as shown in figure 5, is that Japan appeared to be relatively inactive in research on cardiovascular surgery and most active in research on cardiovascular agents. Differences are less clear for the UK, but the subfields with greatest relative activity appear to have been physiology and cardiovascular agents, and the least active subfields to have been diagnostic techniques and cardiovascular surgery. In Germany, the subfield with the highest relative activity was research on diagnostic techniques, and in the US it was research on cardiovascular surgery.

International collaboration in cardiovascular research: 1981-1986 (SCI analysis).



$$\text{Co-authorship Index} = \frac{\text{Number of UK papers co-authored with country X / Number of UK papers internationally co-authored}}{\text{Total number of papers with at least one country X author / Number of world's papers – number of papers with only UK authors}}$$

As research is becoming increasingly internationalised, it was of interest to assess patterns of collaboration between the key countries in cardiovascular research. The degree to which scientists in one country collaborate with those in another can be measured by examining the addresses on each paper. On the SCI, this can be done electronically. Figure 6 shows the strength of collaboration between the UK and the four other nations studied.

The co-authorship index reveals whether the UK's cardiovascular researchers collaborate with another country more than would be expected, given the total number of UK/foreign collaborations, and the number of papers produced by the UK and the country being studied. The higher the index, the stronger the association between the UK and that country.

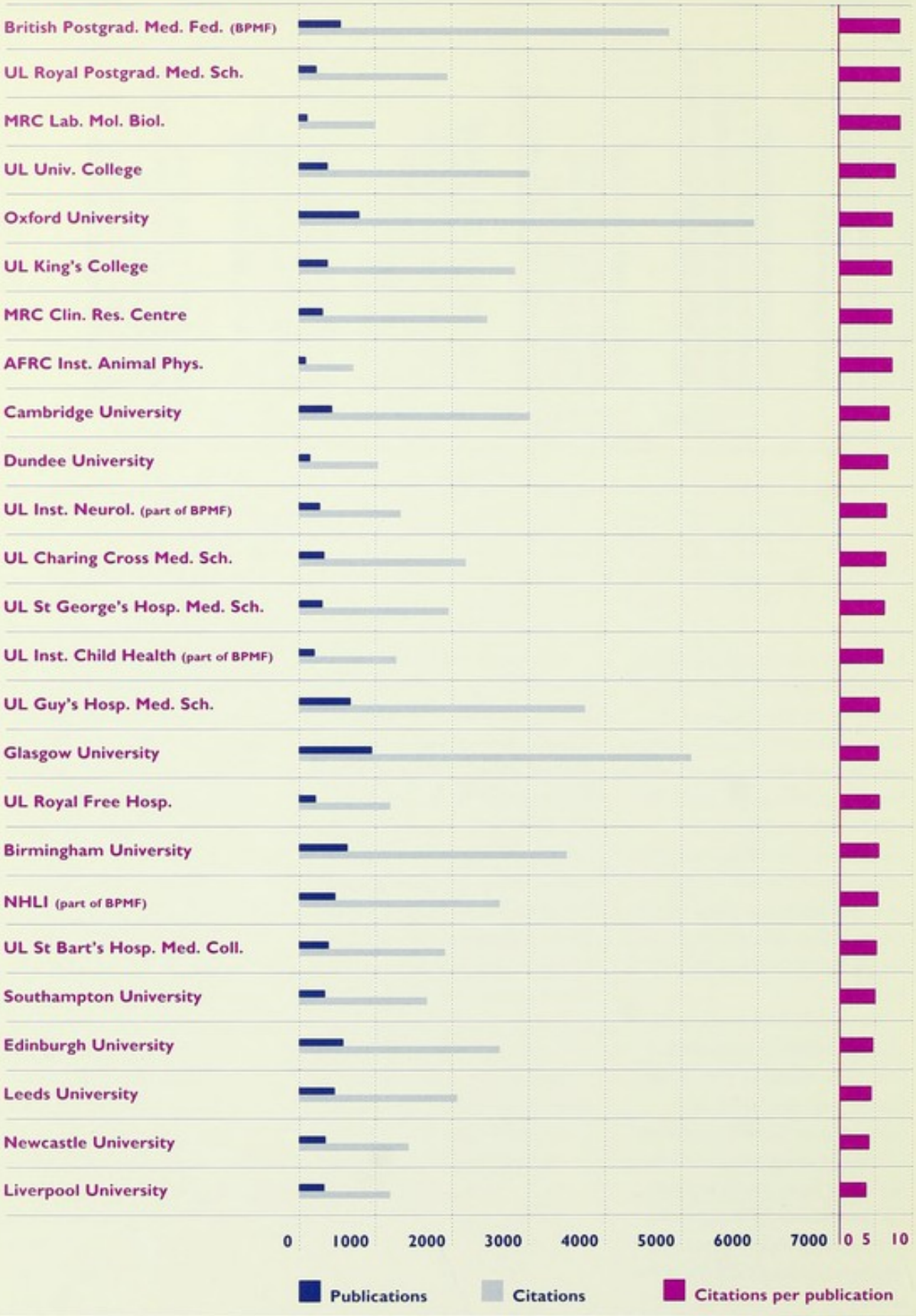
The intensity of UK collaboration with France and Germany is higher than expected, given the number of papers produced and co-authored by these 3 countries internationally. In contrast, collaboration between the UK and US was lower than expected given the volume of research activity in that country. This finding appears to suggest that the degree to which the UK collaborates with another country in cardiovascular research may be influenced by its geographic proximity.

Fig 7

The 25 top producers of publications relevant to cardiovascular science: 1981-1986 (SCI analysis)

An attempt was made to analyse the distribution of publications across institutions within the UK. The only reliable data source for this was the SCI, because this gives the addresses of all authors on all papers.

This first analysis (Fig 7) was at the level of individual institutions and limited to the period 1981-1986. This shows the total number of cardiovascular papers produced, and citations received through this period, ranked according to their average number of citations per paper.



BPMF = British Postgraduate Medical Federation. It is a school of the University of London and comprises 8 research and teaching institutes, the departments of Postgraduate Medicine and Dentistry for the 4 Thames Health Regions and a central administrative office. Papers where only the BPMF was specified were attributed to the BPMF. Where a specific institution falling under the BPMF umbrella was listed the paper, or fraction thereof, was attributed to the institution specified.

The vast majority of cardiovascular publications listed above were produced by researchers working in departments forming part of the medical faculty or school in each university. The publications from teaching hospitals which were associated with each medical faculty or school were also attributed to the relevant university.

London medical schools are listed separately from the University of London publications.

UL UNIV COLLEGE: All papers from University College London (including papers from University College Medical School) and associated teaching hospitals.

UL KING'S COLLEGE: All papers from King's College London (including papers from King's College Medical School) and associated teaching hospitals.

The maps below (Figs 8 and 9) show more recent data than those derived from the SCI (Fig 7), and were produced from a special sampling technique using Medline. During the period 1988-1991, Medline indexed 14 064 UK cardiovascular papers. These carried the names of 21 000 different authors, which were downloaded onto a computer file. The 100 most frequent names in this set of authors were identified as the most 'visible' cardiovascular researchers in the UK during this period. Their institutional locations were identified using various medical and research directories.

Fig 8

Hot spots of publication activity in UK cardiovascular research: 1988-1991 inclusive (Medline analysis)
(Diameter of circles relate to the number of highly visible researchers in country's top 100)

The most active centres outside London were Cambridge, with 7 of the most visible researchers, Glasgow with 6 and Oxford and Nottingham with 5 each.

● = 5 highly visible researchers

* Denotes that London is not represented on this map. It is shown below in Fig 9.

Fig 9

London centres of publication activity in cardiovascular research: 1988-1991 (Medline analysis)
(Diameter of circles relate to the number of highly visible researchers in country's top 100)

London dominated UK cardiovascular research, with 69 of the nations most visible researchers working there. The biggest centre was RPMS with 13 researchers in the top 100, then NHLI with 12 and St George's Hosp. Med. Sch. with 10.

Key: **CRC** Clinical Research Centre (MRC) **ICH** Institute of Child Health **IN** Institute of Neurology **NHLI** National Heart and Lung Institute **RFH** Royal Free Hospital **RPMS** Royal Postgraduate Medical School **UCL** University College London **UMDS** United Medical and Dental School (Guy's and St Thomas's)

● = 10 highly visible researchers

This analysis was based on a very large sample of research papers which effectively represented the total production of papers worldwide. At this macro level, broad patterns of research activity could be discerned which help set the UK's cardiovascular research effort in a global context, and provide some insights into the distribution of cardiovascular research within the UK not possible at a lower level of analysis. The key findings are listed below:

- Using a carefully constructed definition for the field, 1 in 5 of all biomedical research papers published worldwide were identified as having relevance to cardiovascular research

- The US dominated cardiovascular research in terms of numbers of papers produced worldwide. Japan was the second most prolific producer of papers among the five countries, and over recent years has been increasing its lead over the UK. The UK produced more cardiovascular papers than the two other European nations; Germany and France.

- Cardiovascular research appeared to have some prominence in the national research portfolios of Japan and Germany. In contrast, cardiovascular research did not stand out as a specially active field within the UK's national research portfolio.

- Japan appears to have conducted little research on cardiovascular surgery and emphasised research with a focus on cardiovascular agents.

- The UK and US had the highest citation impact internationally. Citation rates to cardiovascular papers produced in these countries were higher than the world citation norm for this field. France, Germany and Japan were below the norm.

- The UK had greater than expected collaboration in cardiovascular research with Germany and France, given the level of research activity in these countries. This suggests that geographic proximity may be an important factor in research collaboration.

- Within the UK, cardiovascular research was concentrated heavily in London. Between 1988 and 1991, sixty nine of the top 100 authors of cardiovascular papers were based in the capital.

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