Shrinking Basic Cardiovascular Research in Japan

The Tip of the Iceberg

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Shrinking Scientific Activities in Japan

The number of research articles from Japan has been dramatically decreasing during the 21st century.[1] Although the number of Nobel Prize laureates from Japan in the natural science field (physiology, medicine, physics, and chemistry) ranks second in the world after United States during this century with 16 winners, these prizes are mostly based on the research performed during the 20th century. According to the database of Web of Science, the number of articles from Japan published in the American Heart Association journals (*Circulation*, *Circulation Research*, and *Arteriosclerosis, Thrombosis, and Vascular Biology*) was 164 (10.0% of all articles) in 2000, which markedly decreased to only 45 (5.5%) in 2016 (Figure 1A). In contrast, the number of articles from other top 10 countries has been almost unchanged in the same period except for China; the number of articles from China has dramatically increased by 570% (Figure 1A). Regarding the number of publications in *Circulation Research*, Japan has already dropped from the top countries; Japan was the second in 2000 (11.1%) and 11th in 2016 (only 2.8%; Figure 1B). Similarly, the number of articles from Japan published in the top basic scientific journals (*Nature*, *Cell*, and *Science*) was 172 in 2000, which decreased to 151 in 2016 (7.6%; Figure 2A). Again, in other top countries, the number of articles in these top journals has been increased, especially with the marked increase from China (Figure 2A). All these data clearly demonstrate the devastating situation in Japan in the field of basic research as compared with other top countries in the world.

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In addition to the shocking situation in basic research in Japan, we further analyzed the changes in the field of clinical research. Interestingly, the number of articles from Japan published in the top clinical journals (*New England Journal of Medicine*, *the Lancet,* and *the Journal of the American Medical Association*) was 42 (2.9%) in 2000, which has slightly increased to 50 (7.0%) in 2016 (Figure 2B). However, other top countries showed more significant increase in the number of publications (Figure 2B). These data demonstrate the shrinkage of medical research in Japan, in both basic and, to a lesser extent, clinical field, as compared with other top countries. We next analyzed the situations in other research fields, including engineering science that is one of the strong research fields in Japan. Strikingly, the number of publications from Japan in engineering science also showed a sharp 30% decrease during the past 10 years as compared with the average number of publication from other countries (United States, United Kingdom, Germany, France, Italy, and Canada; Figure 2C). Thus, in contrast to other top countries, Japan is an exception, showing a devastating situation especially after 2004, where there was no increase in publication in almost all research fields (Figure 2C). The shrinkage of basic cardiovascular research is just a tip of the iceberg in Japan. Next, we examined the cause(s) of this devastating situation in Japan.

Possible Causes for the Devastating Situations in Japan

It is possible that several causes may be involved in the devastating situations of basic research in Japan (Table). Fifty-five years have passed since the national health insurance program was established in Japan (http://www.mhlw.go.jp/english/policy/health-medical/health/index.html). This national health insurance system has significantly improved the health conditions in Japan, and its maintenance is indispensable for public health. As a consequence, the total population of Japan peaked at 2008 (128 million), which has been decreasing after that. The decrease in the population is obviously because of the continuous decrease in the birthrate (1.6 million in the 1980s to 1.0 million in 2016).[2] In contrast, the life expectancy in Japan is steadily increasing with one of the longest life expectancies in the world (average 83.7 years old).[2] All these factors accelerate the aging of the society and reduce the working age population in Japan. This rapid converting to the aging society has resulted in the demand for increasing social security payments, which would progressively increase in the next 20 years. In addition, Japan has geographical conditions with frequent natural disasters, such as big earthquakes and typhoons.[3] Thus, the Japanese government has to invest in the prevention and recovery from such natural disasters. Consequently, the Japanese government needs to allocate the budget to a variety of fields following their priority in well balance to overcome the hard time as an aging country.

In Japan, we experienced a bursting of so-called bubble economy in the early 1990s, and thereafter, the increase in

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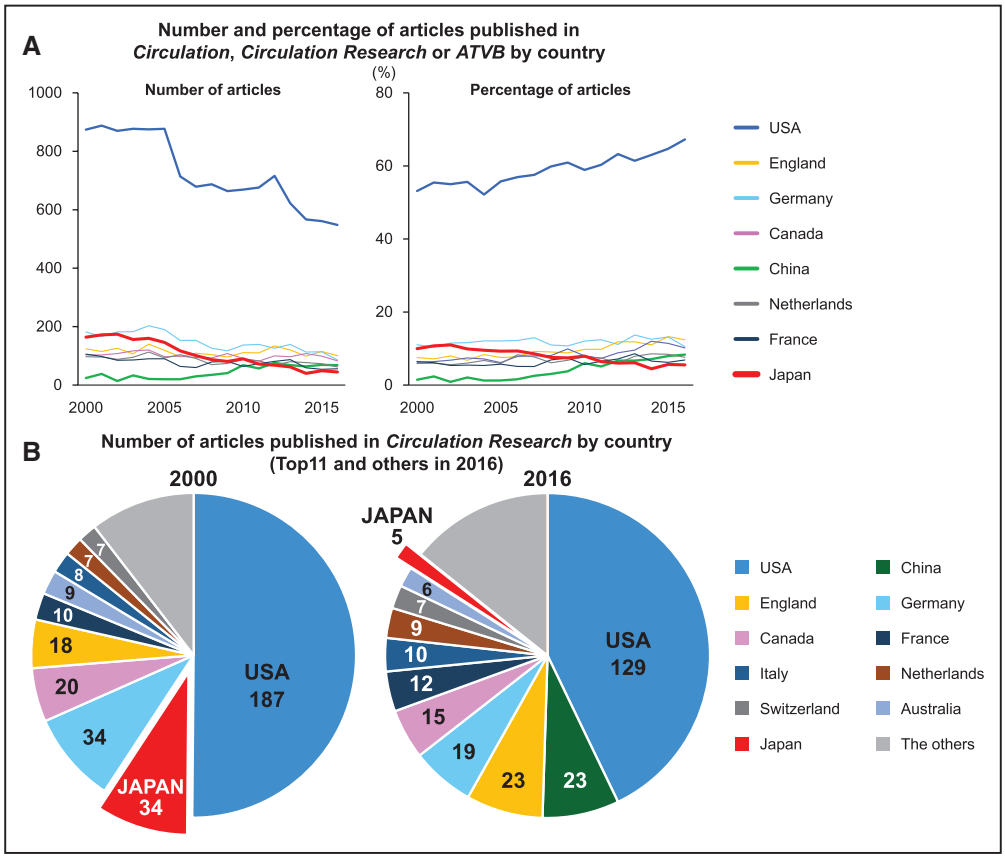

Figure 1. Shrinking scientific activity in cardiovascular medicine in Japan. **A**, Trends in the number (**left**) and percentage (**right**) of articles published in the American Heart Association journals (*Circulation*, *Circulation Research*, or *Arteriosclerosis*, *Thrombosis*, *or Vascular Biology* [*ATVB*]) from 2000 to 2016 by country. Top 8 countries in the number of publications in 2016 are shown. **B**, A pie chart on the international comparison of the number of articles published in *Circulation Research* in 2000 and 2016. The number on the chart represents actual number of papers. Sources: the database of Web of Science (**A** and **B**).

gross domestic product has stopped (Figure 3A). The economy has been slow to recover from the collapse, and again we encountered the Bankruptcy of Lehman Brothers in 2008 and the Great East Japan Earthquake in 2011. Twenty years ago, the spending on research and development (R&D) per gross domestic product was the highest in Japan (http://www.janu.jp/report/files/2014-seisakukenkyujo-uneihi-all.pdf). However, the government's budget for R&D has been continuously low in contrast to the significant increases in other top countries (Figure 3B). Furthermore, the Japanese government's expense for research is only 20% of total spending for R&D, which has been almost flat after 2000 (Figure 3C). Moreover, in 2004, the Japanese government made the National University Corporation Law and started to cut the funding for the management expenses for national universities by ≈1% every year in exchange of some management liberties (http://www.mext.go.jp/b_menu/shingi/chousa/koutou/062/gijiroku/icsFiles/afieldfile/2015/06/16/1358924_1.pdf). As a result, more than one third of universities stopped to fill tenure positions with new researchers after retirement of professors. Consequently, many laboratories cannot afford technicians or young researchers who would make future of scientific research in universities. This decision of the Japanese government seems to have caused, at least in part, the shrinkage of research activities in almost all research fields after 2004 (Figure 2C). In addition, a system for the training of medical school graduates has been drastically changed after 2004, which made it difficult to flexibly select their career. Moreover, after initial 2-year training, the systems for trainings of specialist in each medical field were also introduced, which further reinforced the rigid career development. Thus, it is difficult for Japanese medical school graduates to become a medical researcher during their initial career. Altogether, the number of PhD researchers is also the least in Japan among the top leading countries (the prevalence of PhD researcher in 1 million population is ≈120 in Japan and ≈350 in the United States; http://www.nistep.go.jp/wp/wp-content/uploads/b1_OECD-Laudeline_Auriol.pdf). The national policy to cut the handling budget for national universities also seems to have resulted in the shrinkage of scientific activities in Japan. The number of students entering PhD courses has been decreasing after the peak in early 2000s, which resulted in the reduction in post-docs, especially in medical science, and the shrinkage of scientific activities in Japan (Figure 2C). However, the existing experienced researchers are aging in Japan, like other aging countries in the world. Furthermore, the number of researchers under 40 years decreased by 11% during the past 10 years, whereas the total number of researchers, excluding postdoctoral researchers, in national universities increased by 2%. Traditionally, in Japan, there were limited chances for young researchers to become a principal investigator of large grant

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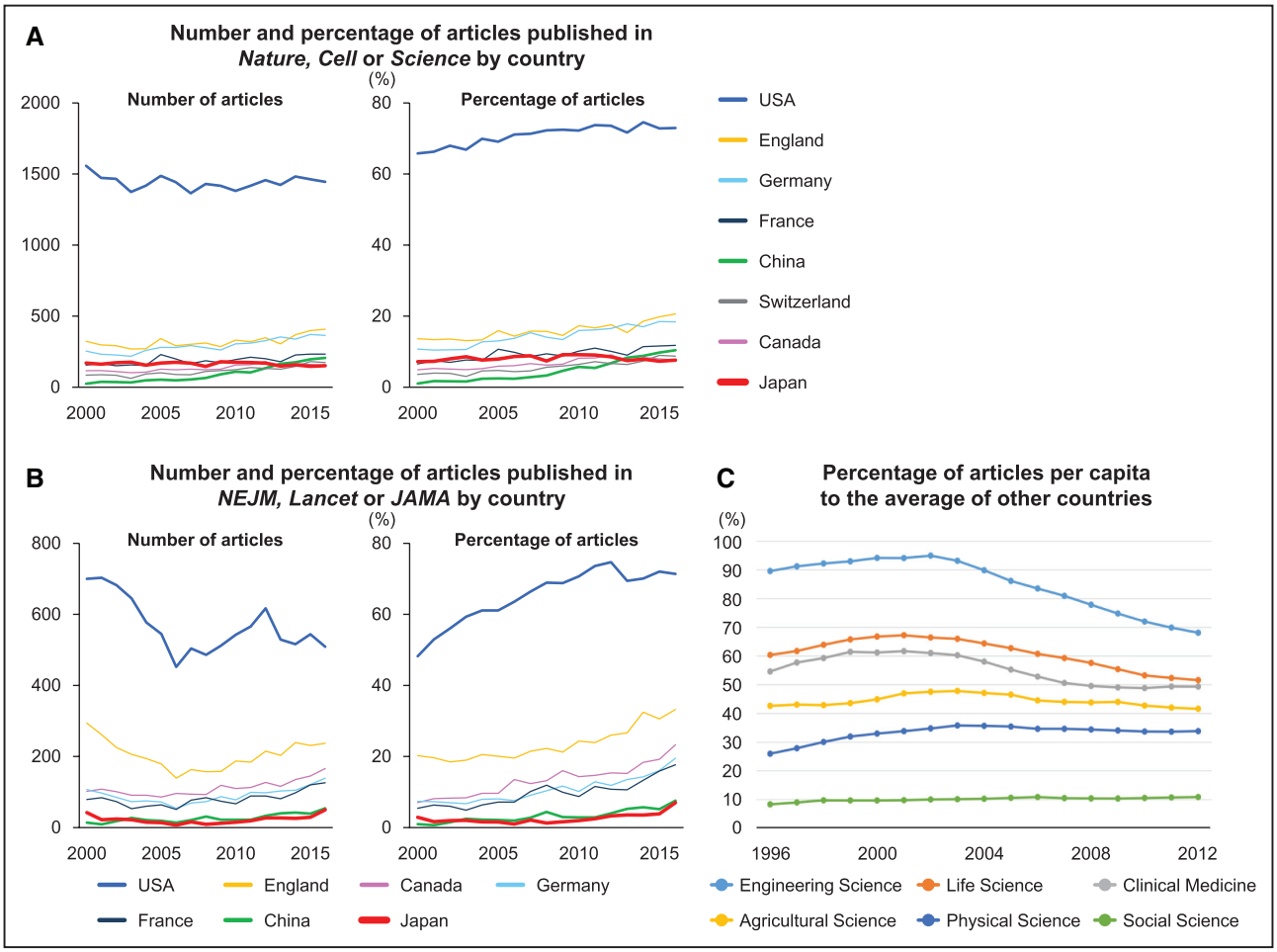

Figure 2. Shrinking scientific activity in almost all research fields in Japan. **A**, Trends in the number (**left**) and percentage (**right**) of articles published in *Nature*, *Cell*, or *Science* from 2000 to 2016 by country. Top 8 countries in the number of publications in 2016 are shown. **B**, Trends in the number (**left**) and percentage (**right**) of articles published in *The New England Journal of Medicine* (*NEJM*), *The Lancet*, or *The Journal of the American Medical Association* (*JAMA*) from 2000 to 2016 by country. Top 7 countries in the number of publications in 2016 are shown. **C**, Trends in proportions of articles per capita to the average of other countries (United States, United Kingdom, Germany, France, Italy, and Canada). Engineering science includes physics, chemistry, materials science, and engineering. Life science includes medicine, biochemistry and molecular biology, and pharmacology. Agricultural science includes agriculture, plant sciences, and environmental science. Physical science includes astronomy, earth science, and mathematics. Sources: the database of Web of Science (**A** and **B**) and the Japan association of national universities (**C**).

studies at an early stage of their career, which may be different from other top countries. The failure of fostering motivated young researchers might be an additional cause of the shrinkage of scientific activities in Japan.

For the Recovery of Medical Research in Japan

To break through the current critical situations and regenerate medical research in Japan, the Japanese government established the Japan Agency for Medical Research and Development in April 2015, which has a function as a control tower for R&D in medicine in Japan (http://www.amed.go.jp/en/aboutus/). Agency for Medical Research and Development manages R&D in the field of medicine to establish and maintain the environment for R&D by providing funding and to promote the integration of medical R&D in the fields of basic, translational, and clinical research. Agency for Medical Research and Development aims to achieve the highest level of research from basic to clinical by establishing and maintaining an environment for the growth of medical R&D. The Japanese government has introduced several programs on the investments for research institutions and the acceptance of foreign students. In accordance with the policy to increase the number of foreign students (Plan for 300 000 Exchange Students) after 2008, the number has been steadily increasing in Japan (64 000 in 2000 to 239 000 in 2016; http://www.jasso.go.jp/en/about/statistics/intl_student_e/2016/index.html). Those young foreign students are expected to stimulate basic scientific activity in Japan. In addition, the Japanese government has started a plan to increase the number of young

Table. Possible Causes of the Decline in Basic Cardiovascular Research in Japan

Decreasing birthrate and aging population
Economic stagnation and no increase in expense for research and development
Shrinking number of PhD researchers
Alteration of the specialist system of medical doctors

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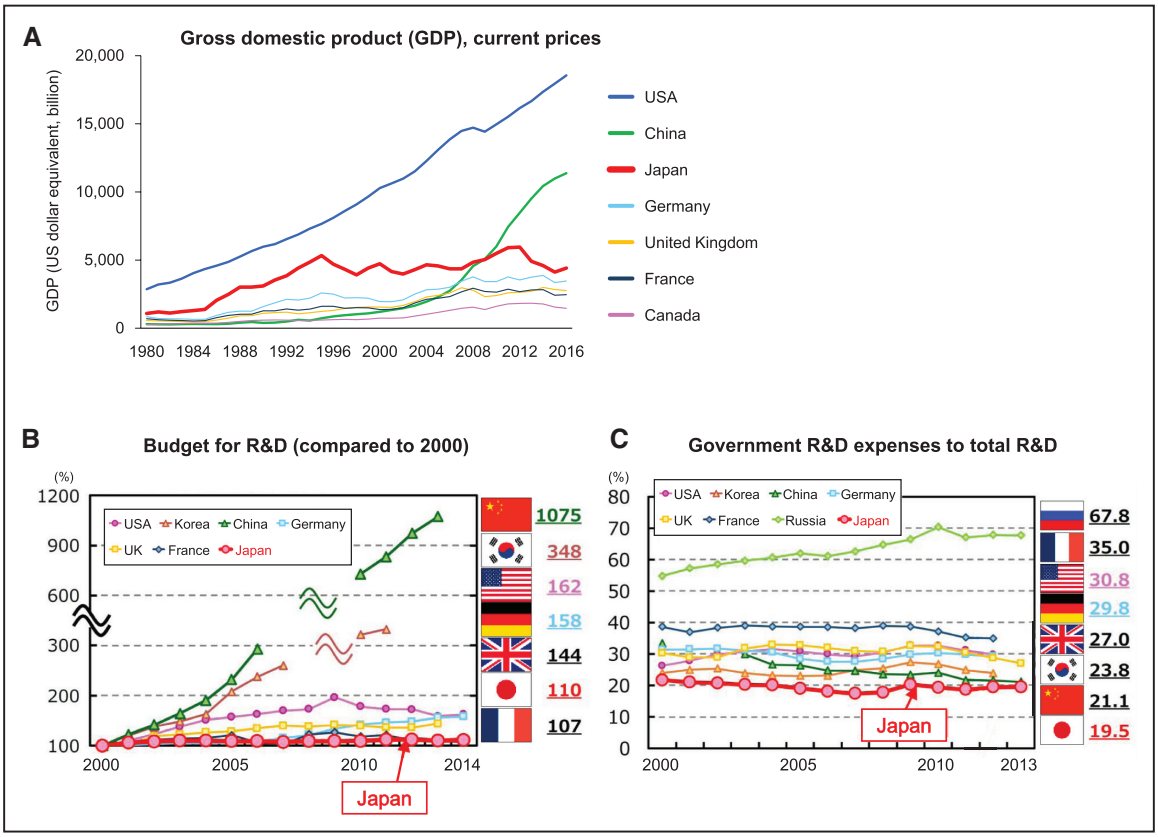

Figure 3. Economic growth and science spending. **A**, The trends of gross domestic product (GDP) of the top 7 countries in 1980 to 2016. Data are represented as US dollar equivalent of the exchange rate in each year. **B**, The trends in the national budget for research and development (R&D) from 2000 to 2014. Data are shown as a ratio to 2000. **C**, The trends in proportions of the government R&D expenses to total R&D from 2000 to 2013. Sources: Organization for Economic Co-operation and Development data (**A**) and the cabinet office, Government of Japan (**B** and **C**).

researchers working in universities under 40 years, partly by supporting initiatives that offer more tenure positions and allowing more flexible use of grants to hire young researchers. In addition, Japanese Circulation Society supports cardiovascular research in several ways, such as encouraging and aiding cardiovascular research, commending achievements, and giving grants to young researchers for their studies abroad. Thus, these efforts may hopefully improve the devastating situations in Japan. In the aging society, in general, the government encounters devastating situations to overcome the hard times to balance between increasing national health payments and investment for the future. However, we have to look the devastating situations in the face in Japan.

Disclosures

None.

References

1. Fuyuno I. What price will science pay for austerity? *Nature*. 2017;543:S10–S15. doi: 10.1038/543S10a.
2. Ando Y. Trends in major indices for the vital events. In: Director-general for statistics and information policy, Ministry of Health, Labour and Welfare, eds. *Vital statistics in Japan-trends up to 2015-*. Tokyo, Japan: Director-general for statistics and information policy, Ministry of Health, Labour and Welfare; 2017:8–14.
3. Aoki T, Fukumoto Y, Yasuda S, Sakata Y, Ito K, Takahashi J, Miyata S, Tsuji I, Shimokawa H. The Great East Japan Earthquake Disaster and cardiovascular diseases. *Eur Heart J*. 2012;33:2796–2803. doi: 10.1093/eurheartj/ehs288.

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