Letter to the Editor

A long way ahead to improve the cost-effectiveness of biomedical research in China

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Dear Editor,

A recent paper by Zhang *et al*. analyzed the recent hematology literature and compared the output in hematology research from China Mainland with those from US, Europe and Asian countries in recent 10 years from 2004 to 2013. The data showed that although China has made considerable progress in hematology research, the quality of research disproportionally lagged behind (1). This paper reminds us again the major challenges ahead for Chinese biomedical scientists, i.e., to improve the research quality. Zhang *et al.*'s analysis showed the ranking for cumulative impact factors (IF) of hematology literature was: (I) USA; (II) Germany; (III) UK; (IV) Japan; (V) China; (VI) South Korea. And the ranking for average impact factors was: (I) USA; (II) Germany; (III) UK; (IV) Japan; (V) South Korea; (VI) China. Germany had the highest average citations, while China had the least. The situation of hematology literature output from the six countries in 2009-2013 had little difference from that in 2004-2013. China ranked last in the number of publications in top 25% journals during 2004 to 2013. The result remained surprisingly the same in the period from 2009 to 2013, a period when China's gross domestic product (GDP) and scientific funding were significantly higher than those from 2004 to 2008. The contribution of Chinese authors to the top 10 hematology journals was also small (2.35%).

In the year of 2012 for China and South Korea and the year of 2011 for others countries, by purchasing power parity comparison, the expenditures on research and development (R&D) in billions of US$ were 405.3 for USA, 296.8 for China, 160.3 for Japan, 69.5 for Germany, 65.4 for South Korea, 42.2 for France, and 38.4 for UK (2). In the year of 2013, China had total citable publications comparable to that of USA with a ratio of 1:1.23, by far surpassed UK which ranked the third place with a ratio of 2.87:1. However, among the top 50 countries in citable document number, China ranked the 45th place in citation per publication. In 2004 China ranked the same 45th place in citation per publication, while at that time China, Japan, UK and Germany had similar citable documents, being about one fourth of USA's (3). In 2013, measured by citation per publication the top nine countries were Switzerland, Denmark, Netherlands, Sweden, Belgium, Austria, UK, Germany, and Israel, respectively. Singapore, Norway, and Finland had the equal position being the tenth, with USA ranked 16th place (3).

It is known that the number of scientific publications is not necessarily proportional to a country's scientific strength. For example, both France and Israel's scientific strength would be underestimated if we only looked at the numerical figure of publications in English-language journals. In addition, a large proportion of scientists are not concerned with journal impact factors (4). Many scientists prefer to publish their results in the journals of their nations and/or their specialty fields (4). For the quality of research, apparently Switzerland takes the lead. With a population of approximately 8 million, close to that of Hong Kong SAR, in 2013 Switzerland ranked 18th for citable publications (Israel being 29th). However, Switzerland consistently ranked among the top in citation per publication (3). In terms of the number of Nobel Prize Winners during the period of

1901-2005, Switzerland had the top relative representation (Share of Nobel laureates/Share of population) of 28.09, followed by UK of 9.38, Germany of 9.16, France of 5.21, and USA of 4.32 (5). Another notable example is Japan. In Zhang et al's analysis the average citations for Japan surpassed those of UK (1). The quality of Japanese biomedical research is further highlighted by Dr Shinya Yamanaka's recent Nobel Prize winning discovery that mature cells can be reprogrammed to become pluripotent, and Dr Masayo Takahashi's first-in-human clinical study based on iPS cells for patients with retinal degeneration (6). In addition to scientific papers, application innovation is arguably more important. This typically implies new drugs and new treatments in the field of hematology. In 2013, among the top 25 pharmaceutical companies, USA had 9, followed by Japan 5, Switzerland 3, Germany 3, UK 2, and France, Israel and Denmark 1 respectively (7). In the same year, among the top 25 biotech companies, USA had 12, Switzerland and Ireland had 2 respectively, while Germany, Belgium, Australia, Israel, Denmark, UK, France, Ireland, and India had 1 respectively (8).

As the second largest economy and with R&D expenditure second only to USA, China is now second only to USA in the number of scientific research papers published annually (3). However, many Chinese researches remain repetitive rather than innovative (9). Some Chinese scientists do research only for the promotion purpose instead of aiming at solving problems (10). A substantial proportion of the research activities lead to meaningless data and publications. As a result, those research investments ended with a waste of manpower and resource. One of the major issues is that the current evaluation process in China confuses both clinicians and scientists (11). In our recent on-line survey, surprisingly, 29.2% of medical doctors at the level of attending physicians or above in teaching hospitals were not able to name a single English journal of their own specialty (12). The English skill of Chinese scholars unarguably undermines their scientific output in English-language journals. Zhang *et al.*'s report finds that the number of meta-analyses published from China approached that published from the USA (1). By pooling the results together from multiple studies, scientists perform meta-analyses to strengthen or decipher elusive conclusions (13). It is plausible that the high number of meta-analysis publications from China was partially driven by publication pressure, and how these publications are associated much improved care patient remains to be further analyzed. In addition to promotion requirement, many Chinese universities award cash prizes or other perks for scientific publications. The pressure and incentives to publish large quantity of papers remain high. In one recent survey, one in three Chinese researchers surveyed at major universities and research institutions admitted to committing plagiarism, falsification or fabrication of data (14).

As one South Korean scientist recently pointed out, "it seems that these days most scientists only care about number of papers published in the journals with IF, instead of developing their unique research fields…that would be a kind of disaster…" (4). China still has a long way ahead to improve the cost-effectiveness of her biomedical research. To achieve this, a few steps can be taken: (I) make sure senior scientists will have enough time dedicated to hand-on research activities; (II) reevaluate the funding mechanisms and assessment process so that priorities be given to innovative proposals, not to publication-driven measures and outcomes; In other words, research outputs should be evaluated and rewarded by their impact on society and healthcares, rather than merely by journal impact factors; (III) to further internationalize civil research, including hire more international staff as research directors and setup over-sea research units (10); (IV) bench-mark one institution against a similar-level international institution in terms of investment and output; for example, bench-mark Peking University against National Seoul University of Korea or Tokyo University of Japan. Comparison and critical cost-effectiveness analysis should be carried out periodically. Quality, not quantity, of scientific research should be the ultimate goal and marker for future funding considerations. Finally, China cannot claim being one of the leaders in biomedical research unless China has a vibrant and innovative pharmaceutical/biotech industry.

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