Chinese contribution to *NEJM*, *Lancet*, *JAMA*, and *BMJ* from 2011 to 2020: a 10-year bibliometric study

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Background: *New England Journal of Medicine* (*NEJM*), *Lancet*, *Journal of the American Medical Association* (*JAMA*), and *British Medical Journal* (*BMJ*) are collectively known as "the Top Four Medical Journals (TFMJ)" in China. Through the analysis of Chinese scholars' publications in the TFMJ in the recent 10 years, this study aimed to clarify the current situation of high-quality medical research conducted by Chinese scholars and institutions.

Methods: Data were retrieved and downloaded manually from PubMed (2011–2020). Information on the publication year, journal, author, affiliation, and citation, etc. were extracted and analyzed using R software.

Results: A total of 761 articles were involved in the final analysis. The number of articles published by Chinese scholars in the TFMJ was 135/29,942 (0.45%) in *BMJ*, 124/14,033 (0.88%) in *JAMA*, 314/16,117 (1.94%) in *Lancet*, and 188/15,242 (1.23%) in *NEJM* (P<0.001). Besides, the letter was the main research type, which was up to 44.54%, and the original research only accounted for 17.47%. The most popular subspecialty and subject were infectious diseases and COVID-19, respectively. The most productive researcher was Chen Wang, and Bin Cao was the most cited Chinese scholar. The most productive institute was Chinese Academy of Medical Sciences and Peking Union Medical College. The most cited study was "Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China".

Conclusions: The presence of Chinese scholars in the TFMJ has grown, but there is still much room to improve. A Matthew effect in China's high-level scientific research was demonstrated.

Keywords: Medical research; China; bibliometric study

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Introduction

Deng Xiaoping, the initiator of China's Reform and Opening, pointed out that science and technology are the primary productive force. The Government of the People's Republic of China has concentrated on this statement as a national strategy to invigorate China through science and technology. With the rapid development of China's economy, economic and human resources were provided to accelerate scientific research. Accordingly, Chinese scholars have markedly contributed to the international academic communities. In Chinese academic circles, the number of published papers, especially science citation index (SCI)-

indexed publications, is an important assessment criterion. Driven by multiple factors, China has become a leading country for SCI-indexed publications. Since 2009, the total number of SCI-indexed papers published by Chinese scholars has continued to rank second in the world, behind the United States. Since 2018, China has surpassed the United States in quantity to have the largest number of SCI-indexed publications, and this gap is still widening (1). However, it should be cautiously realized that quantity is not equal to quality. The citation rate of papers published by Chinese scholars is relatively low, and the majority of them are considered to be of low quality (2).

New England Journal of Medicine (*NEJM*), *Lancet*, *Journal of the American Medical Association* (*JAMA*), and *British Medical Journal* (*BMJ*) are collectively known as "the Top Four Medical Journals (TFMJ)" in China, standing an extraordinary position in Chinese academic circles. Presumably, the reputation is greatly rooted in their long publishing history, with *NEJM*, *Lancet*, *JAMA*, and *BMJ* starting in 1812, 1823, 1883, and 1840, respectively. The broad range of research scope and high standard of publication acceptance also play an important role. The impact factors (IFs) of the TFMJ in 2021 were 91.246, 79.321, 56.272, and 39.890, for *NEJM*, *Lancet*, *JAMA*, and *BMJ*, respectively. Chinese scholars and academic institutions are proud to publish papers in the TFMJ. Therefore, a bibliometric analysis of the literature published in the TFMJ, to a large extent, can reflect the top medical academic level in China.

Through the analysis of papers published by Chinese scholars (first author) in the TFMJ in the recent 10 years (from 2011 to 2020), we attempted to clarify the current situation of high-quality medical research that was conducted by Chinese scholars and institutions. Along with our previous bibliometric analysis (3), we aimed to provide some evidence that may ultimately inform managers, researchers, and policy-makers.

Methods

A statistical analysis and data visualization were performed using the R 3.6.1 software (R Foundation for Statistical Computing, Vienna, Austria). The following R packages were used for data cleaning, data analysis, and visualization: "rio", "stringr", "plyr", "ggplot2", "ggmap", and "maps". Specially, "Rcrossref" was utilized to retrieve citations based on the digital object identifier (DOI) system.

Data were retrieved and downloaded manually from the PubMed database (https://www.ncbi.nlm.nih.gov/pubmed/). A total of 1,188 publications were identified using the following search strategy: "("BMJ (Clinical research ed.)" [Journal] AND "China" [Affiliation] AND 2011/01/01:2020/12/31 [Date-Publication]) OR ("Lancet (London, England)" [Journal] AND "China" [Affiliation] AND 2011/01/01:2020/12/31 [Date-Publication]) OR ("JAMA" [Journal] AND "China" [Affiliation] AND 2011/01/01:2020/12/31 [Date-Publication]) OR ("The New England Journal of Medicine" [Journal] AND "China" [Affiliation] AND 2011/01/01:2020/12/31 [Date-Publication])". There were no other restrictions, such as study type, abstract availability, language of publication, etc. The full text was downloaded if necessary. After excluding the duplicates and those articles whose first author was not affiliated to China, a total of 761 articles were involved in the final analysis.

Statistical analysis

Descriptive analyses were conducted to calculate the frequencies of published articles at the levels of journals, authors, institutions, and cities, etc. Continuous variables were expressed as median with an interquartile range (IQR) and range (min, max). Categorical variables were presented as frequencies with percentages, and analyzed by the Chi-square test or the Fisher's exact test, as appropriate. Pearson's product-moment correlation coefficient was used to determine the correlation between continuous variables. A two-tailed $P<0.05$ indicated statistical significance.

Due to the importance of original research compared with the letters, editorials, etc., a subgroup analysis, which only included original research, was performed, in addition to the "full data" analysis.

Results

Overview of the publications

The number of articles published by Chinese scholars in the TFMJ was as follows: *BMJ* [135/29,942 (0.45%)], *JAMA* [124/14,033 (0.88%)], *Lancet* [314/16,117 (1.94%)], and *NEJM* [188/15,242 (1.23%)], respectively ($P<0.001$). According to the research type, the letters accounted for 339/761 (44.54%), followed by case reports [126/761 (16.55%)], editorials [77/761 (10.11%)], reviews [55/761 (6.92%)], randomized controlled trials (RCTs) [49/761 (6.43%)], cross-sectional studies [39/761 (5.12%)], cohort

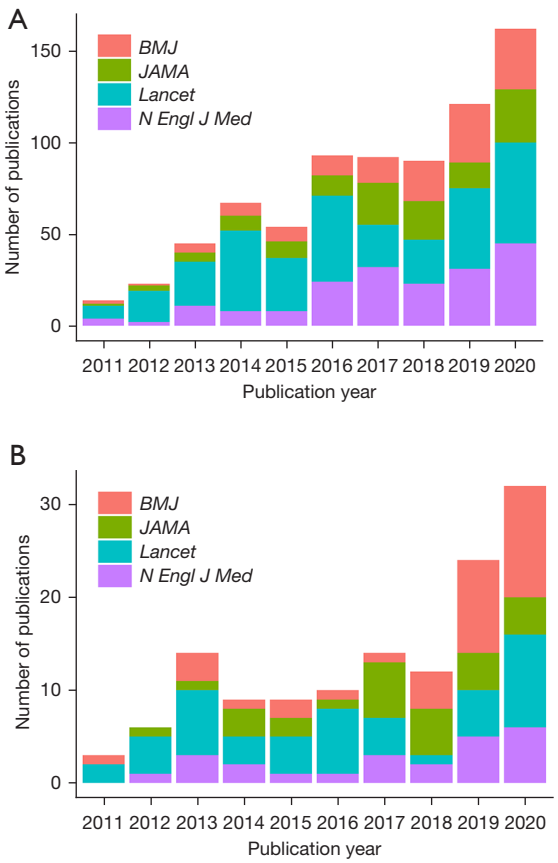

Figure 1 Publication numbers of Chinese scholars on the *NEJM*, *Lancet*, *JAMA*, and *BMJ* from 2011 to 2020. (A) Publications of Chinese scholars on the *NEJM*, *Lancet*, *JAMA*, and *BMJ* from 2011 to 2020 by publication year and journal. (B) Publications of Chinese scholars on the *NEJM*, *Lancet*, *JAMA*, and *BMJ* from 2011 to 2020 by publication year and journal, with only original research included. *NEJM*, *New England Journal of Medicine*; *JAMA*, *Journal of the American Medical Association*; *BMJ*, *British Medical Journal*.

studies [28/761 (3.67%)], case-control studies [17/761 (2.23%)], meta-analyses [24 (3.15%)], and others [7/761 (0.91%)] (P<0.001). Original research included RCTs, cross-sectional studies, cohort studies, and case-control studies, which only accounted for 133/761 (17.47%). The number of original research published in *BMJ*, *JAMA*, *Lancet*, and *NEJM* was 35/135 (25.92%), 27/124 (21.77%), 47/314 (14.96%), and 24/188 (12.76%), respectively (P=0.035). From 2011 to 2020, an overall upward trend was observed (*Figure 1A*). Specifically, only 14 articles were published in 2011, and the number of publications per year did not exceed 100 before 2018, while sharply reaching 121 in 2019 and 162 in 2020 (P<0.01). With the exclusive inclusion of original research, the number of published papers was also increasing annually (*Figure 1B*).

A total of 218/761 (28.64%) studies were funded, of which 81/218 (37.15%) were funded by the National Natural Science Foundation of China (NSFC). With the exclusive inclusion of original research, a total of 124/133 (93.23%) studies were funded, of which 45/33 (36.29%) were funded by the NSFC.

The median number of total authors, first authors, and corresponding authors was 3 (IQR, 2–6; range, 1–66), 1 (IQR, 1–1; range, 1–17), and 1 (IQR, 1–1; range, 1–4), respectively. There was no significant correlation between publication year and the number of total authors [correlation coefficient: 0.01 (95% CI: −0.06 to 0.07); P=0.798], and corresponding authors [correlation coefficient: −0.02 (95% CI: −0.09 to 0.04); P=0.482]. However, a significant positive correlation was observed between the publication year and the number of first authors [correlation coefficient: 0.10 (95% CI: 0.03–0.16); P=0.004]. With the exclusive inclusion of original research, the median numbers of total authors, first authors, and corresponding authors were 18 (IQR, 11–21; range, 2–66), 2 (IQR, 1–3; range, 1–17), and 1 (IQR, 1–2; range, 1–4), respectively. There was no significant correlation between publication year and the number of total authors [correlation coefficient: 0.12 (95% CI: −0.05 to 0.28); P=0.179], and first authors [correlation coefficient: −0.01 (95% CI: −0.08 to 0.05); P=0.646]. However, a significant positive correlation was noted between the publication year and the number of corresponding authors [correlation coefficient: 0.11 (95% CI: 0.04–0.18); P=0.001].

The median number of participating affiliations was 5 (IQR, 2–9; range, 1–46). There was a significant positive correlation between the publication year and the number of participating affiliations [correlation coefficient: 0.25 (95% CI: 0.08–0.40); P=0.003]. With the exclusive inclusion of original research, the median number of participating affiliations in the study was 1 (IQR, 1–3; range, 1–46). There was a significant positive correlation between the publication year and the number of participating affiliations [correlation coefficient: 0.11 (95% CI: 0.04–0.18); P=0.001). A total of 113 (14.84%) studies were multicenter-based, which increased to 90/133 (67.66%) with the exclusive inclusion of original research.

Subspecialty and subject

The top 10 subspecialties (*Figure 2A*) were infectious

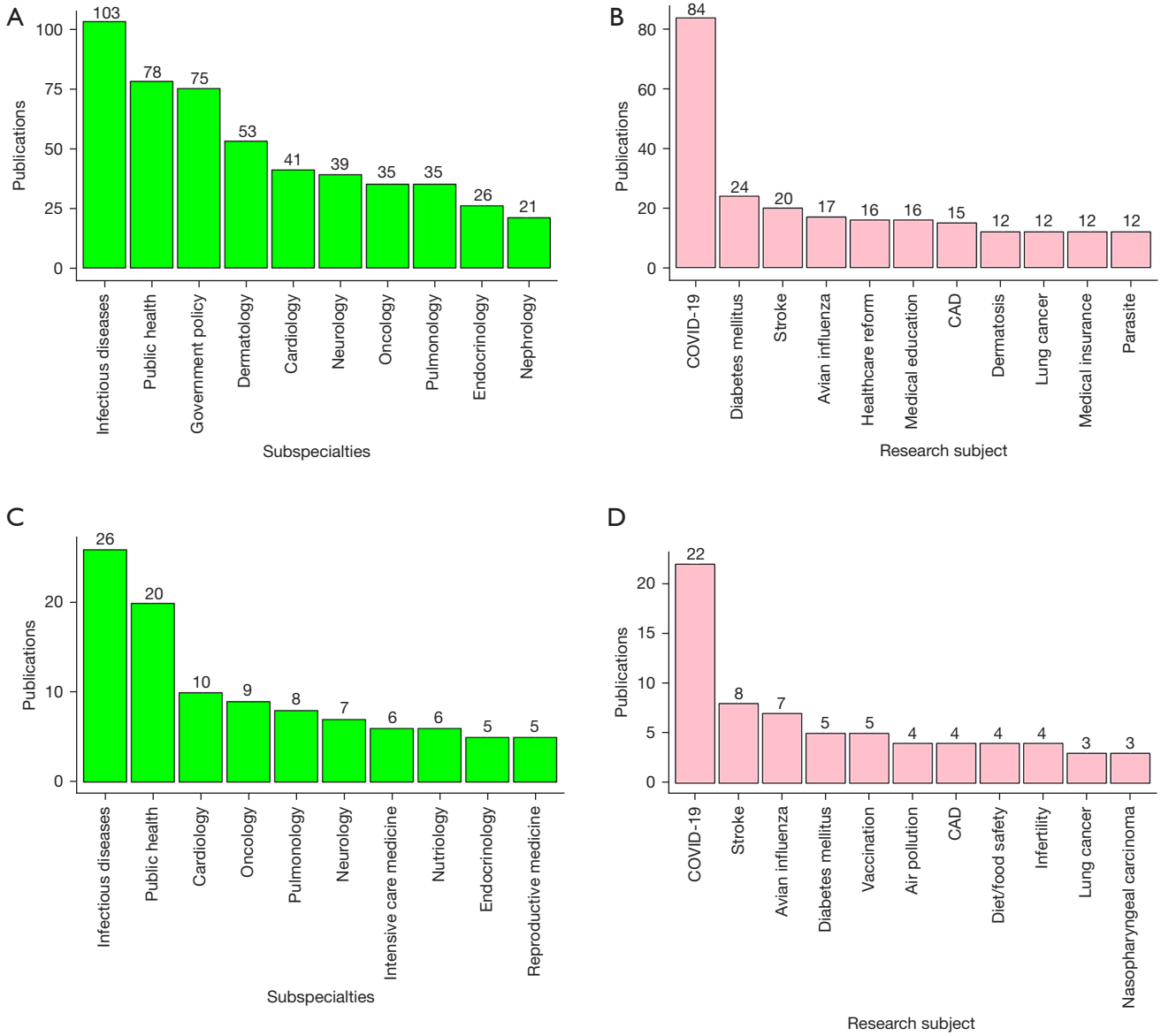

Figure 2 Publication classification and ranking of Chinese scholars on the *NEJM*, *Lancet*, *JAMA*, and *BMJ* from 2011 to 2020. (A) The top 10 subspecialties on the *NEJM*, *Lancet*, *JAMA*, and *BMJ* from 2011 to 2020 by Chinese scholars. (B) The top 10 subjects on the *NEJM*, *Lancet*, *JAMA*, and *BMJ* from 2011 to 2020 by Chinese scholars. (C) The top 10 subspecialties on the *NEJM*, *Lancet*, *JAMA*, and *BMJ* from 2011 to 2020 by Chinese scholars, with only original research included. (D) The top 10 subjects on the *NEJM*, *Lancet*, *JAMA*, and *BMJ* from 2011 to 2020 by Chinese scholars, with only original research included. CAD, coronary artery disease; *NEJM*, *New England Journal of Medicine; JAMA*, *Journal of the American Medical Association*; *BMJ*, *British Medical Journal*.

diseases (n=103), public health (n=78), government policy (n=75), dermatology (n=53), cardiology (n=41), neurology (n=39), oncology (n=35), pulmonology (n=35), endocrinology (n=26), and nephrology (n=21). Note that government policy was not a medical subspecialty strictly. However, the TFMJ seemed to pay much special attention to China's health policy and published numerous relevant comments. According to the subject of the research, the top 10 most popular ones (*Figure 2B*) were COVID-19 (n=84), diabetes mellitus (n=24), stroke (n=20), avian influenza (n=17), healthcare reform (n=16), medical education (n=16), coronary artery disease (n=15), dermatosis (n=12), lung

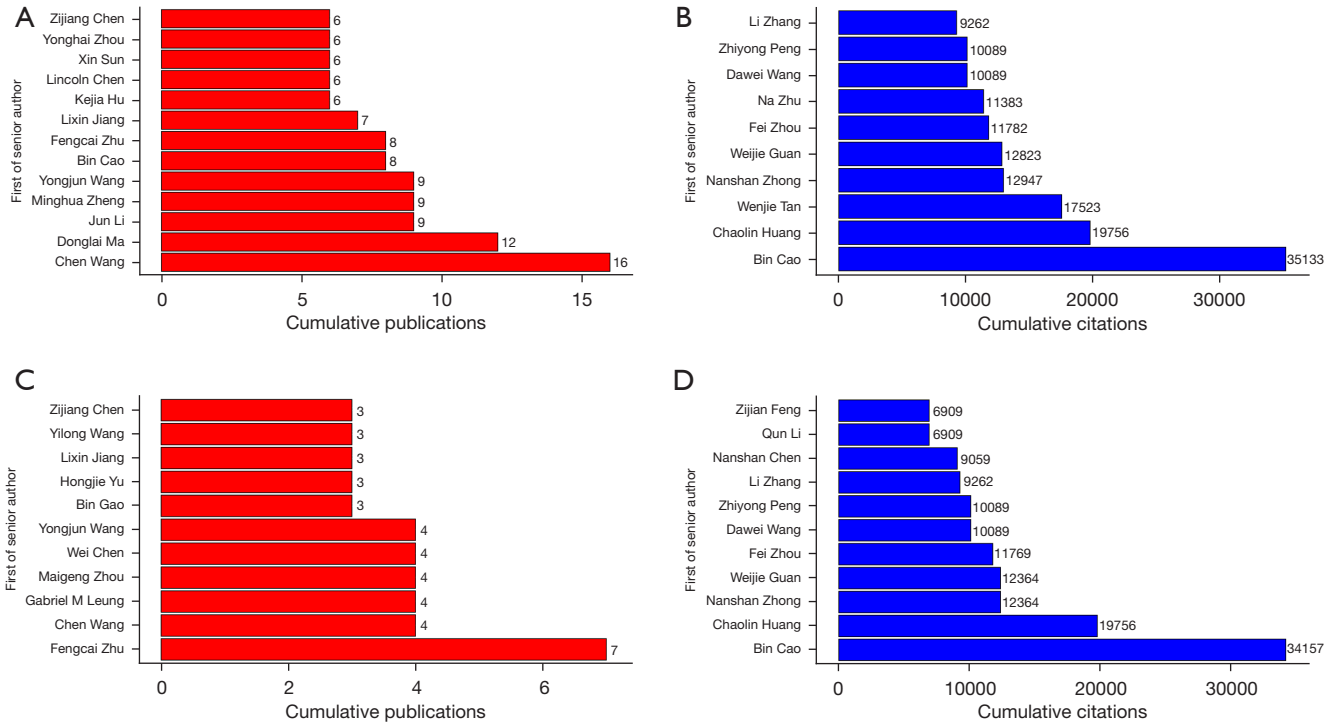

Figure 3 Top Chinese scholars on the *NEJM*, *Lancet*, *JAMA*, and *BMJ* from 2011 to 2020. (A) The top 10 Chinese researchers on the *NEJM*, *Lancet*, *JAMA*, and *BMJ* from 2011 to 2020 by publications. (B) The top 10 Chinese researchers on the *NEJM*, *Lancet*, *JAMA*, and *BMJ* from 2011 to 2020 by citations. (C) The top 10 Chinese researchers on the *NEJM*, *Lancet*, *JAMA*, and *BMJ* from 2011 to 2020 by publications, with only original research included. (D) The top 10 Chinese researchers on the *NEJM*, *Lancet*, *JAMA*, and *BMJ* from 2011 to 2020 by citations, with only original research included. *NEJM*, *New England Journal of Medicine*; *JAMA*, *Journal of the American Medical Association*; *BMJ*, *British Medical Journal*.

cancer (n=12), medical insurance (n=12), and parasite (n=12).

With the original research included exclusively, the top 10 subspecialties (*Figure 2C*) were infectious diseases (n=26), public health (n=20), cardiology (n=10), oncology (n=9), pulmonology (n=8), neurology (n=7), intensive care medicine (n=6), nutriology (n=6), endocrinology (n=5), and reproductive medicine (n=5). The top 10 most popular subjects (*Figure 2D*) were COVID-19 (n=22), stroke (n=8), avian influenza (n=7), diabetes mellitus (n=5), vaccination (n=5), air pollution (n=4), coronary artery disease (CAD) (n=4), diet/food safety (n=4), infertility (n=4), lung cancer (n=3), and nasopharyngeal carcinoma (n=3).

Individual researchers

The top 10 researchers regarding the number of publications (*Figure 3A*) were Chen Wang (n=16, Chinese Academy of Medical Sciences and Peking Union Medical College), Donglai Ma (n=12, Chinese Academy of Medical Sciences and Peking Union Medical College), Jun Li (n=9, Chinese Academy of Medical Sciences and Peking Union Medical College), Minghua Zheng (n=9, First Affiliated Hospital of Wenzhou Medical University), Yongjun Wang (n=9, Beijing Tiantan Hospital), Bin Cao (n=8, China-Japan Friendship Hospital), Fengcai Zhu (n=8, Jiangsu Provincial Center for Disease Control and Prevention), Lixin Jiang (n=7, Fuwai Hospital), Kejia Hu (n=6, Huashan Hospital), Lincoln Chen (n=6, China Medical Board, Cambridge, MA, USA), Xin Sun (n=6, West China Hospital), Yonghai Zhou (n=6, Second Affiliated Hospital and Yuying Children's Hospital of Wenzhou Medical University), and Zijiang Chen (n=6, Shandong Provincial Hospital). Specially, Lincoln Chen from the USA was listed because studies he supervised were first-authored by Chinese scholars. When it came to citations, the top 10 researchers (*Figure 3B*) were Bin Cao (n=35,133, China-Japan Friendship Hospital), Chaolin Huang (n=19,756, Jin Yin-tan Hospital), Wenjie Tan (n=17,523, Chinese Center for Disease Control and Prevention),

Nanshan Zhong (n=12,947, First Affiliated Hospital of Guangzhou Medical University), Weijie Guan (n=12,823, First Affiliated Hospital of Guangzhou Medical University), Fei Zhou (n=11,782, Chinese Academy of Medical Sciences and Peking Union Medical College), Na Zhu (n=11,383, Chinese Center for Disease Control and Prevention), Dawei Wang (n=10,089, Zhongnan Hospital of Wuhan University), Zhiyong Peng (n=10,089, Zhongnan Hospital of Wuhan University), and Li Zhang (n=9,262, Jin Yin-tan Hospital).

With the original research included exclusively, the top 10 researchers regarding the number of publications (*Figure 3C*) were Fengcai Zhu (n=7, Jiangsu Provincial Center for Disease Control and Prevention), Chen Wang (n=4, Chinese Academy of Medical Sciences and Peking Union Medical College), Gabriel M. Leung (n=4, Chinese University of Hong Kong), Maigeng Zhou (n=4, Chinese Center for Disease Control and Prevention), Wei Chen (n=4, Beijing Institute of Biotechnology and Academy of Military Medical Sciences), Yongjun Wang (n=4, Beijing Tiantan Hospital), Bin Cao (n=3, China-Japan Friendship Hospital), Hongjie Yu (n=3, Chinese Center for Disease Control and Prevention), Lixin Jiang (n=3, Fuwai Hospital), Yilong Wang (n=3, Beijing Tiantan Hospital), and Zijiang Chen (n=3, Shandong Provincial Hospital).

With the original research included exclusively, the top 10 researchers regarding the number of citations (*Figure 3D*) were Bin Cao (n=34,157, China-Japan Friendship Hospital), Chaolin Huang (n=19,756, Jin Yin-tan Hospital), Nanshan Zhong (n=12,364, First Affiliated Hospital of Guangzhou Medical University), Weijie Guan (n=12,364, First Affiliated Hospital of Guangzhou Medical University), Fei Zhou (n=11,769, Chinese Academy of Medical Sciences and Peking Union Medical College), Dawei Wang (n=10,089, Zhongnan Hospital of Wuhan University), Zhiyong Peng (n=10,089, Zhongnan Hospital of Wuhan University), Li Zhang (n=9,262, Jin Yin-tan Hospital), Nanshan Chen (n=9,059, Jin Yin-tan Hospital), Qun Li (n=6,909, Chinese Center for Disease Control and Prevention), and Zijian Feng (n=6,909, Chinese Center for Disease Control and Prevention).

Research institutes and geographical pattern

The top 10 research institutes or universities included Chinese Academy of Medical Sciences and Peking Union Medical College (n=79), Peking University (n=61), Hong Kong University (n=39), Capital Medical University (n=34), Shanghai Jiao Tong University (n=30), Fudan University (n=28), Central South University (n=26), Sun Yat-sen University (n=26), Zhejiang University (n=24), and Chinese Center for Disease Control and Prevention (n=23). With the original research included exclusively, the top 10 research institutes or universities included Chinese Center for Disease Control and Prevention (n=12), Peking University (n=12), Hong Kong University (n=11), Huazhong University of Science and Technology (n=11), Jiangsu Province Center for Disease Control and Prevention (n=8), Chinese Academy of Medical Sciences and Peking Union Medical College (n=7), Zhejiang University (n=7), Capital Medical University (n=6), Fudan University (n=6), Shanghai Jiao Tong University (n=6), and Sun Yat-sen University (n=5).

The top 10 hospitals included Peking Union Medical College Hospital (n=32), West China Hospital (n=16), Second Xiangya Hospital (n=13), Ruijin Hospital (n=12), China-Japan Friendship Hospital (n=11), First Hospital of China Medical University (n=11), Fuwai Hospital (n=11), Peking University First Hospital (n=11), Beijing Tiantan Hospital (n=10), and First Affiliated Hospital of Zhejiang University (n=9). Notably, Fuwai Hospital was the only specialized hospital on the list. With the original research included exclusively, the top 10 hospitals included Ruijin Hospital (n=5), Beijing Tiantan Hospital (n=4), Fuwai Hospital (n=4), Peking University First Hospital (n=4), First Affiliated Hospital of Zhejiang University (n=3), Sun Yat-sen University Cancer Center (n=3), Tongji Hospital (n=3), Chang Gung Memorial Hospital (n=2), China-Japan Friendship Hospital (n=2), Jin Yin-tan Hospital (n=2), Shandong Provincial Hospital (n=2), and West China Hospital (n=2).

From the perspective of geographical pattern, the most productive institutions were concentrated in the eastern China (*Figure 4A*,*4B*), especially in the central and south China. The top 10 cities were Beijing (n=239), Shanghai (n=88), Hong Kong (n=67), Guangzhou (n=49), Wuhan (n=33), Changsha (n=26), Hangzhou (n=24), Chengdu (n=22), Nanjing (n=20), and Jinan (n=17). With the original research included exclusively, the top 10 cities included Beijing (n=45), Shanghai (n=15), Hong Kong (n=14), Wuhan (n=13), Guangzhou (n=11), Nanjing (n=8), Hangzhou (n=7), Jinan (n=3), Chengdu (n=2), Shenyang (n=2), and Taiwan (n=2).

Hot studies

Table 1 shows the top 10 most cited articles (4-13), all of which are related to COVID-19. It ranked first in terms of

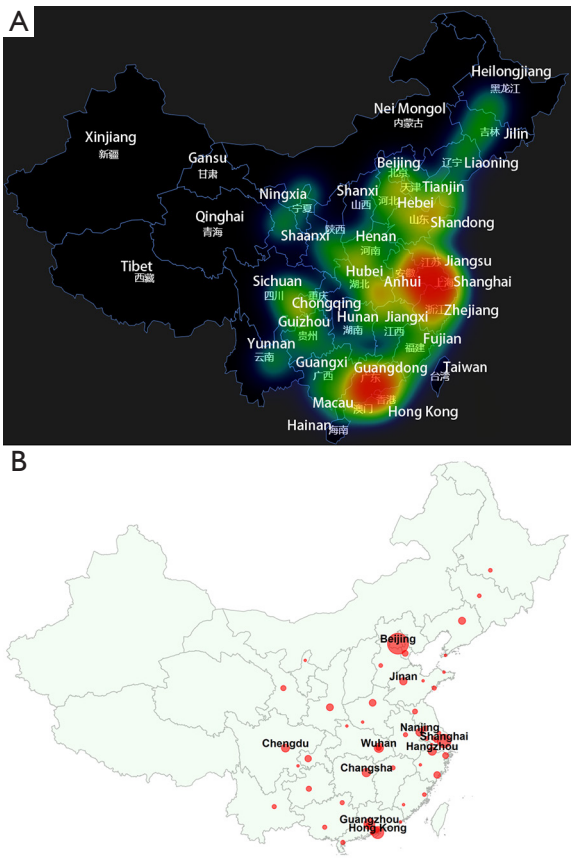

Figure 4 The geographical pattern of the publications of Chinese scholars on the *NEJM*, *Lancet*, *JAMA*, and *BMJ* from 2011 to 2020. (A) Heat map of Chinese publications on the *NEJM*, *Lancet*, *JAMA*, and *BMJ* from 2011 to 2020. (B) Map showing the top 10 cities of China publishing on the *NEJM*, *Lancet*, *JAMA*, and *BMJ* from 2011 to 2020. Please note that we are fully aware of and respect the territorial integrity of China. To highlight the main subject, the latitude and longitude have been intercepted, resulting in a seemingly incomplete map of China. *NEJM*, *New England Journal of Medicine*; *JAMA*, *Journal of the American Medical Association*; *BMJ*, *British Medical Journal*.

citation that "*Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China*". The top 10 most cited articles irrelevant to COVID-19 were shown in *Table 2* (14-23), in which the first rank belongs to "*Prevalence and control of diabetes in Chinese adults*".

Discussion

The TFMJ are leading medical journals with a high academic influence. Through analyzing the papers published by Chinese scholars in the TFMJ from 2011 to 2020 with bibliometric methodology, the present study helps to understand the current situation of high-quality medical researchers in China.

An upward trend of publications in the TFMJ by Chinese scholars was observed (*Figure 1A*). In 2011, only 14 articles were published, and it did not exceed 100 before 2018, while reached 121 in 2019 and 162 in 2020 sharply (P<0.01). However, we must admit that there was still a big gap between China and developed countries such as the United States. Of note, the total number of articles published in the TFMJ by Chinese scholars was very small, which did not match the surprising number of the total SCI-indexed publications. The number of articles published by Chinese scholars in the TFMJ was *BMJ* of 135/29,942 (0.45%), *JAMA* of 124/14,033 (0.88%), *Lancet* of 314/16,117 (1.94%), and *NEJM* of 188/15,242 (1.23%), respectively (P<0.001), none of which exceeds 2%. Besides, the letter was the main research type, which was up to 44.54%, with the original research only accounting for 17.47%. The length of the letter is short and it does not have to be very formal with data and statistics, making it much easier to write than original research. Funding is usually not required. And the letter is typically supervised directly by the editor without external review, allowing for faster publication with a relatively low publication threshold. The journals also seem to have enough motivation to publish the letter. The number of the letters indicates to a certain extent the popularity of a journal. Importantly, for the calculation of IF, the letter can add citations to the nominator but not counted as "citable" in the denominator, driving up the IF (24). To evaluate the academic level, the letter appears to be less significant. Therefore, we conducted a subgroup analysis that included only the original research.

Scientific research is inseparable from financial support, which is especially true for high-level research in the TFMJ. With the original research included exclusively, a total of 124/133 (93.23%) studies were funded, of which 45/133 (36.29%) received funding from the NSFC. China is known for its enthusiasm for scientific research and huge financial investment (25). The State Council approved the establishment of the NSFC in 1986. For more than 30 years, the NSFC has markedly participated in promoting the development of basic research, discovering and cultivating outstanding scientific and technological researchers. Although the research published in the TFMJ

Table 1 The top 10 most cited studies

PMID	Title	Citations	Publication year	Journal	First author	Senior author	First affiliation	NSFC funded
31986264	*Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China*	19,756	2020	*Lancet*	Chaolin Huang	Bin Cao	Huazhong University of Science and Technology	1
32109013	*Clinical Characteristics of Coronavirus Disease 2019 in China*	12,364	2020	*NEJM*	Weijie Guan	Nanshan Zhong	Guangzhou Medical University	1
32171076	*Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study*	11,769	2020	*Lancet*	Fei Zhou	Bin Cao	Chinese Academy of Medical Sciences and Peking Union Medical College	0
31978945	*A Novel Coronavirus from Patients with Pneumonia in China, 2019*	11,383	2020	*NEJM*	Na Zhu	Wenjie Tan	Chinese Center for Disease Control and Prevention	0
32031570	*Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China*	10,089	2020	*JAMA*	Dawei Wang	Zhiyong Peng	Wuhan University	1
32007143	*Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study*	9,059	2020	*Lancet*	Nanshan Chen	Li Zhang	Huazhong University of Science and Technology	0
32091533	*Characteristics of and Important Lessons From the Coronavirus Disease 2019 (COVID-19) Outbreak in China: Summary of a Report of 72 314 Cases From the Chinese Center for Disease Control and Prevention*	7,652	2020	*JAMA*	Zunyou Wu	Jennifer M. McGoogan	Chinese Center for Disease Control and Prevention	0
31995857	*Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus-Infected Pneumonia*	6,909	2020	*NEJM*	Qun Li	Zijian Feng	Chinese Center for Disease Control and Prevention	1
32007145	*Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding*	4,923	2020	*Lancet*	Roujian Lu	Wenjie Tan	Chinese Center for Disease Control and Prevention	0
31986261	*A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster*	4,308	2020	*Lancet*	Jasper Fuk-Woo Chan	KwokYung Yuen	Hong Kong University	0

NEJM, *New England Journal of Medicine*; *JAMA*, *Journal of the American Medical Association*; *BMJ*, *British Medical Journal*; NSFC, National Natural Science Foundation of China.

were mainly clinical studies, a large number of them were funded by the NSFC. It could reflect the developing trend of translational medicine (from basic research to bedside application) to a certain extent.

The most popular subspecialty and subject were infectious diseases (n=103), and COVID-19 (n=84), respectively. The top 10 most cited articles were all related to COVID-19, which has caused lots of disturbance and anxiety so far.

Table 2 The top 10 most cited studies excluding COVID-19

PMID	Title	Citations	Publication year	Journal	First author	Senior author	First affiliation	NSFC funded
24002281	*Prevalence and control of diabetes in Chinese adults*	1,706	2013	*JAMA*	Yu Xu	Guang Ning	Shanghai Jiao Tong University	1
23577628	*Human infection with a novel avian-origin influenza A (H7N9) virus*	1,677	2013	*NEJM*	Rongbao Gao	Yuelong Shu	National Institute for Viral Disease Control and Prevention	1
27959700	*Osimertinib or Platinum-Pemetrexed in EGFR T790M-Positive Lung Cancer*	1,391	2017	*NEJM*	Tony S. Mok	Vassiliki A. Papadimitrakopoulou	The Chinese University of Hong Kong	0
23746901	*Rapid health transition in China, 1990-2010: findings from the Global Burden of Disease Study 2010*	1,128	2013	*Lancet*	Gonghuan Yang	Christopher J. L. Murray	Chinese Academy of Medical Sciences and Peking Union Medical College	0
22386035	*Prevalence of chronic kidney disease in China: a cross-sectional survey*	990	2012	*Lancet*	Luxia Zhang	Haiyan Wang	Peking University	1
21410387	*Fever with thrombocytopenia associated with a novel bunyavirus in China*	869	2011	*NEJM*	Xuejie Yu	Dexin Li	Chinese Center for Disease Control and Prevention	0
25073782	*Fruit and vegetable consumption and mortality from all causes, cardiovascular disease, and cancer: systematic review and dose-response meta-analysis of prospective cohort studies*	822	2014	*BMJ*	Xia Wang	Frank B. Hu	Shandong University	1
23803136	*Clopidogrel with aspirin in acute minor stroke or transient ischemic attack*	798	2013	*NEJM*	Yongjun Wang	S. Claiborne Johnston	Capital Medical University	1
28655017	*Prevalence and Ethnic Pattern of Diabetes and Prediabetes in China in 2013*	761	2017	*JAMA*	Limin Wang	Linhong Wang	Chinese Center for Disease Control and Prevention	1
26510778	*Cause-specific mortality for 240 causes in China during 1990-2013: a systematic subnational analysis for the Global Burden of Disease Study 2013*	644	2016	*Lancet*	Maigeng Zhou	Xiaofeng Liang	Chinese Center for Disease Control and Prevention	0

NEJM, *New England Journal of Medicine*; *JAMA*, *Journal of the American Medical Association*; *BMJ*, *British Medical Journal*; NSFC, National Natural Science Foundation of China.

Chinese scientists should be acknowledged for announcing their clinical experience and scientific research results related to COVID-19 to the world in the early phase, providing strong theoretical support for other countries to make timely and effective responses. Apart from the COVID-19, the epidemiological data of chronic diseases, such as diabetes also received a high rate of citation. On the one hand, it shows that several research works conducted by Chinese

scholars have been widely recognized. On the other hand, we should pay further attention to more groundbreaking work such as novel treatment in addition to epidemiological data collection and analysis.

Another noteworthy discovery of the present study lies in the extreme imbalance between regions of scientific research development, the so-called Matthew effect. Eastern coastal cities such as Shanghai and Guangzhou have an absolute advantage regarding both the total number of publications and the number of centers capable of performing world-class research to publish in the TFMJ. This kind of Matthew effect in scientific research is supposed to be highly related to China's economic policies. As mentioned above, scientific research is inseparable from financial support. As Xiaoping Deng once put it, "*Some people and some regions are allowed and supported to get rich first, and we encourage those 'early birds' to help the lagging behind*". Indeed, the coastal areas have taken the lead in economic development, promoting scientific research as a result. These are higher-income regions with larger, more highly-ranked and better-funded hospitals/institutions. To overcome the disadvantages of imbalanced development, China has successively put forward strategies including "*western (Region) Development*" and "*Promoting the rise of the central region*". As shown in *Figure 4A*,*4B*, Chengdu (a western city) and Wuhan (a central city) have also made certain achievements in publishing in the TFMJ. While further consolidating the scientific research capability of eastern regions, we hope that the central and western regions can make greater progress and improvement.

The most productive Chinese scholar in the TFMJ (*Figure 3A*) was Chen Wang (n=16, Chinese Academy of Medical Sciences and Peking Union Medical College) with all the studies included, and Fengcai Zhu (n=7, Jiangsu Provincial Center for Disease Control and Prevention) with the original research included exclusively. The most cited Chinese scholar in the TFMJ (*Figure 3B*) was Bin Cao (n=35,133, China-Japan Friendship Hospital) either with the full data or original research. The most productive institute or university was Chinese Academy of Medical Sciences and Peking Union Medical College (n=79) with all the studies included. It turned out to be Chinese Center for Disease Control and Prevention (n=12) and Peking University (n=12) with the original research included exclusively. The most productive hospital was Peking Union Medical College Hospital (n=32), and Ruijin Hospital (n=5) with the original research included exclusively. The lists we provided were noticeably consistent with those by Hospital Management Institute of Fudan University Hospital (26). Again, it indicates the Matthew effect of China's scientific research, with the best resources centered in a few top hospitals.

Study limitations

This study had some limitations. Due to the typesetting of some journals, the information of affiliation had to be extracted manually, which might result in some minor inaccuracies. COVID-19 bears many other names, especially at the early stage of the research, such as 2019-nCoV (Novel Coronavirus), coronavirus, Coronavirus, SARS-CoV-2 (severe acute respiratory syndrome coronavirus-2), etc., not to mention the letter case. It increases the difficulty of information extraction and integration. The same problem applies to inconsistencies in affiliation naming. In addition, due to the nature of Chinese names, the name repeating phenomenon is not rare. However, these deficiencies are believed to be not enough to impact the stability of the analysis as a whole. Finally, as an important index, citation frequency is greatly affected by time, and the influence of time cannot be taken into account for some recent studies.

Conclusions

The presence of Chinese scholars in the TFMJ has increased, but there is still much room for growth. The publications are mainly the letters, dwarfing the original research. Funding agencies, such as NSFC, have become an important support for high-level research. The most popular research was the epidemiological study of infectious diseases and chronic diseases. There is a Matthew effect in China's high-level scientific research, with the best resources centered in a few top hospitals.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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