

Changes and Analysis of Research Collaboration Before and After Funding from the Changjiang Scholars Program: A Case Study of 2005 Changjiang Scholars (Postprint)

Authors: Liu Xiaojuan, Yu Mengxia, Zhao Zhuojing, Wei Yu

Date: 2023-04-01T16:15:49+00:00

Abstract

[Purpose/Significance] Scientific collaboration has become a ubiquitous phenomenon, and many research programs have incorporated teamwork into their evaluation criteria for implementation effectiveness. This study examines, from the perspective of scientific collaboration, whether the collaboration patterns of Changjiang Scholars change after receiving funding, and investigates the roles they play in team building, international and domestic cooperation, thereby contributing to the evaluation of project implementation effectiveness and promoting the sustainable development of talent programs. [Method/Process] Taking the 2005 Changjiang Scholars Distinguished Professors as a case study, we collected personal information of 83 Changjiang Scholars and all their SCI/SSCI publications from 1996-2015. Two time windows were defined: the 10-year period before receiving the Changjiang Scholar title (1996-2005, referred to as the pre-award decade) and the 10-year period after (2006-2015, referred to as the post-award decade). The Wilcoxon signed-rank test was employed to analyze changes in scientific collaboration before and after receiving the title, including variations in collaboration network size, collaboration intensity, collaboration sustainability, role undertaken in collaborations, and international and domestic cooperation. [Results/Conclusion] The findings reveal that Changjiang Scholars played a leading academic role in the post-award decade, exerting significant influence in team building and international and domestic cooperation. During this period, both the scientific collaboration network size (42 vs. 148) and collaboration intensity (2.17 vs. 2.45) increased significantly. However, the duration of collaboration with individual collaborators remained predominantly short both before and after receiving the title, with nearly 70% of collaborations lasting only one year. The role undertaken by Changjiang Scholars in collaborations changed significantly, showing a post-award preference for serving as last author

(96%) and corresponding author (84%) rather than first author.

Full Text

Preamble

Volume 64, Issue 3, February 2020

Changes and Analysis of Scientific Research Cooperation Before and After Receiving the Cheung Kong Scholars Award: A Case Study of 2005 Cheung Kong Scholars

Liu Xiaojuan, Yu Mengxia, Zhao Zhuojing, Wei Yu

School of Government, Beijing Normal University, Beijing 100875

Abstract: [Purpose/Significance] Scientific research cooperation has become a widespread phenomenon, and many research projects have incorporated teamwork into their evaluation of implementation effectiveness. This study analyzes whether the research cooperation patterns of Cheung Kong Scholars change after receiving the award, examining their roles in team building and international/domestic collaboration. This perspective contributes to evaluating project implementation effectiveness and promoting sustainable development of talent programs. [Method/Process] Taking the 2005 Cheung Kong Scholars as examples, we collected personal information for 83 scholars and all their SCI/SSCI publications from 1996-2015. Two time windows were established: the 10 years before receiving the award (1996-2005, referred to as the pre-award period) and the 10 years after (2006-2015, referred to as the post-award period). Using the Wilcoxon signed-rank test, we analyzed changes in research cooperation before and after the award, including network size, cooperation intensity, collaboration duration, authorship roles, and international/domestic collaboration patterns. [Result/Conclusion] The findings reveal that Cheung Kong Scholars played leading academic roles in the decade following their award, demonstrating significant impact in team building and international/domestic cooperation. In the post-award period, both cooperation network size (42 vs. 148) and cooperation intensity (2.17 vs. 2.45) increased significantly. However, collaboration duration remained short, with nearly 70% of collaborations lasting only one year. Scholars' authorship roles changed significantly, with a post-award preference for last author (96%) and corresponding author (84%) positions over first author.

Keywords: Cheung Kong Scholars; research cooperation; cooperation role; international collaboration

Classification Number: G250

DOI: 10.13266/j.issn.0252-3116.2020.03.011

Talent constitutes the backbone of social development, with high-level talents

who possess profound expertise or high prestige in specific disciplines playing particularly important roles in economic and social development as well as scientific and technological innovation. The Cheung Kong Scholars Award, jointly established by the Ministry of Education of the People's Republic of China and the Li Ka Shing Foundation in 1998, represents a high-level talent program designed to select and cultivate academic leaders with internationally competitive expertise while maximizing their academic impact, expanding international cooperation, and driving team building. As a leading initiative in China's higher education talent development system, the Cheung Kong Scholars Program represents an essential component of the national talent strategy in higher education.

Evaluating the implementation effectiveness of this important talent program is both necessary and critical, requiring consideration of multiple influencing factors. Recent research has approached this from macro-level perspectives using surveys and field visits to investigate policy implementation, benefits, impacts, and talent satisfaction, while micro-level studies have employed bibliometric and curriculum vitae analysis to compare changes in research output, academic influence, and academic development before and after funding. Despite these advances, evaluation perspectives and methods for major talent programs require continuous refinement, with research cooperation representing an important lens for assessing implementation effectiveness. Most studies demonstrate that collaboration promotes productivity and efficiency, and analyzing changes in Cheung Kong Scholars' cooperation patterns can reveal their roles in team building and international/domestic collaboration, thereby contributing to program evaluation.

2 Related Research

Current domestic academic research on Cheung Kong Scholars primarily focuses on group characteristics, including gender, geography, discipline, and educational background distributions. Wang et al. analyzed Cheung Kong Scholars in humanities and social sciences, finding fewer female elites, significant regional disparities, obvious talent agglomeration effects, and longer growth cycles. Niu et al. examined social characteristics of recipients from three major high-level talent programs, including gender ratios, selection age, geographic location, career status, and interconnections. Zhang et al. found that agricultural universities had fewer Cheung Kong Scholars with gender imbalances, age structure mismatches, and uneven east-west distributions. Other studies have explored scholars' growth trajectories and mobility patterns, revealing that international education backgrounds, continuous doctoral training, and interdisciplinary education models accelerate top talent development, while also identifying structural imbalances in inter-organizational mobility.

Research cooperation has become ubiquitous, driven by interdisciplinary trends, research complexity, and expensive equipment requirements. Most studies confirm positive relationships between collaboration and scientific productivity. Price and Beaver found significant correlations between productivity and co-

author numbers. Zuckerman's interviews with Nobel laureates established close links between collaboration and productivity. Chen et al. observed that research cooperation occurs more frequently among prestigious institutions and developed countries, creating virtuous cycles that expand knowledge production advantages. However, some researchers note potential negative effects, with Landry et al. arguing that collaboration inevitably incurs transaction costs in time and energy, while Chen et al. found that countries with lower scientific productivity paradoxically show higher rates of international collaboration.

Various metrics have been proposed to evaluate scientific collaborations, including Petersen's measures of collaboration duration and intensity, and Bu et al.'s indicators of collaboration persistence and stability. Studies of high-level talent programs have primarily focused on Nobel laureates, with some examining Howard Hughes Awards and Fields Medal recipients. Zuckerman explored productivity, cooperation, and authorship patterns among Nobel Prize winners. Chan et al. found Nobel laureates remain loyal to pre-award collaborators. Wagner et al. discovered significant increases in average co-authors per paper after receiving the award, with a temporary surge in solo-authored review articles that quickly returned to pre-award levels.

In summary, while research on Cheung Kong Scholars' characteristics is extensive, post-award evaluation requires deeper investigation. Although research cooperation studies are well-developed with multiple quantifiable indicators, few have examined the Cheung Kong Scholars Program from this perspective. This study quantitatively analyzes changes in award recipients' research cooperation before and after selection, including co-author numbers, output per collaborator, average collaboration duration, authorship positions, and international/domestic collaboration patterns, thereby reflecting the program's role in driving domestic scholar development and expanding international cooperation.

3 Research Object and Data

3.1 Research Object

The Cheung Kong Scholars Program operates on a position appointment system, with universities establishing positions for Distinguished Professors, Chair Professors, and Young Scholars through open domestic and international recruitment. By the 2017 award cycle, the program had recognized over 2,000 Distinguished Professors, nearly 1,000 Chair Professors, and more than 700 Young Scholars.

This study examines the 2005 Cheung Kong Distinguished Professors, analyzing their SCI/SSCI publications from 1996-2015 to compare cooperation patterns in the decades before and after receiving the award. Among 102 Distinguished Professors selected in 2005, this study focuses on 83 scholars from natural sciences (28, 34%), engineering (41, 49%), agricultural sciences (3, 4%), and medical sciences (11, 13%), excluding humanities and social sciences due to disciplinary differences. The sample includes 79 males and 4 females, with average and me-

dian appointment age of 42 years ($SD=3.5$). Age distribution was concentrated: 5 scholars aged 31-35, 19 aged 36-40, 50 aged 41-45, and 9 aged 46-49, reflecting the program's age restrictions. Further analysis revealed that 78 scholars (94%) had already established research careers by 1996 (58 had earned doctorates by 1996; the remaining 20 had stable SCI/SSCI publication records, with at least 8 already holding lecturer, associate professor, or professor positions), while the other 5 began only 1-2 years later. This confirms minimal variation in research career stages and validates the 10-year pre/post comparison windows.

3.2 Dataset Construction

Based on the 2005 Cheung Kong Scholars list, we collected personal information for 83 scholars including name, gender, birth year, institution, position, and research field. Using name-institution combined queries, we retrieved all SCI/SSCI publication records from Web of Science for 1996-2015 (retrieval date: June 2016). Due to name ambiguity and diverse English expressions, automated data collection proved incomplete, necessitating nearly 5 months of manual screening by three researchers to ensure accuracy.

The final dataset includes basic information for 83 scholars and 11,522 papers: 2,515 from the pre-award decade and 9,007 from the post-award decade, increasing per capita output from 30 to 109 papers. Only 125 papers were single-authored (59 pre-award, 66 post-award), yielding a 98.92% co-authorship rate (97.66% pre-award, 99.27% post-award). Average co-authors per paper increased from 4.88 to 6.10, and per-scholar median co-authors rose from 4.28 to 5.43 ($P=0.000^*$), as shown in Table 2 .

Collaborators were defined as anyone co-authoring at least one paper with a Cheung Kong Scholar (all authors except the scholar themselves). This produced 20,399 unique collaboration pairs totaling 57,272 collaboration instances, calculated using full counting where all collaborators receive equal weight regardless of authorship order.

4 Indicators and Methods

4.1 Indicator Definitions

This study employs two 10-year windows: pre-award (1996-2005) and post-award (2006-2015). For each scholar, we calculated cooperation network size, cooperation intensity, collaboration duration, authorship roles, international influence, and domestic team building metrics. Except for authorship role calculations, all metrics were computed at the collaboration-pair level, treating each scholar-collaborator combination as one partnership.

Table 3 summarizes the indicators:

- **Cooperation Network Size (n_1, n_2):** Number of unique collaborators in pre/post periods

- **Cooperation Intensity** (S_i , S_{ij}): Average papers co-authored per collaborator, where S_i represents papers with collaborator i
- **Collaboration Duration** (L_i , L_{ij}): Average collaboration length per partner, measured as years between first and last co-authored paper within the window
- **First Author Metrics** (FA_i , FA_{ij}): Count and proportion of first-author papers
- **Corresponding Author Metrics** (CA_i , CA_{ij}): Count and proportion of corresponding-author papers (if a scholar is both corresponding and last author, only counted as corresponding)
- **Last Author Metrics** (LA_i , LA_{ij}): Count and proportion of last-author papers
- **Leadership Role Metrics** ($FCLA_i$, $FCLA_{ij}$): Count and proportion of papers as first OR corresponding OR last author
- **International Influence**: Number of cooperating countries (C_1 , C_2) and collaboration frequency/proportion with each country
- **Domestic Team Building**: Number of domestic collaborators (M_1 , M_2), domestic collaboration frequency/proportion, intra-institutional collaboration frequency/proportion, and collaboration degree with the appointment institution

The appointment institution refers to the scholar's 2005 award-affiliated university.

4.2 Research Methods

Bibliometric and citation data typically follow skewed distributions. Therefore, this study employs the non-parametric Wilcoxon signed-rank test to examine differences in publication and citation data between pre-award and post-award periods. This test is suitable for paired comparisons without requiring normally distributed differences and without assumptions about population distribution.

5 Research Results

5.1 Cooperation Overview

5.1.1 Changes in Cooperation Network Size and Intensity All 83 Cheung Kong Scholars expanded their cooperation networks after receiving the award. Wilcoxon test results confirm significant network expansion ($P=0.000^*$), with median collaborators increasing from 42 pre-award to 148 post-award (Table 4). Only two scholars experienced network contraction (by 18 and 19 collaborators). For 53 scholars (64%), network growth ranged 0-150 collaborators; two scholars increased networks by over 500 (from 183 to 1,058 and from 3 to 604 collaborators).

Fifty-three scholars (64%) increased cooperation intensity post-award, with Wilcoxon tests showing significant increases ($P=0.000^*$), rising from median

2.17 to 2.45 papers per collaborator (Table 4). Thirty scholars experienced decreased intensity. For 49 scholars (59%), intensity increased, with most changes ranging 0-2 additional papers per collaborator; only one scholar's intensity increased by more than 3 (from 3.44 to 8.47).

5.1.2 Changes in Collaboration Duration Overall, 66.2% of all collaborations lasted only one year, representing extremely weak ties; 9.93% lasted two years and 6.66% lasted three years. Figure 1 [Figure 1: see original paper] shows that while post-award collaboration counts increased across all duration categories, the proportional distribution remained nearly identical, with approximately 70% of collaborations lasting only one year. At the individual level, 58 scholars (70%) increased their average collaboration duration, with Wilcoxon tests indicating significant differences ($P=0.000$), rising from median 1.75 to 2.0 years (Table 4).

5.2 Authorship Roles

Between 1996-2015, the 83 scholars published 11,522 papers, with 11,397 (98.92%) co-authored. As first authors, they published 1,142 papers (703 pre-award, 439 post-award), representing 9.91% of total output. As corresponding authors, they published 3,997 papers (950 pre-award, 3,047 post-award), accounting for 34.69%. As last authors, they published 3,183 papers (382 pre-award, 2,801 post-award), representing 27.63%. As first OR corresponding OR last authors, they published 7,486 papers (1,533 pre-award, 5,953 post-award), comprising 64.97% of total output.

Figures 2 [Figure 2: see original paper] and 3 [Figure 3: see original paper] compare authorship patterns between periods. Figure 2(a) shows 52 scholars (63%) published fewer first-author papers post-award. Figures 2(b) and 2(c) indicate most scholars preferred corresponding author and last author roles after receiving the award. Figure 2(d) reveals 75 scholars (90%) increased their total papers as first/corresponding/last author post-award.

Table 5 presents Wilcoxon test results showing significant differences in authorship roles. First-author papers decreased significantly from median 8 to 3. Corresponding-author papers increased from median 8 to 23. Last-author papers increased from median 2 to 22. First/corresponding/last author papers increased from median 16 to 52. First-author proportion decreased significantly from median 25.00% to 4.17%. Last-author proportion increased significantly from median 10.64% to 25.15%. Corresponding-author proportion showed no significant difference (40.00% vs. 30.77%). The proportion of first/corresponding/last author papers also showed no significant difference (65.12% vs. 66.91%).

5.3 International Influence

The scholars' primary cooperating countries remained relatively stable, but the number of partner countries increased from 34 pre-award to 57 post-award, indicating expanded international cooperation. Major collaborations concentrated in developed countries/regions including the United States, Japan, and Canada, with lower cooperation rates with other nations (Figure 4 [Figure 4: see original paper]). However, domestic collaboration remained dominant, increasing from 50% to 80% of total cooperation, while U.S. collaboration represented only 22% and 11% in respective periods, demonstrating that Cheung Kong Scholars promoted domestic scholar development while expanding international reach.

5.4 Domestic Team Building

Using full counting methods, we analyzed domestic collaborator numbers, domestic collaboration frequency, domestic collaboration proportions, and institutional distribution patterns.

Figure 5 [Figure 5: see original paper] shows 82 scholars (99%) increased domestic collaborator numbers post-award, with Wilcoxon tests confirming significant expansion ($P=0.000^*$), growing from median 13 to 112 domestic collaborators.

Figure 6 [Figure 6: see original paper] illustrates changes in domestic collaboration frequency and proportion. In terms of quantity (Figure 6(a)), 82 scholars (99%) increased domestic collaboration counts post-award. In terms of proportion (Figure 6(b)), 67 scholars (81%) increased their domestic collaboration share, with the group median rising from 59% pre-award to 89% post-award.

Figure 7 [Figure 7: see original paper] shows intra-institutional versus inter-institutional collaboration patterns. Post-award intra-institutional collaboration increased from 26% to 36%, while inter-institutional collaboration remained dominant. Pre-award collaborating institutions totaled approximately 370 (about 110 domestic), increasing to approximately 1,600 post-award (about 760 domestic).

The scholars' impact on their appointment institutions is crucial. Figure 8 [Figure 8: see original paper] shows collaboration degree with appointment institutions (2005 award-affiliated universities) over time. Scholars strengthened institutional collaboration before receiving the award, establishing foundations for their appointments. Post-award collaboration remained stable at approximately 60%.

Figure 9 [Figure 9: see original paper] displays individual changes in institutional collaboration. Seventy-five percent of scholars (62) strengthened institutional ties post-award. The 25% (21) showing decreased proportions may reflect expanded external collaboration rather than reduced institutional collaboration; only 4 of these 21 scholars changed institutions post-award. Overall, 66 scholars (79.52%) remained at their appointment institutions after the award period,

while 17 (20.48%) changed institutions at an average age of 48, averaging 6 years post-award.

6 Summary and Discussion

This study examined 2005 Cheung Kong Distinguished Professors, analyzing changes in research cooperation from four dimensions: cooperation overview (network size, intensity, duration), authorship roles, international influence, and domestic team building. Overall, Cheung Kong Scholars significantly increased per-paper co-authors post-award, making collaboration more prevalent—consistent with Wagner et al.’s findings on Nobel laureates. Scholars demonstrated significant leadership in team building and international/domestic cooperation.

Key findings include:

1. **Network Expansion:** Significant increase in cooperation networks (42 to 148 collaborators) and cooperation intensity (2.17 to 2.45 papers per collaborator) in the post-award decade.
2. **Short Collaboration Duration:** Approximately 70% of collaborations lasted only one year in both periods, though a minority persisted longer—warranting future investigation.
3. **Authorship Role Shifts:** Significant changes in authorship patterns, with post-award preference for last author (96%) and corresponding author (84%) over first author (37%). This aligns with expected career-stage responsibilities, though the impact on research development merits further interview-based study.
4. **International Expansion:** Cooperation countries increased from 34 to 57, primarily with developed nations (U.S., Japan, Canada), while domestic collaboration remained dominant at 80%.
5. **Domestic Team Building:** Post-award domestic collaboration proportion increased from 50% to 80%; domestic networks expanded significantly (13 to 112 collaborators); 99% of scholars increased domestic collaboration frequency; individual domestic collaboration proportions rose from median 59% to 89%; institutional collaboration remained stable at approximately 60%, with 75% of scholars strengthening institutional ties.

The Cheung Kong Scholars Program fundamentally aims to enhance China’s research strength. After more than 20 years, it has undoubtedly created a mutually beneficial situation for research development and talent cultivation. However, concerns about “emphasizing selection over evaluation” highlight the need for systematic post-award assessment. This study provides a reference perspective for post-evaluation regarding international cooperation and team building, though more comprehensive analysis incorporating comprehensive quality, research benefits, social impact, economic benefits, and sustained influence is

needed. Research cooperation could serve as one component of social impact evaluation.

Limitations: First, due to high data preprocessing costs, this study analyzed only 83 scholars from 2005, limiting sample size and disciplinary analysis. Future research should expand samples across multiple years for greater generalizability. Second, this study included only SCI/SSCI papers, excluding other languages or publication types, primarily because the program aims to enhance international disciplinary impact, and also due to time constraints in data acquisition and processing.

References

- [1] Zhang Jianwei, Wang Jian, Zhou Jie, et al. An empirical study on the growth of high-level leading talents in universities [J]. *Science Research*, 2019, 37(2): 235-244.
- [2] Li Boping, Zou Dewen. Implementation effect evaluation and policy optimization of Hubei Overseas High-level Talent “Hundred Talents Program” [J]. *Science & Technology Progress and Policy*, 2015(9): 32-37.
- [3] Yang Heqing, Chen Yian. Evaluation of overseas high-level talent introduction policy implementation effect: Taking the central “Thousand Talents Program” as an example [J]. *Science & Technology Progress and Policy*, 2013, 30(16): 107-112.
- [4] Zhao Junfang, Ye Tiantian. A bibliometric study on the academic development of “Thousand Talents Program” recipients: Based on the first five batches from “985 Project” universities [J]. *China Higher Education Research*, 2014(11): 43-48.
- [5] Zheng Qiaoyi, Zhu Jiani, Zhang Guodong. Evaluation of “Thousand Talents Program” implementation effect: Based on academic performance of “long-term Thousand Talents” at C9 universities [J]. *China Agricultural Education*, 2015(6): 22-27.
- [6] Lotka A J. The frequency distribution of scientific productivity [J]. *Journal of the Washington Academy of Science*, 1926, 16: 317-323.
- [7] Price D J, Beaver D D. Collaboration in an invisible college [J]. *American psychology*, 1966, 21(11): 1011-1018.
- [8] Zuckerman H. Nobel laureates in science: patterns of productivity, collaboration, and authorship [J]. *American sociological review*, 1967, 32(3): 391-403.
- [9] Wang Fan, Guo Honglin, Zhang Ran. Research on growth characteristics of leading talents in humanities and social sciences: Based on analysis of Cheng Kong Distinguished Professors [J]. *Journal of Renmin University of China Education*, 2015(4): 128-145.

- [10] Niu Heng, Zhou Jianzhong. Research on characteristics of China's high-level scientific and technological talents based on CV analysis: Taking "Hundred Talents Program", "Cheung Kong Scholars" and "Distinguished Young Scholars" as examples [J]. Journal of University of Science and Technology Beijing (Social Sciences Edition), 2012, 28(2): 96-102.
- [11] Zhang Yan, Li Yue, Li Ruzhen, et al. Research on Cheung Kong Distinguished Professors in agricultural universities [J]. Higher Agricultural Education, 2014(11): 41-44.
- [12] Gao Yong. Research on academic growth path of Cheung Kong Scholars [D]. Beijing: Tsinghua University, 2014.
- [13] Yang Deqian, Jiang Qun. Research on growth path of Cheung Kong Distinguished Professors [J]. Higher Education Exploration, 2018(5): 27-35.
- [14] Huang Haigang, Lian Jie, Qu Yue. "Talent competition" in universities: Who are the beneficiaries?—An empirical analysis based on Cheung Kong Scholars [J]. Journal of Beijing Normal University (Social Sciences), 2018(5): 39-52.
- [15] Zhang Yingying, Xie Tianguang, Zhang Xuekai. Do Cheung Kong Scholars improve university research innovation efficiency?—An empirical test based on 42 world-class university construction universities [J]. Higher Education Management, 2019, 13(4): 80-90.
- [16] Chen Yue, Liu Zeyuan, Jiang Zhaohua, et al. Quantitative analysis of regional knowledge production cooperation [J]. Science Research, 2005, 23(21): 68-71.
- [17] Landry R, Amara N. The impact of transaction costs on the institutional structuration of collaborative academic research [J]. Research policy, 1998, 27(9): 901-913.
- [18] Chen Lixin, Liang Liming, Liu Zeyuan. Does Matthew effect exist in international mechanics science cooperation? [J]. Science of Science and Management of S.& T., 2006, 27(8): 12-16.
- [19] Petersen A M. Quantifying the impact of weak, strong, and super ties in scientific careers [J]. Proceedings of the National Academy of Sciences of the United States of America, 2015, 112(34): E4671-E4680.
- [20] Bu Y, Ding Y, Liang X, et al. Understanding persistent scientific collaboration [J]. Journal of the Association for Information Science and Technology, 2018, 69(3): 438-448.
- [21] Bu Y, Murray D S, Ding Y, et al. Measuring the stability of scientific collaboration [J]. Scientometrics, 2018, 114(2): 463-479.
- [22] Azoulay P, Stuart T, Wang Y. Matthew: effect or fable? [J]. Management science, 2013, 60(1): 92-109.

[23] Borjas G J, Doran K B. Prizes and productivity: How winning the Fields Medal affects scientific output [J]. *Journal of human resources*, 2013, 50(3): 728-758.

[24] Chan H F, ?nder A S, Torgler B. Do Nobel Laureates change their patterns of collaboration following prize reception? [J]. *Scientometrics*, 2015, 105(3): 2215-2235.

[25] Wagner C S, Horlings E, Whetsel T A, et al. Do Nobel Laureates create prize-winning networks? An analysis of collaborative research in physiology or medicine [J]. *PLOS ONE*, 2015, 10(7): e0134164.

Author Contributions: Liu Xiaojuan: Responsible for topic selection and guidance; Yu Mengxia: Responsible for main writing; Zhao Zhuojing: Responsible for auxiliary writing and revision; Wei Yu: Responsible for revision.

Note: Figure translations are in progress. See original paper for figures.

Source: ChinaXiv — Machine translation. Verify with original.