

COMMENT

ZOOLOGY Collaboration drove taxonomy pioneer **p.28**



HISTORY From tax to dice and astrology — what did Einstein really say? **p.30**

ARTIFICIAL INTELLIGENCE Studies of surveillance technology need ethical review **p.31**

SUSTAINABILITY Sea-bed mining code prompts concern for environment **p.31**

CLAUDIO BRESCEANI/AFP/GETTY



Chemist Youyou Tu, who discovered the malaria treatment artemisinin, was the first Chinese female scientist to win a Nobel prize.

Close the gender gap in Chinese science

Analysis shows that extending the age limit for grants boosts the number awarded to women, but more must be done to achieve parity, say **Ying Ma** and colleagues.

“**W**omen hold up half the sky” was a popular slogan in Mao Zedong’s China of the mid-twentieth century, intended to emphasize the equal importance of women in public and private life. But even though China used such slogans and had constitutional claims of gender equality decades

before many other nations, inequalities persist. By 2017, just 6% of the members of the Chinese Academy of Science were women.

In the 1980s and 1990s, advances in the country’s technological capacity generally involved importing knowledge. Now, China is focused explicitly on building its

own research and development (R&D) and innovation. Its R&D staff swelled from 3.2 million in 2009 to 5.8 million in 2016 (ref. 1), and the increased demand for talent has highlighted the need for more female scientists. Currently, women make up only about one-quarter of this workforce. At the same time, increased connections ▶

► between China and the international community have made concerns about gender inequality more prominent.

Multiple governmental and scientific organizations in China have taken measures to promote women in science. Here we present the results of several initiatives undertaken by the National Natural Science Foundation of China (NSFC) (where X.G. and L.S. work; Y.H.Z. did so until March 2018).

Notably, after age limits for female grant applicants were extended, the percentage of women winning grants from a major fund for young scientists went from 33% to 43% in one year. But there is still a long way to go.

MINDING THE GAP

Women in China have one of the highest rates of participation in the labour force when compared with women from both large developed and emerging economies, such as the United States, Germany, Brazil and India. This is a legacy of its planned-economy era, starting in 1949, when women's participation in the workforce was encouraged and protected. As late as 1988, women made up 48% of the labour force in China, and women's average earnings were 84% of those for men. By 2002, however, 10 years after the country moved to a market economy, women made up 46% of the labour force and their earnings were 79% of those of men².

Many universities in China have adopted a policy of 'promote or leave'. This means that scientists gain a permanent position only if they pass an evaluation at the end of a 6-year probationary period, which often coincides with women's child-bearing years.

Similar to other countries, China has a 'leaky pipeline' for women in science — fewer women advance through each stage of a scientific career. In 2016, 53% of master's students and 39% of doctoral students in China were women³. That proportion falls to 14% for recipients of the NSFC's Distinguished Young Scholars Award, which helps rising researchers under 45 to become leaders in their fields.

In 2010, a joint document from the Central Committee of the Communist Party of China and the State Council called for the creation of policies to help talented men and women balance work and family. It advocated for a more equitable gender ratio in professional workplaces. In 2011, the Ministry of Science and Technology and the National Women's Federation jointly issued a policy document to champion the development of women in science and technology careers.

In 2010, a survey of the NSFC's applicants found that about 70% of women and 24% of men supported a policy that sought to redress historical disadvantages through affirmative action. Measures around maternity and parental rights were

GENDERED ATTITUDES

Nearly 6,000 scientists across China were asked whether they agree with the following statements. The survey found viewpoints, especially among men, that could hold back women's careers.

"Women are 'not suitable' for research work."



"A man's success is measured by his career, while a woman's success is measured by her family."



"Men make better project leaders."



supported by majorities of both genders⁴.

Most grant and job applications in China already restrict eligibility by age, so changing these requirements offered a way to support female scientists. Thus, in 2011, the NSFC increased the age limit for women applying to its Young Scientist Fund from 35 to 40, while that for men remained at 35 (one of us, X.G., was involved in making this decision). This programme is the second-largest of the NSFC funds and the main way in which early-career scholars in basic science receive national funding. As of 2016, the programme represented 13.8% of the roughly US\$4.1-billion budget the NSFC spent on projects, and financed 39% of all individual projects.

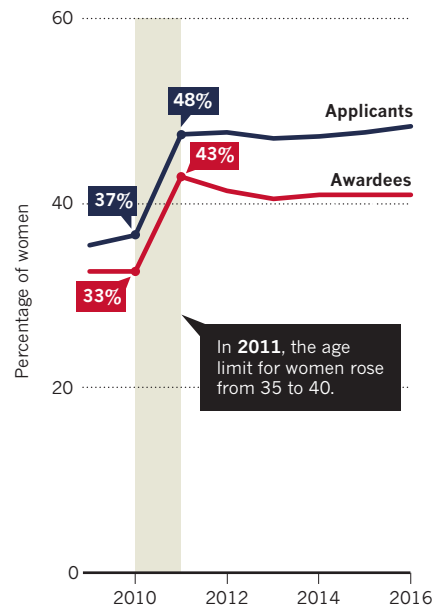
Higher age limits (38 for men, 40 for women) were also established for a new

programme, the Excellent Young Scientist Fund. This supports about 400 projects a year and represents 2.2% of the NSFC budget. Another new policy allowed women to apply to extend NSFC project terms (but not funding amounts) by up to 24 months for maternity leave.

Also in 2011, the NSFC pledged to increase the number of female scientists on review panels, although it did not set a quota. It invited review panels to consider prioritizing female applicants when all else was equal; enhanced the publicity surrounding research findings by female scientists financed by its programmes; and started to collect statistical data about the gender of applicants and awardees⁵. In 2016, the Chinese Academy of Science and Technology for Development (CASTED) surveyed more than 5,800 scientists about their attitudes to gender roles and recent policies (an effort led by Y.D.Z. and Y.M.).

MORE GRANTS FOR WOMEN

Policies to accommodate parenthood increased female applicants and awardees for a Chinese fund for young scientists.



EFFECTS AND EXPECTATIONS

What happened? Raising the age bar in 2011 saw the percentage of women applying for the Young Scientist Fund increase from 37% to 48% (see 'More grants for women'). Applications from women soared by 94% to 25,694; about one-third were aged 36–40. Applications from men went up by 23%, to 28,397 in the same period. The year before, applications rose by 25% for men and 31% for women⁴, partly owing to swelling numbers of people gaining science and engineering PhDs: a 58% increase from 2006 to 2016.

The percentage of female award recipients jumped from 33% to 43% in 2011, and has remained at about this level. Despite this increase, a female scientist's chance of winning one of these grants has declined slightly, from 21% in 2010 (compared with 24% for men) to 19% in 2016 (26% for men). A lower success rate for women has been found in other programmes in

China and internationally⁶. It is hard to pin this on discrimination, differences in application styles or other reasons. We did observe that the success rate of women applicants aged 36–40 is lower than that of younger women. Despite this, more women are now receiving these awards.

Women's representation on review panels went up by 45% between 2010 and 2017, to 13.3%. That is still low, but consistently higher than rates seen from 1986 to 2009, which fluctuated around 6%.

No women have yet applied to extend their project terms for pregnancy or child rearing. However, we think that many would have applied for extensions had they known about the policy: in the 2016 survey, 60% of female scientists indicated that they had never heard of it.

Although these measures have had relatively little time to influence the scientific enterprise in China, more than 70% of female scientists polled expect that each policy will have a positive effect in their discipline.

Men who responded to the poll are less enthusiastic. About 60% thought that raising age limits for female applicants would have a positive effect on their field, as did 53% for extending project terms for maternity leave. Only 39% of men thought that increasing the number of women on review panels or favouring female applicants when all else was equal would be good for their fields.

WIDESPREAD PROBLEM

Discrimination and bias towards women in the workplace in China, as elsewhere, is all too common. A 2015 survey conducted in Beijing found that 87% of female university students encountered gender discrimination in their job hunt.

Even among scientists, the CASTED survey found bias and burdens that must affect women's careers (see 'Gendered attitudes'). More than 20% of men and around 10% of women agreed with the statements "A man's success is measured by his career, while a woman's success is measured by her family" and "men make better project leaders". For the second statement, 48% of men and 81% of women disagreed. (We did not ask inverted versions of the questions, such as whether women make better project leaders.)

Women feel the effects of these attitudes. Thirty-two per cent of female scientists reported that they encountered employers in their first job search who wanted to recruit only men. Given that 84% of the women surveyed were aged 45 or under, we must assume that most of this pool had experienced

"Eighteen per cent of male scientists say that their spouse does most of the housework."



Chemist Youyou Tu worked with pharmacologist Lou Zhicen (left) on traditional Chinese medicine in the 1950s, when women's participation in the workforce in China was encouraged and protected.

discrimination in recent decades.

Unequal responsibilities for child rearing, care for older people and other domestic labour also hinder women's career advancement in China, as has been reported for the United States⁷. Among married scientists in our survey, 30% of women compared with just 6% of men reported doing most housework themselves. And 2% of female researchers and 18% of male scientists say that their spouse does most of the housework. What's more, the gradual lifting of China's one-child policy from 2013 has placed more parental responsibilities on women.

Women are less likely than men to change location to advance their career. One scholar explored why only 11.4% of Chinese recipients of funds from a German programme for visiting researchers in 2011 were female, and concluded that the 'price for mobility' was much higher for women than for men, because of marriage and family⁸.

Chinese society in general and the scientific community in particular are undergoing big transformations. The optimistic view from our perspective is that straightforward policy changes are helping. However, as a funding agency, the NSFC's role is limited. It is up to institutions to make decisions in hiring, appraising and promotion. The next step would be for the rest of China's research system to explicitly acknowledge

that various barriers in science prevent women from enjoying a level playing field with men, and to take measures to eliminate the existing gender bias. ■

Ying Ma and Yandong Zhao are senior researchers at the Institute of Science, Technology and Society, Chinese Academy of Science and Technology for Development (CASTED), Beijing, China. **Xu Gong** is a senior researcher and **Li Sun** is a researcher at the Bureau of Policy, National Natural Science Foundation of China, Beijing, China. **Yonghe Zheng** is a professor in the Faculty of Education at Beijing Normal University, Beijing, China.
e-mails: may@casted.org.cn; zhaoyd@casted.org.cn

1. National Bureau of Statistics and Ministry of Science and Technology. *China Statistical Yearbook on Science and Technology 2017* (China Statistics Press, 2017).
2. Li, C. & Li, S. *Sociol. Stud.* **2**, 94–117 (2008).
3. Liu, C. (ed.) *Educational Statistics Yearbook of China 2016* (China Statistics Press, 2017).
4. Zhao, Y., Ma, Y. & Liao, M. *Bull. Natl Nat. Sci. Found. China* **5**, 403–409 (2016).
5. Gao, R. *Bull. Natl Nat. Sci. Found. China* **2**, 94–96 (2011).
6. Bornmann, L., Mutz, R. & Daniel, H.-D. *J. Informetrics* **1**, 226–238 (2007).
7. Schiebinger, L. & Gilmartin, S. K. *Academe* **96**, 39–44 (2010).
8. Leung, M. W. H. *Sustainability* **5**, 2644–2663 (2013).

CORRECTION

The Comment 'Close the gender gap in Chinese science' (*Nature* **557**, 25–27; 2018) stated that women's application rates rose by 10% when they actually rose by 10 percentage points.