NIH Career Development Awards: conversion to research grants and regional distribution

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The four major NIH-supported career development K awards are the K01, K08, K23, and K99, which comprise 70% of the investment allocated to the 15 K-type career awards. One measure of early career success is the conversion of the K award to an NIH R01 grant. Analysis of the outcomes of K-to-R01 conversion within 5 years of receipt of the K award across the NIH during the period 2008–2012 showed that K99 awards have a uniform (up to 60%) increased conversion success compared with the K01, K08, and K23 mechanisms. The K99 success continued to 7 years for the available analysis period (2008–2010). The largest number of K award recipients and their conversion to R01 were at institutions located in California, Massachusetts, and New York. Several measures that may enhance conversion of the K01/K08/K23 and diversify the distribution of the awardees are highlighted.

Investing in early-career researchers

The NIH has made significant investments in researcher career development, including a range of research training (T-type), career development (K-type), and fellowship (F-type awards) (1). In federal fiscal year 2017 alone, NIH directed 4.5% ($1.5 billion) of its $33.1 billion budget to K ($680 million), T ($664 million), and F ($158 million) grants (2, 3). After completion of higher degree training (e.g., PhD/MD/DDS/PharmD), four NIH-supported awards account for nearly 70% of 15 K-type awards (2): K01 (established in 1997, supports postdoctoral or early-career research scientists committed to research), K08 (established in 1997, supports clinician scientists to develop into independent investigators), K23 (established in 1999, supports clinically trained professionals committed to patient-oriented research), and K99 (established in 2007, supports an initial mentored research K99 experience for postdoctoral researchers, and 3-year independent R00 funding if an independent faculty position is secured) (4, 5). The NIH has published two detailed reports to evaluate the career development mechanism (6, 7). Most recently, the 2011 analysis indicated that K01, K08, or K23 awardees had higher R01 award success and R01 renewal rates than individuals with no prior career development support; K99 awards were not included in this analysis since that K-type award was relatively new (7). One conclusion is that these awards are meeting the goal of fostering independent research careers of early-stage clinicians and research doctorates (7).

Assessing outcomes of career awards

In order to evaluate the K99 mechanism and compare it to K01/K08/K23 mechanisms, we examined the career development success of the K01/K08/K23/K99 awards using conversion to R01 independent research funding within 5 and 7 years of receipt of the K as a benchmark. We collected data from the NIH Research Portfolio Online Reporting Tool (RePORTER) and tabulated conversion success to an R01, including the distribution of the K awardees and the K-to-R01 recipients in different states within the United States. We focused on the number of awards given during 2008–2012, which allowed a full 5-year follow-up through 2017. There were some fluctuations in the number of K awards, with slightly more K99 awards than K01/K08/K23 awards given annually since 2012 (e.g., 235 K99 awards in 2017 compared with 195–217 awards for K01/K08/K23; Supplemental Table 1; supplemental material available online with this article; https://doi.org/10.1172/JCI123875DS1).

For investigators who converted to more than one R01, only the first R01 was included in the analysis. The overall mean K-to-R01 within 5 years of receipt of the K awards was markedly higher for the K99 awardees during the period 2008–2012 (30.3% average for K99 compared with 19.1%–22.8% for K01/K08/K23) (Figure 1A). The average 7-year conversions increased for all K awards (30.2%–48.4% conversions during 2008–2010) (Figure 1A and Supplemental Table 2). This compares with the R01-equivalent success rates of 33%–39% during 2008–2017 (Supplemental Table 3). The 7-year, compared with the 5-year, conversion success for the K01 increased by 44%, whereas the K08/K23/K99 increased by 58%–62%. As might be expected, most conversions to R01 (82%) took place at a different institution than where the K99 was received (Supplemental Table 4).

For the K awards received during 2008–2012, 39–43 of the states had at least one K awardee, and 28–36 of the states had at least one R01 awardee who converted their K within 5 years (Supplemental Tables 5 and 6). Of note, three states (CA, MA, NY) collectively had the largest number of K (40%) and K-R01 (35%) awardees of the total (Figure 1, B and C), with California and Massachusetts capturing 78% (K) and 73% (K-to-R01) of the three-state share (Supplemental Tables 7 and 8). Between 2008–2012, the average populations of the three states relative to the US population were 12.1% (CA), 2.1% (MA), and 6.3% (NY), while the corresponding market share of the NIH budget was 15.6% (CA), 10.3% (MA), and 8.5% (NY) (8).

Although the K99 mechanism has been in place for 10 years, this 5-year

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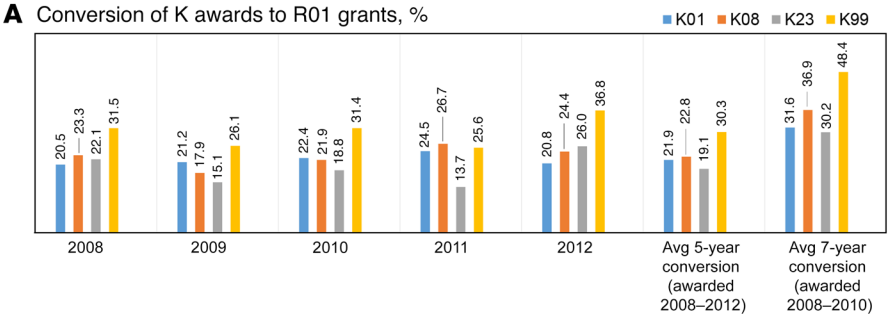

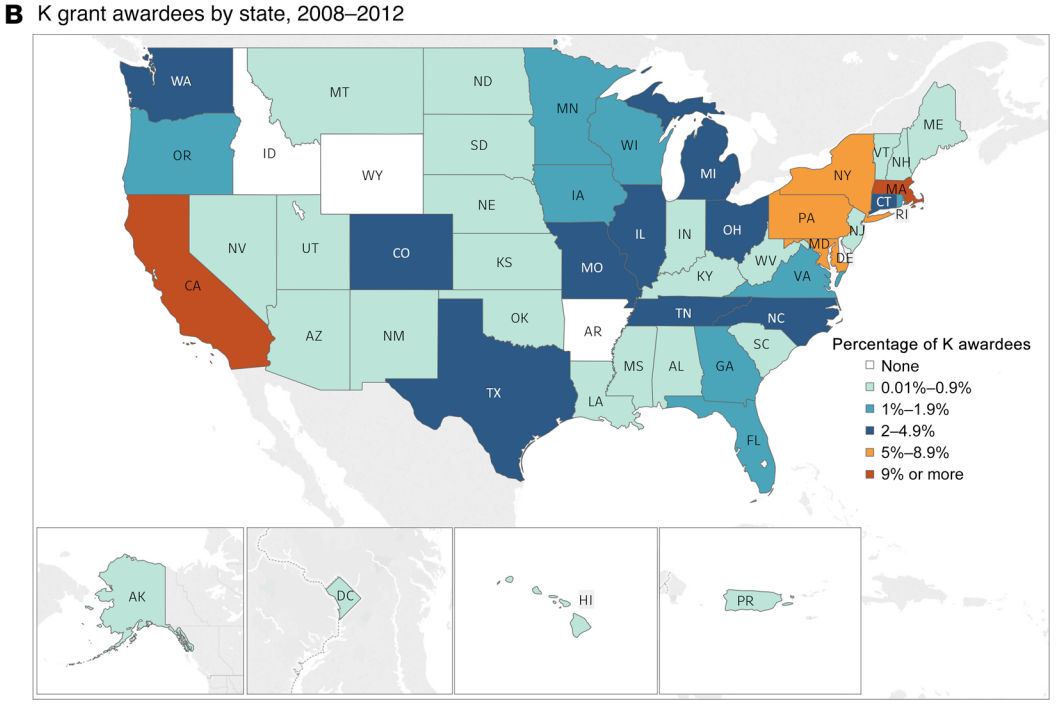

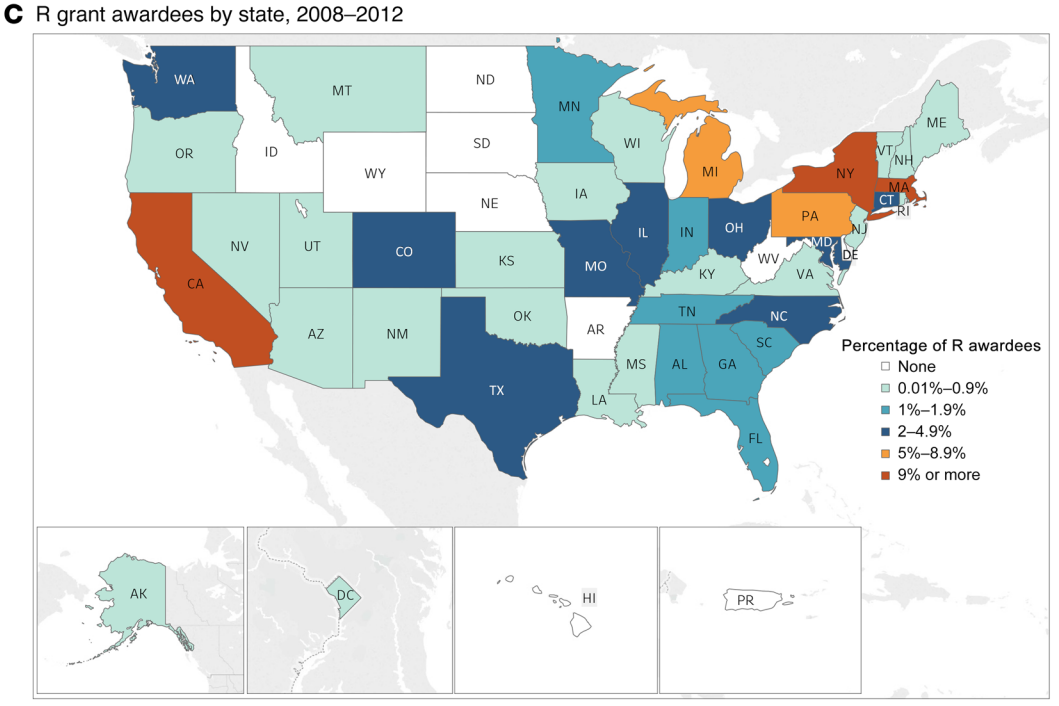

Figure 1. Success of NIH K award conversion to R01 independent research funding and geographical distribution of grant awardees. (**A**) The overall mean K-to-R01 conversion rates within 5 and 7 years of receipt of the K awards. (**B**) Geographical distribution of K awards received during 2008–2012. (**C**) Geographical distribution of R awards received during 2008–2012.

comparative analysis indicates it is outperforming by 33%–59% the K01/K08/K23 mechanisms in K-to-R01 conversion. What accounts for this difference? One possible factor is the requirement to obtain a faculty position within 2 years of receipt of the K99, coupled with the availability of the R00; these may serve as catalysts to jump-start an independent career, particularly as the tenure-track faculty designation provides awardees with additional infrastructure and resource support. Also, the more competitive nature of the K99 has been documented (9); this might contribute to preselecting candidates who are more prepared to publish and write grants. The mean success rates to secure a K award during the period of analysis were 36% (K01), 44% (K08), 38% (K23), and 24% (K99) (Supplemental Table 9); these numbers are similar to the 2017 success rates (10). Finally, the shorter postdoctoral period for K99 awardees may play a motivational role. A candidate cannot be a postdoctoral trainee for more than 4 years when applying for a K99, versus the 5- to 7-year allowable postdoctoral window for the other three K mechanisms.

Improving support for the next generation of researchers

In contrast to the 2011 NIH report (7), the conversion rates of K awardees reported herein are not compared with a cohort of researchers who did not receive the mentored K, and additional measures of success such as bibliometric data, competitive renewal of the R01, or career promotions were not examined. Also, career outcomes and research funding assessment of K awardees who did not convert their K to an R01 are not known. Despite these limitations, we believe there are recommendations to consider that are supported by our analysis. First, we concur with several of the recommendations made to Congress, the NIH, the National Science Foundation, and other biomedical research institutions in the National Academy of Sciences 2018 report on the US biomedical research ecosystem (11). These recommendations include establishing a Biomedical Research Council to address challenges confronting the next generation of biomedical researchers, increasing the NIH budget related to training to allow expansion of some of the award mechanisms, enhancing mentoring and training and related expectations, and standardizing data on outcomes (11). Second, we suggest that institutions share best practices that increase both infrastructure and capacity for mentoring, including recognition of mentoring activities as service for promotion and tenure purposes, and focused training on grant writing for early-career researchers. Third, we believe there is a need to increase funding and success rates for the K99 mechanism: FY2017 support for the K99 was $27.1 million (a marked increase from the $17.1 million allocated in 2008), as compared with $30.5 million for the K01, $33.8 million for the K08, and $39.7 million for the K23. This can be achieved by increased allocation for K awards in the NIH budget, and potentially changing the indirect cost recovery rate for the R00 to the standard 8% to match other K awards. We estimate that the latter could add more than $50 million annually if the R00 is capped annually at $150,000 (excluding the 8% indirects), although we acknowledge that discussion regarding indirect cost recovery can be both contentious and complicated. Fourth, institutional commitment to K awardees and not sole reliance on the NIH is essential. Fifth, since the K01 is the primary comparator with the K99, as applicants for both mechanisms are typically PhD scientists (though the K99 does not require US citizenship or permanent resident status), strengthening the K01 deserves assessment. This could involve modifying the mechanism to include the additional R00 resources: for example, making the K01 award 2–3 years and coupling it with 2–3 additional years of an R00 (5 years of total support), similar to the K99/R00 in terms of expectations. This may enhance the future success and career development of the K01 awardees by providing additional resources, a faculty position with a start-up package, and other associated benefits. Sixth, similar considerations can be made for the K08 and K23 mechanisms; clearly, maintaining the pipeline of clinicians and clinician scientists engaged in biomedical research is essential (11). Notably, the NIH Physician-Scientist Workforce 2014 Report made several recommendations, including that NIH should provide physician scientists with programs similar to the K99/R00, since the K99/R00 program goes almost exclusively to individuals holding a PhD degree (12). One potential caveat of our analysis, particularly for the K23 mechanism given that we focus strictly on the first R01, is that many K23 awardees may not be engaged in R01-type research.

Finally, we call attention to the uneven distribution of career awards across the US and encourage NIH to further assess diversification of career awards to broaden distribution within the US, while still making selection decisions based on candidate qualifications and the research environment. However, further analysis of the apparent geographic disparity is needed, including whether it is related to the number of research-intensive institutions (e.g., using the Carnegie Classification, ref. 13) and the support infrastructure of the institutions in the more heavily represented states. A challenge for diversification is the need to have the necessary infrastructure, resources, and mentoring to insure success of the awardees. Such challenges can be addressed, in part, by forming partnerships with appropriately resourced institutions, encouraging co-mentoring (possibly by providing a discretionary stipend), and continued monitoring of awardee progress. Although investing in research career development does not guarantee a continued successful research career for any one individual, it does show that research careers are valued, which is critical for a diverse and successful research workforce pipeline of biomedical investigators.

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