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## Limited achievement of NIH research independence by pediatric K award recipients

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Hope for the pediatric physician-scientist in the United States begins in the pipeline which presently begins with National Institutes of Health (NIH) Mentored Clinical Scientist Research Career Development Award (K08 and K23) recipients ([https://grants.nih.gov/grants/funding/funding\\_program.htm](https://grants.nih.gov/grants/funding/funding_program.htm)). K08 awards focus on translational research (application of basic research discoveries toward the diagnosis, management, and prevention of human disease), where as K23 awards focus on patient-oriented research (research conducted with human subjects). To maintain the pool of pediatric physician-scientists, these awardees must transition to research independence (commonly an NIH R01 award), which is also the expectation of the NIH and of most tenure-accruing Departments. The NIH provides hundreds of mentored K awards per year to catalyze the research careers of junior faculty members ([https://grants.nih.gov/training/K\\_awards\\_evaluation\\_finalReport\\_20110901.pdf](https://grants.nih.gov/training/K_awards_evaluation_finalReport_20110901.pdf)). Success rates among pediatric career development awardees (CDAs) for K (08 or 23)-to-R01 transition and the characteristics of successful CDAs are unknown.

We accessed NIH RePORTER (<https://projectreporter.nih.gov/reporter.cfm>), an electronic tool that allows users to search a repository of NIH-funded research projects, on February 12, 2018 to identify K08 and K23 CDAs from the fiscal years (FY) 2012–2017 in the Department of Pediatrics according to previous methods(1). The division, sex, degrees, academic rank and all NIH awards (during FYs 2012-February 12<sup>th</sup> 2018) were determined for the CDAs using an internet search and NIH RePORTER. Complete methodological details are available at <http://www.peds.ufl.edu/files/Wynn2017>.

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During the study period, 619 pediatric NIH K08 or K23 awards were made. Ten institutions supported 329 (53%) of all K08/23 awards (Table 1). Five NIH institutes supported 502 (81%) of all K08/23 awards (Table 1). We identified 314 unique K08 awards. Ten institutions supported 174 (55%) K08 awards and five NIH institutes supported 250 (80%) of K08s. We identified 305 K23 awards during the study period. Ten institutions supported 180 (59%) K23s and five NIH institutes supported 258 (85%) K23s.

We identified 259 K08/23 awards (134 K08, 125 K23) that ended during 2012–2016 (mean K08 end 12/2014, mean K23 end 3/2015) and curated the rate of R01-equivalent award (DP2; R01; R23; R29; R37; RF1), R21 award (early stages of project development), or Program Project Grant (PPG; synergistic research programs; P01; M01; P20; P30; P50; U54) conversion (Table 2). Among the 86 CDAs that received an R01-equivalent award, 45 (52%) were female, 41 are associate professors (38 assistant professors), 42 had an MD-equivalent with additional graduate degree, and many were concentrated in academic general (n=15), hematology-oncology (n=14), infectious disease (n=10), neonatology (n=9), and cardiology (n=5) divisions. Among the 259 CDAs, 146 (56%) had not successfully competed for an R01, R21, or PPG award at a minimum of one-year post-K award completion. Among the 86 CDAs that received an R01, the mean time from K award end to R01 start was 144 days (95% confidence intervals; –13, 302) and 169 days (CI; 21, 318) for K23.

A greater conversion to R01 for CDAs with K08 as compared to K23 supports that mechanistic approaches are advantageous. To test this proposed relation, project summaries for 1372 previously identified pediatric R01-equivalent awards made to 907 physician-scientists from 2012 to May 17, 2017(1) were reviewed and labeled mechanistic if there was any description of planned experimental investigation to uncover the causes of an effect. Mechanistic R01s accounted for 853 (62%) of the R01s awarded. Mechanistic grants were funded by National Heart, Lung, and Blood Institute (NHLBI, 22%), National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK, 18%), National Institute of Allergy and Infectious Diseases (NIAID, 17%), National Cancer Institute (NCI, 14%) and were awarded to 559 predominantly male (69%) physicians at the rank of professor (58%) concentrated in hematology-oncology (20%), infectious diseases (11%), neonatology (10%), and academic general (7%) divisions. Descriptive grants were funded by NHLBI (18%), Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD, 18%), NIDDK (12%), NIAID (7%), and were awarded to 405 predominantly male (58%) physicians at the rank of professor (62%) concentrated in academic general (19%), infectious diseases (10%), hematology-oncology (9%), and neonatology (7%) divisions.

Among all NIH K08 awardees from a 15 year era (1990–2005), 32% received an R01 as compared to 18% of K23 awardees (2000–2005) ([https://grants.nih.gov/training/K\\_awards\\_evaluation\\_finalReport\\_20110901.pdf](https://grants.nih.gov/training/K_awards_evaluation_finalReport_20110901.pdf)). Here, we demonstrate that current pediatric-specific CDAs exhibit a comparable trend where K08 awardees demonstrate greater R01 success compared to K23 awardees, likely secondary to the predominance of mechanistic R01s in the pediatric physician-scientist pool. It is concerning that over half of all pediatric CDAs whose award ended prior to 2017 had not achieved substantial NIH funding at the time we accessed RePORTER. Between October 1999 and September 2001,

171 NICHD-sponsored K awardees (K08 or K23 with or without a prior K12 award) from, 101 (59%) received a research project grant(2). We examined the rate of achieving all substantial NIH grant awards among pediatric CDAs whose award had ended at least one year ago, funded by all NIH institutes over the last 5 years. Among the 619 CDAs we identified, 111 were NICHD-sponsored, of which 57 finished the K award prior to 2017. Twenty-three (40%) had successfully competed for a substantial NIH award, and 32 (56%) had been awarded either an R21 or a substantial NIH award.

Similar to our findings for R01-funded pediatric investigators(1), the majority of K08/23 awards were concentrated at a small number of centers where mentoring opportunities may be more widely available. These data, in conjunction with the limited number of R01-funded pediatric investigators, particularly those performing mechanistic-focused research, raise concern for our ability to support young trainees that, for a number of reasons, may not be able to train at those centers with ample mentors. Although mechanisms of early career support vary internationally, a bottleneck for junior physician-scientist researchers is not limited to the United States (<https://www.nature.com/news/young-researchers-lose-out-in-european-funding-programme-1.9669>)(3). Our study suggests that a key choke point for investigator support is the transition to independent funding. We remain hopeful that recognition of these data by government funding programs globally will lead to additional support for early-stage investigators that will in turn increase the pool of pediatric physician-scientists to promote discovery and advancement for children.

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**Table 1.**

Supporting institutions and institutes for K08 and K23 awards

All K08/23 awards (n = 619)	K08 (n = 314)	K23 (n = 305)
Institutions (number of awards)		
Children's Hospital of Philadelphia, 67	Boston Children's Hospital, 33	Children's Hospital of Philadelphia, 39
Boston Children's Hospital, 61	Children's Hospital of Philadelphia, 28	Boston Children's Hospital, 28
Cincinnati Children's Hospital, 44	Cincinnati Children's Hospital, 22	Cincinnati Children's Hospital, 22
University of California, San Francisco, 31	University of California, San Francisco, 17	University of Colorado, Denver, 16
University of Colorado, Denver, 31	University of Colorado, Denver, 15	Johns Hopkins University, 15
Johns Hopkins University, 25	Washington University, 14	Vanderbilt University, 14
Baylor College of Medicine, 25	Baylor College of Medicine, 14	University of California, San Francisco, 14
Vanderbilt University, 23	University of Michigan, 11	Seattle Children's Hospital, 13
Seattle Children's Hospital, 22	Johns Hopkins University, 10	Baylor College of Medicine, 11
University of Michigan, 19	Stanford University, 10	Emory University <sup>a</sup> , 8
Institutes (number of awards, % of awards)		
NHLBI (140, 23%)	NHLBI (72, 23%)	NICHD (89, 29%)
NIDDK (117, 19%)	NIDDK (67, 21%)	NHLBI (68, 22%)
NICHD (111, 18%)	NIAID (58, 19%)	NIDDK (50, 16%)
NIAID (90, 15%)	NINDS (31, 10%)	NIAID (32, 10%)
NINDS (44, 7%)	NICHD (22, 7%)	NIMH (19, 6%)

<sup>a</sup>1. University of Michigan and University of California, Los Angeles also supported eight K23 awards

**Table 2.**

R01, R21, and PPG conversion among 259 K08/23 awards that ended prior to 2017

	<b>K08 or K23 (n = 259)</b>	<b>K08 (n = 134)</b>	<b>K23 (n = 125)</b>
R01 or R21 or PPG (n, %)	113 (44%)	57 (43%)	56 (45%)
R01	86 (33%)	50 (37%)	36 (29%)
R21	32 (12%)	13 (10%) <sup>a</sup>	19 (15%) <sup>b</sup>
PPG (P01, M01, P20, P30, P50, U54)	12 (5%)	6 (4%) <sup>c</sup>	6 (5%) <sup>d</sup>
No R01 or R21 or PPG <sup>e</sup>	146 (56%)	77 (57%)	69 (55%)

<sup>a</sup> 1. 9/13 also had an R01<sup>b</sup> 2. one also had a PPG, 2 had an R01<sup>c</sup> 3. three also had an R01<sup>d</sup> 4. one also had an R01<sup>e</sup> 5. nine individuals (4 K08, 5 K23) that did not receive an R01 or R21 or PPG received another NIH award of significance (>\$100,000/year) that included ZIA, U2C, U19, U01, R56, R41, R34, and DP3

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