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The Fragile State of the National Institutes of Health Pediatric Research Portfolio, 1992-2015
Doing More With Less?

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In this article, we examine the status of the National Institutes of Health (NIH) pediatric research portfolio between start of federal fiscal year (FY) 1992 and end of FY 2015. The NIH experienced the greatest mean annual growth rate during the "doubling era" (FY 1998-2003): both the NIH budget (13.5%) and pediatric research portfolios (11.5%) increased annually by double digits. However, in the "postdoubling" era (FY 2004-2009), both the NIH (2.0%) and pediatric (−0.2%) mean annual growth rates decreased dramatically. In the most recent era (FY 2010-2015), the NIH mean annual growth rate has been flat (−0.1%) and pediatric research funding has posted very modest gains (3.5%) without accounting for 1-time increases under the 2009 American Recovery and Reinvestment Act. We offer recommendations to protect against further erosion of the pediatric research portfolio because continuation of these trends will have a negative effect on the health of children during their childhood and as adults. As capacity to conduct basic and applied research is further constrained, it will be a challenge for pediatric researchers to do more with less and less.

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Editorial
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The allocation of US federal budget outlays to address the well-being of children is a major area of focus for child and family policy researchers. In 2016, the Urban Institute reported trends in federal funding for children on more than 100 major federal programs. Although the children's share of the federal budget has increased from 3.2% (1960) to 10.7% (2010), it is expected to decrease in the future (7.7% by 2026).[1] These trends indicate that although children may have once been an increasing national policy priority, this support may be waning. In this article, we report recent trends and assess overall progress (or lack thereof) of the National Institutes of Health (NIH) pediatric research portfolio.

Initial scholarly efforts to analyze funding for biomedical pediatric research focused only on the flow of dollars to academic pediatric departments rather than NIH pediatric research funding as an independent category or portfolio.[2-6] Our prior reviews report on the status of the NIH pediatric research portfolio over the "predoubling" (fiscal year [FY] 1992-1997), "doubling" (FY 1998-2003), and "postdoubling" (FY 2004-2009) periods.[7,8]

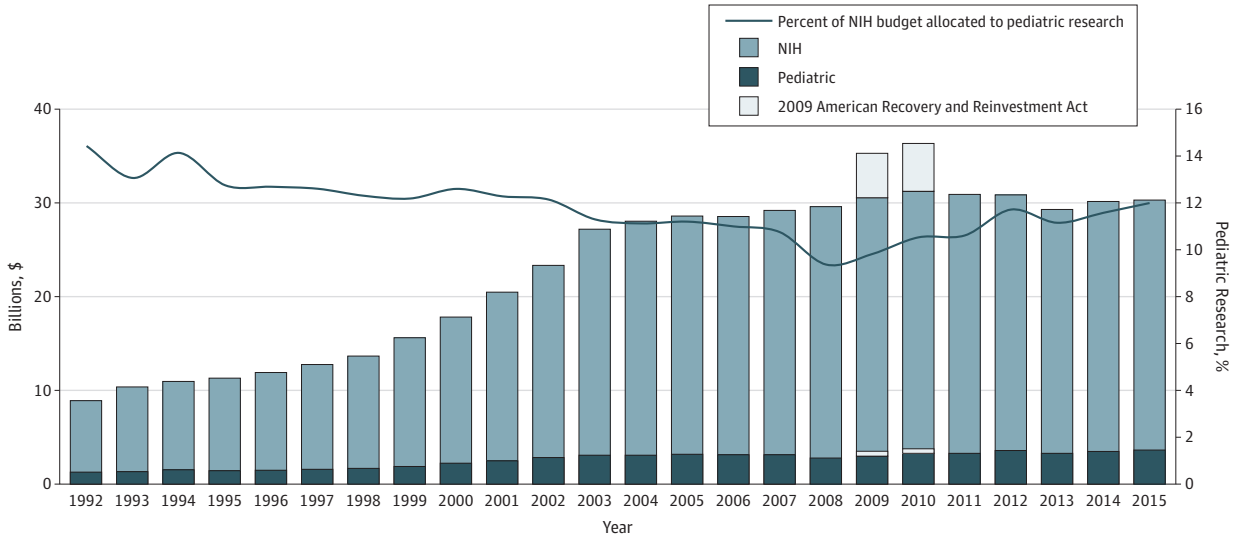
In this article, we report on the most recent era (FY 2010-2015) and highlight how the NIH pediatric research portfolio has fared in comparison with the overall NIH budget. Some caution that our "age-specific" focus on the NIH roadmap or other targeted pediatric collaborations is misguided. Others suggest that measures of spending must be commensurate with disease burden. However, we believe that given the high potential benefit of resolving the origins of later-life diseases in early life, thereby reducing lifelong disease burden, the potential to reduce disease burden via pediatric research must be among our highest priorities.

We do not report whether the funds spent by the NIH on pediatric research are commensurate with disease burden (eg, prevalence, incidence, mortality, morbidity).[9-11] Because of the many nuances of measuring public health burden, the NIH itself concludes that it is not possible to have a justifiable one-size-fits-all approach for reporting burden across diseases. Rather, careful consideration of multiple data types and sources on a case-by-case basis is the best strategy for understanding disease burden and public health need. Indeed, we encourage additional caution against conclusions about NIH pediatric research funding without accounting for non–age-specific biomedical research, which frequently spreads across subpopulations in an undifferentiated manner.

Public Policy and Measuring the NIH Pediatric Research Portfolio

In the mid-1990s, Congress expressed concern that the NIH pediatric research portfolio was inadequate[12] and requested that the NIH develop performance indicators to measure progress toward achieving the goal of a strong pediatric research portfolio. Since then, the NIH has issued annual reports that "use a variety of methods to evaluate their [NIH institutes' and centers'] progress in achieving a strengthened portfolio in research on children."[13]

Figure 1. The National Institutes of Health (NIH) Budget and Pediatric Research Spending (Fiscal Year 1992-2015, Nominal Dollars) and Percentage of NIH Budget Allocated to Pediatric Research[14,15,22]



The fiscal year 2009 and 2010 figures include 1-time allocations from the 2009 American Recovery and Reinvestment Act. In 2008, the NIH adopted the Research, Condition, and Disease Categorization system, changing the method by which it estimates pediatric research funding.

Beginning in 1995, each institute and center within the NIH began reporting the total funding of pediatric research, as well as other crosscutting research areas. Given that each institute and center report used slightly different mechanisms, this system was inconsistent. Thus, Congress requested that the NIH begin a process to provide better consistency and transparency in the reporting of all of its funded research. The new process, the Research, Condition, and Disease Categorization (RCDC) system, began in 2008 and uses text data mining along with the NIH-wide definitions to match projects to categories, reducing variability.[14] Thus, one should use caution in comparing pediatric and other disease-specific spending before and after implementation of the RCDC system. Pre–FY 2008 data were provided to us by the NIH Budget Office.[8] The RCDC data presented here were obtained via the NIH website.[14] These values represent the best estimates of the NIH and were consistent with data obtained from alternative sources (NIH Reporter System,[15] NIH internal data [National Institutes of Health, Office of Budget. Pediatric Research - FY 2008 through FY 2013 Actual Annual Funding. Obtained under the Freedom of Information Act from NIH; requested June 13, 2017; received August 17, 2017]). The terms and cutoffs for each RCDC category are modified on a regular basis, which results in considerable variation in the grants identified as pediatric. This is observed in the data presented here and by examination of individual grants each year. However, when one accounts for biomedical research and development price index and NIH budget changes, these variations are smaller. The NICHD grant data presented in later sections were obtained from several online NIH resources.[16-21] The data presented here were not examined using statistical analysis, thus limiting possible interpretations.

We define the pediatric research portfolio as the total funds obligated by the NIH to conduct or support pediatric research, both clinical and basic. Pediatric research has been defined by the NIH as "studies in all categories of biomedical research (basic, clinical, epidemiologic, behavioral, prevention, treatment, diagnosis, as well as outcomes and health services) that relate to diseases, conditions, or the health/development of neonates, infants, children, and adolescents up to age 21."[8] Importantly, much basic research on normal development and the origins of disease is relevant to child health. The data reported here include support for research in developmental biology and clinical pediatrics as part of the NIH pediatric research portfolio, raising the possibility that any observed increase is due to increases in these areas.

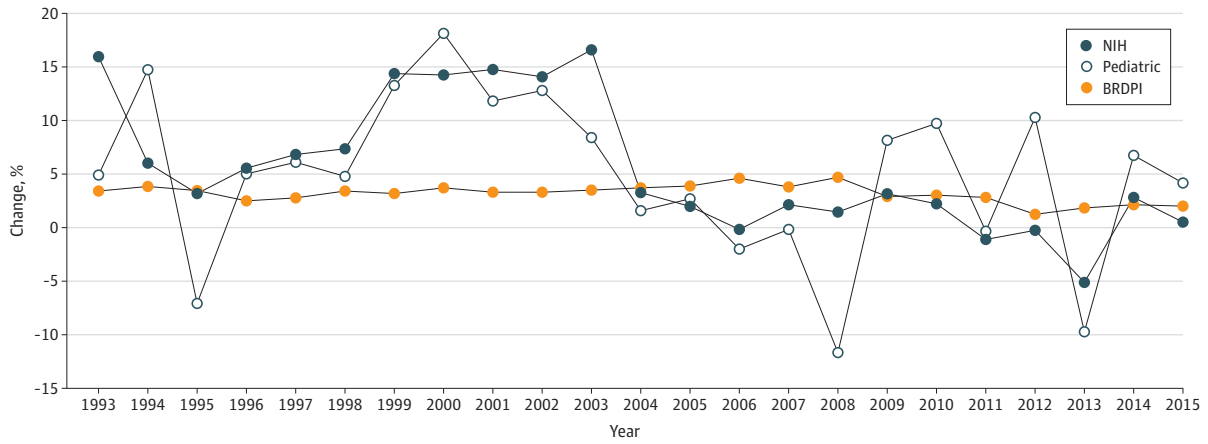
In an attempt to address some of the underinvestment in the pediatric research portfolio, Congress—under the 2000 Children's Health Act (CHA)—authorized an "expansion, intensification, and coordination" of NIH activities with respect to pediatric research. The Pediatric Research Initiative (PRI) aimed to boost federal pediatric research funding, enhance collaborations in pediatric research across institutes and centers, accelerate pediatric clinical trials, and expand investment in pediatric research trainees via loan repayment programs. In the most recent era (FY 2010-2015), funding for the PRI has remained stagnant (from $412 million to $418 million). As part of the PRI, the NIH has produced annual reports highlighting pediatric research advances, expanded research efforts within diverse programs across the NIH, and implemented ongoing research programs.[24]

The NIH and the Pediatric Research Portfolio

Figure 1 reports the status of the overall NIH budgets and the pediatric research portfolio spending between FY 1992 and 2015.

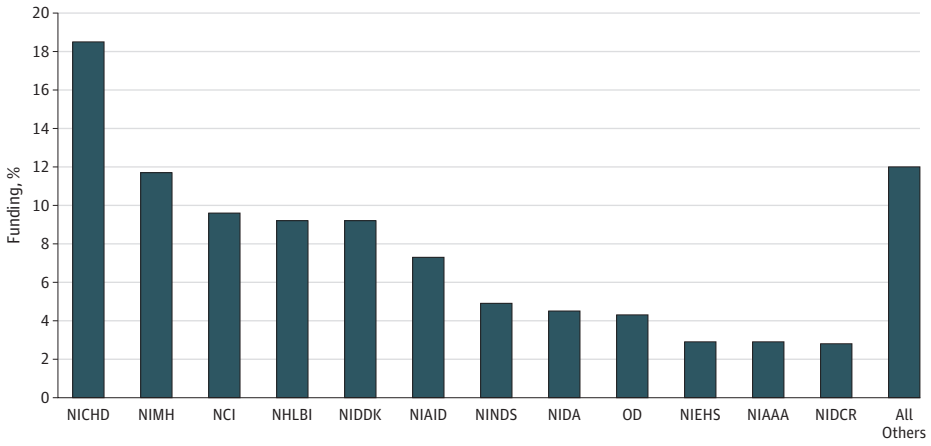
In the early 1990s, overall NIH budget growth was static or contracting in real dollars.[8] In the "predoubling" era (FY 1993-1997), the mean annual growth rate of the NIH budget (7.5%) exceeded that

Figure 2. Comparing National Institute of Health (NIH) and Pediatric Annual Growth Rates With Biomedical Research and Development Price Index (BRDPI) (Fiscal Years 1993-2015)[14,22,23]



Data show percent change over previous fiscal year in nominal dollars.

Figure 3. National Institutes of Health Pediatric Research Portfolio by Institute/Center, Fiscal Year 2015[15]



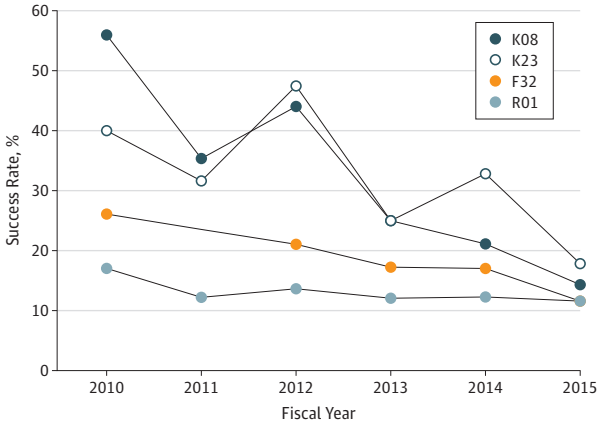
National Institutes of Health pediatric funding was $3.63 billion (fiscal year 2015). All others include the following: National Eye Institute, 2.4%; National Institute on Deafness and Other Communication Disorders, 2.1%; National Institute of Arthritis and Musculoskeletal and Skin Diseases, 1.8%; National Institute of General Medical Sciences, 1.6%; National Human Genome Research Institute, 1.2%; National Institute on Minority Health and Health Disparities, 0.8%; National Institute of Nursing Research, 0.7%; National Institute on Aging, 0.4%; National Institute of Biomedical Imaging and Bioengineering, 0.4%; National Center for Advancing Translational Sciences, 0.3%; John E. Fogarty International Center, 0.2%; National Center for Complementary and Integrative Health, 0.1%. NCI indicates National Cancer Institute; NHLBI, National Heart, Lung, and Blood Institute; NIAAA, National Institute on Alcohol Abuse and Alcoholism; NIAID, National Institute of Allergy and Infectious Diseases; NICHD, Eunice Kennedy Shriver National Institute of Child Health and Human Development; NIDA, National Institute on Drug Abuse; NIDCR, National Institute of Dental and Craniofacial Research; NIEHS, National Institute of Environmental Health Sciences; NIMH, National Institute of Mental Health; NINDS, National Institute of Neurological Disorders and Stroke; OD, Office of the Director.

of pediatric research (4.8%). The proportion of NIH research devoted to pediatrics declined from 13.1% to 12.6%.

In the late 1990s, Congress (and former President Clinton) agreed to double federal funding for the NIH over a 5-year period (FY 1998-2003). This represented an extraordinary political commitment as the NIH budget had only doubled every 10 years over the previous 4 decades. Although pediatric research funding increased substantially (82.3%) during this period, the NIH mean annual growth rate (13.5%) exceeded that of pediatric research (11.5%). Thus, growth was not equitable and the proportion of the total NIH budget devoted to the pediatric research portfolio decreased from 12.3% to 11.3%.

Figure 2 reports the annual growth rates of both the pediatric research portfolio and overall NIH appropriations. After the doubling period, the NIH became particularly vulnerable to static funding levels. For example, during the "postdoubling" era (FY 2004-2009), the mean annual growth rates increased at markedly lower rates (NIH, 2.0%; pediatric, −0.2% without

Figure 4. Eunice Kennedy Shriver National Institute of Child Health and Human Development Success Rates by Grant Types (Fiscal Year 2010-2015)[16]



K08 indicates Mentored Clinical Scientist Research Career Development Awards; K23, Mentored Patient-Oriented Research Career Development Award; F32, Ruth L. Kirschstein Postdoctoral Individual National Research Service Award; R01, Research Project Grants.

American Reinvestment and Recovery Act). In the most recent era (FY 2010-2015), mean annual growth rates have been weak (NIH, −0.1%; pediatric, 3.5% without American Reinvestment and Recovery Act), although the percentage of the NIH budget spent on pediatric research, excluding the American Reinvestment and Recovery Act, has rebounded modestly (from 10.5% to 12.0%).

Weak and inconsistent annual growth since 2004 has led to failure to keep pace with biomedical research and development price index rates (3.1%), considerably reducing the buying power of each portfolio (overall, −22.1%; pediatric, −16.0%). This indicates substantial declines in research capacity for researchers overall, as well as those interested in pediatrics.

The Distribution of Pediatric Research Within the NIH Budget, FY 2015

The pediatric research portfolio is distributed across the NIH, with pediatric-related research reported by 25 institutes and centers each year. Although the NICHD is characterized as the principal institute for the "profession of pediatric research," **Figure 3** shows that the NICHD accounted for only 18.5% of total pediatric research funding in FY 2015. Furthermore, in FY 2015, just more than half of the NICHD's overall budget ($1.26 billion) was awarded to pediatric research. It is important to note that the NICHD's pediatric funding totals exclude reproductive, behavioral, demographic, and rehabilitation research not specifically aimed at improving the health of pediatric populations.

Although the NICHD funds the largest amount of pediatric research, some notable trends have occurred with respect to pediatric funding in other institutes. Between 2010 and 2015, declines were observed in the share of pediatric research funded by the NICHD (from 19.2% to 18.5%) and the National Institute on Drug Abuse (the 6.4% to 4.5%), while considerable increases were observed at the National Cancer Institute (from 5.2% to 9.6%) and the National Institute of Diabetes and Digestive and Kidney Diseases (from 7.8% to 9.2%).

The Case of the NICHD Budget and Its Effect on the Individual Pediatric Researcher

In the most recent era (FY 2010-2015), the mean annual growth rate of the NICHD budget has decreased (−0.1%). The anemic (and negative) NICHD annual growth rates have had a considerable effect on researchers, especially when accounting for biomedical inflation. Although the number of grants has remained relatively constant, the individual pediatric researcher is facing a reduced capacity to train for and conduct research when funded.

Figure 4 reports the success rate of key award types within the NICHD. Success rates are the proportion of reviewed applications that receive funding. The success rates for each award type have decreased since 2010, indicating the increasing difficulty of obtaining financial support across career stages.

Although our analysis focuses on trends in NICHD awards, it is important to note that other institutes make ample contributions to the pediatric research portfolio, as demonstrated by the number of pediatric grants awarded in FY 2015 to institutes and centers outside the NICHD (6260 of 7760 total). However, given the importance of the NICHD to pediatric research, the primary focus of this analysis is grants awarded by the NICHD. We focus our attention on the most recent period, between FY 2010 and 2015. To illustrate these trends, the values for FY 2010 and 2015 are presented. Trends in research career development awards (K-awards) reveal that over this period the number of funded awards decreased (overall, from 295 to 252; new, from 63 to 50), although the funding provided per award (from $142 111 to $156 921) increased slightly. The payline (the percentile below which grants are projected to be funded) for competing K award applications decreased over this period (from 30% to 16%), reflecting the increasing competition for these awards. The percentage of funded "new" K08 awards declined (from 56.3% to 14.3%), reflecting a decline in awards (from 9 to 3), similar to the decline in the percentage of funded K23 awards (from 40.0% to 17.8%), a trend driven by award reductions (from 21 to 13). These trends followed a substantial successful effort on the part of the NICHD to expand the types of K awards. Overall, these trends are a barrier to clinical academic pediatric trainees interested in pursuing a research career.

Similarly, success rates for NICHD institutional training grants (T32s) supporting research and academically oriented pediatric trainees declined (from 30.0% to 26.1%), another trend driven by reductions in the number of awards (from 24 to 12). Furthermore, the number of positions funded via this mechanism declined at the predoctoral (from 398 to 272) and postdoctoral (from 304 to 243) levels. The number of postdoctoral National Research Service Award (NRSA) "individual" fellowships (F32s) declined (31 to 13), causing a decrease in application success rate (from 26.3% to 11.6%). Furthermore, NIH NRSA stipends have remained stagnant (predoctoral, from $21 180 to $22 920; postdoctoral, from $37 740 to $42 840). This either deters young physician scientists, or shifts costs to institutions, should they attempt to keep

up with, or exceed, inflation. A small reduction in the number of new applicants (from 424 to 377, 2010-2014) for Loan Repayment Program–Pediatric Research grants has driven a modest rebound in success rates (from 37.5% to 40.5%) despite a reduction in the number of new grants funded (from 159 to 153). It is discouraging that the driving force for this increased success is a decline in the number of applications.

With respect to R01 grants, the funding payline at NICHD declined (from 13% to 9%). Declines in awards (from 177 to 153) coupled with an increase in the number of applications (from 1157 to 1313) have reduced the success rate (from 17.0% to 11.7%). This continues the previously observed decline.

In contrast, modest gains have been observed in terms of funding for the NIH exploratory developmental research grant awards (R21s) at the NICHD (total, from 166 to 217; new, from 89 to 101). R21 success rates at the NICHD, however, have declined (from 10% to 8%) due to an increase in the number of applications (from 888 to 1187). Correspondingly, the payline for this mechanism has decreased (from 13% to 9%). The NICHD now only accepts R21 applications in response to institute-specific NIH requests for applications, similar to other institutes, an effort partly aimed at reducing applications that do not reflect the specific scientific areas of emphasis at the NICHD. This approach likely will reduce overall R21 applications to the NICHD and perhaps other institutes. Whether this will increase funding success rates remains uncertain, as well as whether the number of grants in response to specific requests for applications would increase or not.

Notably, success rates for all competing Program Project (P01) grants declined over this period (from 36.0% to 18.8%), a reflection of a reduction in the number of awards (from 10 to 6). Additionally, paylines have decreased (from 13% to 8%). The impact of reduced support for this mechanism on the typical scientist funded through the NICHD is not clear.

In general, lower cutoff scores (ie, lower or better scores are needed to achieve funding) indicate increases in principal investigators applying for funding from the same pot of money. Alternatively, it may indicate an increased emphasis on the grant type of interest, leading to increased funding. Concurrently, study sections have been encouraged to broaden the scoring range of grants discussed at study section meetings, which theoretically should increase the cutoff scores.

These trends indicate that the likelihood of successfully obtaining the funding required to complete training and transition to career development and independent investigation has been reduced for pediatric researchers. These trends are particularly discouraging for young pediatricians considering research careers.

Conclusions and Recommendations

Clearly, the NIH pediatric research portfolio is in a fragile state, demanding fewer pediatric researchers to do more with less and less. To protect against further erosion and strengthen investments in pediatric research, several recommendations are appropriate.

The original intent of the PRI was to support pediatric research with "dedicated, identifiable dollars that represented new funding,"[8(p467)] indicating that in the future specific allocations would be made for this initiative. However, a key staffer with knowledge of the original CHA debate noted that the intention of the CHA was not to make earmarked appropriations but to allocate dollars from within the overall NIH budget to fund research consistent with the PRI. In any event, no funds have been appropriated by Congress specifically for the PRI since 2000.[8]

Thus, the current PRI is funded with (1) a 1-time NIH Director Discretionary Fund Distribution (FY 2002, $5 million) and (2) grants funded within an institute's or center's existing annual budget. To fulfill the goal of providing "dedicated, identifiable dollars that represent new funding" in the reporting year, making specific appropriations to the PRI is the only mechanism by which the PRI can expand beyond its fixed percentage of the overall pediatric research funding portfolio.

Given the relatively constant proportion of the NIH budget devoted to pediatric research, the inclusion of children in relevant clinical research is key. Several programs will play an important role in remedying this issue. For example, the 21st Century Cures Act[25] includes a mandate to the NIH to include pediatric populations in research studies involving human subjects. In response, the NIH held a workshop including experts in clinical research to focus on how to meet this new mandate for inclusion of appropriate age groupings, specifically including children of all ages, in clinical research. The effective implementation of this mandate will be important with respect to future pediatric clinical research.

Moreover, the National Pediatric Research Network Act[26] was approved by Congress and signed into law by former President Obama in 2013. The purpose was to provide funds for research infrastructure specific to pediatric research at competitively successful academic institutions, similar to the NIH–National Cancer Institute Cancer Centers. To date, however, this congressional action has not received specific appropriations and remains an unfunded mandate, much like the PRI. Funding pediatric research acts and initiatives that actually are law should be a first priority.

It is important to note that the NIH developed the new National Center for Advancing Translational Sciences to support clinical and translational research, education, training, and collaborations among funded institutions through Clinical Translational Science Awards (CTSAs). Specific funding for pediatric research and training in these areas has not been included, however, despite the admonition to include focus on pediatric research and child health by the National Academy of Medicine.[27] Specific funding for the unique requirements of pediatric clinical and translational research and training of pediatric physician scientists through the CTSAs would be a major advance in promoting child health.

After elimination of the National Children's Study, funding was redirected to 2 initiatives, the Environmental Influences on Child Health Outcomes (ECHO) project and an expansion of the Institutional Development Award (IDeA) program. The ECHO program has objectives similar to those of the National Children's Study, although it attempts to reduce costs by using existing cohorts and narrowing the scientific focus of research.[28-31] The IDeA program aims to enhance access to clinical trials for underrepresented categories of children.[32]

The IDeA program seeks to fulfill its goals by means of 2 funding mechanisms: (1) funding research centers in states with historically low NIH funding and (2) funding logistical support such that well-funded states may recruit patients from poorly funded states. The expansion

of the IDeA program fulfills goals similar to those of the National Pediatric Research Network Act. Thus, although this act has become, in effect, an unfunded mandate, its goals may be ultimately met.

Funding of training awards is particularly important to sustaining the pipeline of the next generation of pediatric researchers. As noted by the American Academy of Pediatrics in their Blueprint for Children, "funding new and emerging scientists is absolutely essential to ensure that important scientific advances will continue to be made in the future."[33(p35)]

The Life Cycle and the Return on the NIH Pediatric Research Investment

Sadly, we document declining pediatric research support across much of the NIH, despite strong evidence of major benefits to child health.[5,34-36] Furthermore, the benefits, including improved health, reduced financial costs, and enhanced determinants of productivity, continue over the lifespan.[37-40]

Data clearly demonstrate that adult health risks (eg, obesity) are influenced by life events before and throughout pregnancy, as well as during childhood (eg, fetal growth disorders). Thus, in recognition of this relationship, funding support also should enhance research done in conjunction with obstetricians and maternal-fetal medicine specialists. Furthermore, enhanced funding support to investigate the relationship between genetic variation and disease risk is key.

There could be many ways in which, separate from NIH funding, pediatric research could be promoted (ie, local institutional support and mentoring). However, NIH support remains the principal mechanism for research support, especially at academic institutions. Without it, there would be little reason to encourage early-career academicians to aim for a research career. Moreover, NIH and federal research support has produced outstanding accomplishments in child health.[41,42] If properly funded, pediatric researchers could expand even more on such accomplishments and improve child health and the health of the US population even more.

Although some novel programs promise to expand our capacity to study pediatric conditions (eg, the ECHO program), overall, our conclusion is that currently the pediatric biomedical research landscape at NIH is increasingly bleak, and there is an urgent and fundamentally important need to reverse current trends and work toward increasing future support for pediatric biomedical research at the NIH. To achieve this, pediatricians will need to offer novel pieces of evidence and theoretical arguments demonstrating the long-term health benefits for the adults of tomorrow to be gained by improving the health of our current pediatric populations. In sum, to ensure the improved health of our future children, during their childhood and as adults, it is imperative that national policymakers, particularly members of Congress, the administration, and the NIH work with the pediatric research and clinical community to prioritize increasing investments in both basic and clinical pediatric research.

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