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Federal funding of nursing research by the National Institutes of Health (NIH): 1993 to 2017

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ABSTRACT

Background: There has been a dramatic increase in the number of doctoral programs (PhD and DNP) that prepare nurse research scientists and advanced practitioners since establishment of the National Institute of Nursing Research (NINR) at the National Institutes of Health (NIH) in 1985.

Purpose: The purpose of this report is to examine the historical context of federal research funding to schools/colleges of nursing to determine if the NINR/NIH budget is adequate.

Method: Data were extracted from the NIH RePORT/ER database from 1993 to 2017. Additional data were obtained from the American Association of Colleges of Nursing. A return on investment analysis for four landmark nursing studies is included.

Findings: The percent of the NINR budget awarded to schools/colleges of nursing peaked in 2005; since 2011, more funding to schools/colleges of nursing was received from all other NIH institutes combined, compared to NINR. The return on investment for four nursing research studies, ranged from $1:$202 to $1:$1,206, and far exceeds the Standard and Poor's 500 Index (S&P 500) of 10%.

Discussion: Federal funding of nursing research is inadequate and a chokepoint relative to the number of doctoral programs. We suggest the NINR budget would need to increase at least fivefold to over $763 million to adequately fund nursing science. The impact of inadequate funding on the discipline is discussed.

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Choke point: "In military strategy, a ***choke point*** *(or* ***chokepoint****) is a geographical feature on land such as a valley, defile or a bridge or at sea such as a strait, which an armed force is forced to pass, sometimes on a substantially narrower front and therefore greatly decreasing its combat power, to reach its objective (Wikipedia, 2019)."*

Chokepoints occur when there are inadequacies in the supporting infrastructure to support the capacity of mobilizing forces, and they lead to the obstruction of progress, in this case by nurse scientists, to discover new knowledge to improve human health. Critical to the success of discovering new knowledge by nurse

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scientists is adequate research funding to conduct research studies and support the required infrastructure. While other nursing faculty challenges exist and have been identified, such as the average age of doctoral degree completion being 47 (Dracup et al., 2009), or the 30% difference in salaries between assistant professors in academia and service professionals (Institute of Medicine (IOM), 2011), impactful research would be impossible without federal funding. The Federal government, across all agencies, is the largest major source of biomedical research funding in the United States. However, the National Institutes of Health, critical to the development of the capacity of research faculty, is the largest single federal agency that funds scientific research conducted by investigators in schools/colleges of nursing accounting for 94% of funding between 1988 and 2014 (Kerr, 2016).

The National Institute of Nursing Research (NINR), founded as the National Center for Nursing Research (NCNR), at the National Institutes of Health was established by legislation when Public Law 99-158 was passed on November 20, 1985. The stated purpose for NINR in this public law was "...the conduct and support of, and dissemination of information respecting, basic and clinical *nursing* [emphasis added] research, training, and other programs in patient care research." Passage of this legislation was the culmination of efforts of leaders in the nursing community and congressional supporters. The first Congressional appropriation to NINR of $20 million was received in 1987 and remains one of the smallest levels of funding ever budgeted by Congress to launch a new institute in the decade before and in the decades following the establishment of NINR (U.S. Department of Health and Human Services, National Institutes of Health, Office of Budget, 2019). And, unlike many other new institutes established at NIH, there was no appropriation committed to constructing a building for this new institute (Public Law 99-158 (99th Congress). Health Research Extension Act of 1985, 1985.

Nursing science contributes to the health of the nation by discovering new knowledge to improve human health. In short, the focus of nursing research is to promote and restore health. The march of discovery by nurse scientists has led to improving the cardiovascular health of children, identifying the contribution of nurse staffing levels to decreasing mortality, improving the capacity of teens to manage diabetes, managing hypertension in inner city African-American men while lowering associated complications and developing measures to predict the risk of developing pressure ulcers (U.S. Department of Health and Human Services, National Institutes of Health, National Institute of Nursing Research, 2006). These "landmark" studies (U.S. Department of Health and Human Services, National Institutes of Health, National Institute of Nursing Research, 2006) were all supported by the NINR at the National Institutes of Health (NIH). The inadequate support for nursing research was identified early by the Institute of Medicine (IOM) report, "Nursing and Nursing Education: Public Policies and Private Actions," in 1983 that fostered establishment of NINR by recommending that an entity be established at the federal level to support nursing research (Institute of Medicine (IOM) 1983). The challenge to secure funding for nurse scientists remains after more than 30 years since the existence of the NINR (Conn et al., 2015). As voiced by Dr. Linda Aiken, "The funding has never been as great as we imagined it could be and so the overall funding is a constraining factor in terms of the ability of the NINR to really make significant progress" (Cantelon, 2010).

The purpose of this article as the NINR approaches 35 years of history at NIH is to examine in detail how nursing research capacity has reached a chokepoint in development relative to the number of research investigators and doctoral (PhD and DNP) programs that have grown over the last decades and has exceeded the capacity of resources available in the Federal system to fund innovative cutting edge research. Our analysis includes PhD and DNP programs because (1) it provides equivalency with funded investigators in other professional schools/disciplines (medicine and dentistry) where the data include individuals with a variety of doctoral degree types, (2) eligibility for NIH funding for research awards (R awards) has no degree requirements, and (3) expectations for scholarly productivity is increasing for both PhD and DNP faculty in schools/colleges of nursing. We also performed a preliminary analysis of four landmark studies to examine how nursing science contributes to advancing the health of the Nation to demonstrate how each dollar invested in nursing science yields a substantial return on investment (ROI). Since funding is critical to continued progress to build research infrastructure in schools/colleges of nursing, we present findings on both current federal funding for nursing research and the historical context to provide data and understand what actions the nursing community can take to increase funding for nurse scientists. Here, we build on the previous work of Kerr (Kerr, 2016) who in her article identified the federal agencies funding nursing research and the types of awards provided.

Methods

The publicly accessible NIH Research Portfolio Online Reporting Tools (RePORT/ER) using the NIH Awards by Location and Organization database provided data for analysis in this article. Data from 1993 to 2017 were used since it contained the search fields/terms used to compile and isolate data for each year. Search criteria used for this article included: fiscal year, institute/center, and organization type (schools of nursing). Data harvested and compiled included: fiscal year, name of Principal Investigators (PIs), number of awards (this includes all types of awards for research and training, "R," "T," "F," "K," and "P" unless otherwise specified), name of institution, department of institution, and funding amount. Search results on the RePORT/ER database were then exported using the Microsoft Excel spreadsheets option, and pertinent data were copied into separate master spreadsheets. These secondary master spreadsheets were then used to create the figures and statistics presented in this article.

Funding amounts from the RePORT/ER database combine direct and indirect cost, when available, into 1 dollar amount. This total amount was used to represent total dollar amounts awarded. These grants represent extramural grants and do not include intramural grants, those awarded to NIH-employed scientists.

Kerr (Kerr, 2016), in her article on federal support for nursing science, used data from the same database starting in 1988. However, these years (1988–1992) were since archived into the ExPORTER CRISP Legacy Data database and were not used for this article, as they are unable to be sorted by the search criteria used in our analysis. Data from year 1998 were excluded from this article because of coding errors in the database that had gone undetected until we began our analyses. Although all grants for the year were present, search criteria did not accurately sort data. Database organizers were unable to restore the integrity of the search criteria (C. LaPlante, personal communication, February 10, 2016).

Data on the NIH and institute/center budget funding/appropriation levels were obtained from the NIH Office of Budget *Appropriations History by Institute/Center (1938 to Present)* at https://officeofbudget.od.nih.gov/approp_hist.html. Additional data on funding success rates and the 2017 budget request were also obtained from the NIH Office of Budget. Additional data on NIH funding for FY 1994 to 2017 were obtained from the Congressional Research Service at https://www.everycrsreport.com/reports/R43341.html#_Toc513202348.

For Figure 2, each value represents the percent of the total NIH extramural budget as the percent of dollars awarded to each type of organization. Each of the queries in the RePORT/ER database isolated all awards by organization type (schools of nursing, dentistry, and medicine), and year. Resulting queries were exported using the Microsoft Excel spreadsheet option and summed. This summation represented the amount (in dollars) of extramural awards in total to each school type. Each of these values were then divided by the sum of all NIH extramural awards for that year, summed by exporting a query selecting the year and leaving all other search categories to “all.” Data were reported as percentages.

Data for Figure 3 were queried from ReORT/ER that was exported using the Microsoft Excel option and summed. The base value of $119,992,629 was used to represent the amount of NINR extramural funding for 2017. Likewise, total NIH extramural awards were retrieved by isolating year 2017, and specifying organization type as schools of medicine. This resulting query was exported using the Microsoft Excel option. Each listed medical school was compared to the total extramural funding of the NINR amount.

NINR funding of schools of nursing data was harvested from data available in RePORT/ER for 2017 and then used to graph data used in Figure 5 and compiled for use in Tables 2 and 3. The number of doctoral level nursing programs data were gained from the *Enrollment and Graduations in Baccalaureate and Graduate Programs in Nursing* from the American Association of Colleges of Nursing (AACN reports) from years 1993 to 2017 (data obtained directly from AACN).

ROI analysis was performed by estimating cost savings and predicting savings to the health care system if the intervention (Brooten et al., 1986; Naylor et al., 2004), health promoting behavior (Harrell et al., 1996), or use of a tool to prevent pressure ulcers (Bergstrom, Braden, Kemp, Champagne, & Ruby, 1996) was adopted. Data were obtained from the articles cited themselves or in conjunction with cost estimates for disease conditions based on the cost of care for the respective condition (very low-birth-weight infants, cardiovascular disease, heart failure, and pressure ulcers) obtained from a review of literature or cited in the article (Murphy & Topel, 2003). Cost savings were calculated in the (1) Brooten et al. (Brooten et al., 1986) article if the transitional care model were adopted and used for one-half of the early discharged very low-birth-weight infants saving a total of $334 million; (2) Harrell et al. (Harrell et al., 1996) article if the physical activity intervention resulted in a 1% decrease in the cost of cardiovascular disease treatment for the year 1996 (Miller, Hughes-Cromwick, & Roehrig, 2011) saving $1.336 billion; (3) Bergstrom et al. (Bergstrom et al., 1996) article if the use of the Braden risk tool that was widely adapted resulted in a 10% decrease in the cost of treating pressure ulcers estimated to be $9 billion (U.S. Department of Health and Human Services, Agency for Healthcare Research and Quality (AHRQ), 2011) resulting in a $900 million savings; and (4) Naylor et al. (Naylor et al., 2004) article where a savings of $4,845 for each of 135,000 readmissions would result in a $654,075,000 million savings.

Findings

Congressional Appropriations History of NIH and NINR; and of NIH Institutes by Year of Founding

We first examined the Congressional appropriation history of NIH and found that it has grown dramatically from 1987 when NINR received its first congressional appropriation of $20 million. At that time, the total NIH appropriation was about $6.2 billion, and over the next two decades from 1987 to 2007, the total NIH budget rose to over $29.2 billion representing a doubling each decade (Table 1). Then, in the decade from 2007 to 2017, there was a change in the growth

Table 1 – Congressional Appropriation History of NIH and NINR for 1987, 1997, 2007, and 2017

Year	NIH	NINR	Percent of NIH Budget
1987	6,182,910,000	20,000,000	0.323%
1997	12,740,843,000	59,721,000	0.469%
2007	29,178,504,000	137,404,000	0.471%
2017	34,300,999,000	150,273,000	0.438%

rate of the total NIH budget where it began to grow incrementally. NINR increased from its first funding of $20 million in 1987 rising to $137 million in 2007 and then to $150 million in 2017; over the ensuing decades, its budget also doubled until 2007. Thus, the NINR budget overall has largely mirrored the budgetary increases received by NIH overall and the dollars invested in nursing science have remained relatively stable with less than 1% of the NIH budget being invested in nursing science, despite the responsibility of nurses being the nation's largest providers of health care who depend on science to provide the most scientifically advanced health care. From an initial 0.323% of the NIH budget, NINR rose to 0.471% and as of 2017 is now 0.43% of the budget.

Examining the history of congressional appropriations to the institutes and centers at NIH, we graphed the funding of each institute by year of founding to examine the relative growth in the NINR budget compared to other institutes at NIH. As can be seen in Figure 1, The National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), started in the same year (1987) as NINR, began with $138.7 million or over six times the NINR budget of $20 million and received almost double the funding of NINR in 2017, $557.8 million for NIAMS compared to $150.2 million for NINR. Other institutes started after NINR were the National Institute of Deafness and Other Communication Disorders (NICCD) in 1989 with an initial budget of $94.1 million; the National Human Genome Research Institute (NHGRI) in 1990 with an initial budget of $59.5 million; the National Center for Complementary and Alternative Medicine (NCCCAM), now the National Center for Complementary and Integrative Health (NCCIH) in 2000, with an initial budget of $68.3 million; the National Institute for Minority Health and Health Disparities (NIMHD) in 2001 with an initial budget of $130 million; and the National Institute of Biomedical Imaging and Bioengineering (NIBIB) in 2002 with an initial budget of $111.8 million. This shows that the initial NINR budget was a rate limiting step accompanied

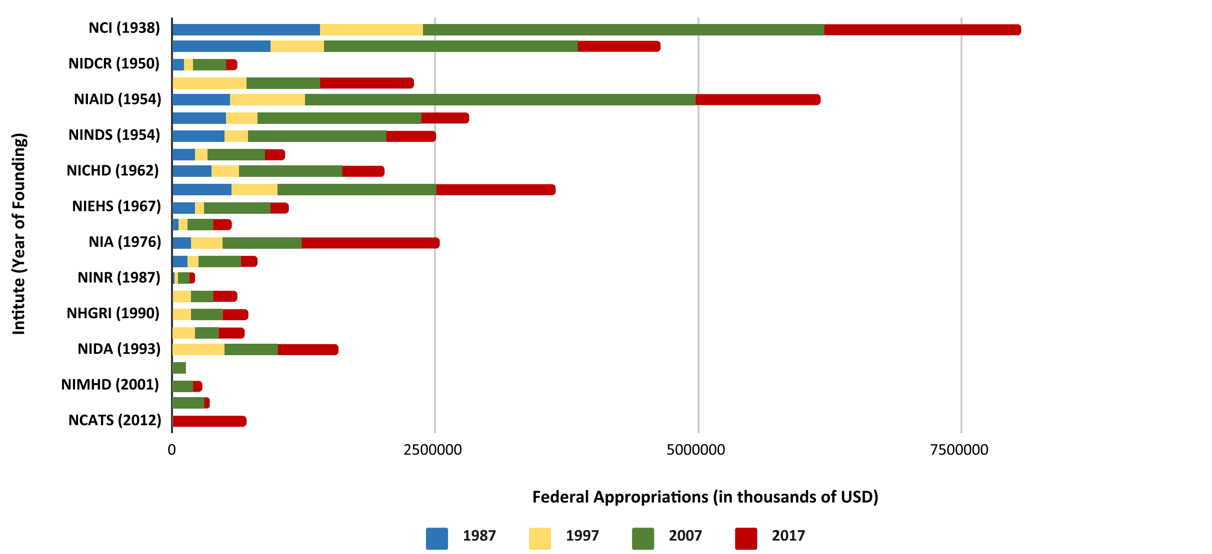

Figure 1 – NIH Institute Appropriations by Institute Year of Founding for NINR and all other institutes for 1987, 1997, 2007, 2017. Note: NCI, National Cancer Institute; NHLBI, National Heart, Lung, and Blood Institute; NIDCR, National Institute for Dental and Craniofacial Research; NIMH, National Institute of Mental Health; NIAID, National Institute of Allergy and Infectious Disease; NIDDK, National Institute of Diabetes, Digestive and Kidney Diseases; NINDS, National Institute of Neurological Disorders and Stroke; NEI, National Eye Institute; NICHD, National Institute of Child Health and Human Development; NIGMS, National Institute of General Medical Sciences; NIEHS, National Institute of Environmental Health Sciences; NLM, National Library of Medicine; NIA, National Institute on Aging; NIAMS, National Institute of Arthritis and Musculoskeletal and Skin Diseases; NINR, National Institute of Nursing Research; NIDCD, National Institute on Deafness and Other Communication Disorders; NHGRI, National Human Genome Research Institute; NIAAA, National Institute on Alcohol Abuse and Alcoholism; NIDA, National Institute on Drug Abuse; NICCH, National Center for Complementary and Integrative Health (NCCAM is now NCCIH); NIMHD, National Institute on Minority Health and Health Disparities (NCMHD is now NIMHD); NIBIB, National Institute of Biomedical Imaging and Bioengineering; NCATS, National Center for Advancing Translational Sciences.

by a lack of comparable budget increases over time resulting in a restricted budget growth over time.

The Research Project Grant (RPG) success rate is calculated annually for each institute and reflects the awards that support various research grant mechanisms (R01, R15, R21, R00, etc.) across the various NIH institutes. In 2017, the RPG success rate for NINR was 8.9%, the lowest among all NIH institutes, compared to an overall success rate of 18.7% (RePORT, 2017). By comparison, in 1997 (earliest year available in the database), the RPG success rate was 28.7% when 224 applications were received and 64 were funded; compared to 570 received and 51 funded in 2017. This means that in 2017, NINR would have been able to fund an additional 56 grants if their RPG success rate were 18.7% rather than 8.9%. Overall, the next lowest RPG rate was 10.8% for the Fogarty International Center (FIC) to a high of 30.6% for the National Institute for General Medical Sciences (NIGMS). The three largest institutes, NCI, NIAID, and NHLBI, have success rates of 11.7%, 19.1%, and 23.5%, respectively. While the three smallest institutes (other than NINR) NCCIH, NIMHD, and NIBIB have success rates of 16.7%, 21.5%, and 13%, respectively. This indicates that more grants are submitted to NINR that are scored, but are not being funded compared to the funding levels of other NIH institutes due to the inadequate NINR budget.

Examining the budgets of NIH institutes from 2000 to 2017, further funding trends emerge. From 2000 to 2017, the total NIH budget increased by slightly more than twofold or 2.09 times; while the range was from a low of 1.659 times (X) for NHGRI (excluding NCATS that was 1.29 times) to a high of 3.749X for NIA, followed by NIBIB at 3.378X, NIAID at 2.926X, and NIMHD at 2.33X. The institutes with the lowest increase across this period were for NHGRI (1.659), NIDCR (1.665), NHLBI (1.667), and NIAMS (1.676), while the NINR budget increased 1.765, falling between the highest and lowest increases. Of significant note is the dramatic increase in the budget of the Office of the Director (OD) at NIH where across this same period the budget grew from $282,000,000 to $1,925,893,000 representing a 6.829X increase. There was a significant notable increase between 2006 and 2007 when the OD budget grew from $478,000,000 to $1,046,901,000 or by 2.19X over a *single* year. We make note of this relative dramatic increase in the OD budget to indicate that Congress has the capacity to dramatically increase the budgets of various NIH institutes in response to constituent demands.

Percent Extramural NIH Funding of Nursing, Dental, and Medical Schools (1993, 2003, 2013, and 2017)

Next, we examined the level of NIH funding that flows to nursing, dental, and medical schools because together these professional programs conduct research to improve human health and serve as the educational foundation for the next generation of researchers and practitioners/providers. These funds provide both direct costs for the conduct of research and for the associated indirect costs that build research capacity in these professional schools. Medical school funding increased over the decades receiving almost 40% to 50% of the total extramural funding awarded by NIH (Figure 2). Over that same period NIH funding to schools/colleges of nursing declined from 0.63% to 0.55%, less than 1% of the NIH budget, while dental schools also declined from 2.75% to 1.67%. There were 155 medical schools (MD) operating in 2017 compared to 374 nursing schools offering the PhD/DNP/DNS meaning that a larger percentage of funding from NIH is concentrated per institution in medical schools to conduct studies and to build infrastructure to support research.

In 1993, when data were first available for this analysis, the budget of NINR was $48.1 million out of a $10.335 billion NIH budget representing 0.46% of the NIH budget. By 2017, the NINR budget was $150,273,000 million out of a $34.3 billion budget representing 0.46% of the NIH budget, representing no change over the decades to increase the percent of the NIH budget supporting the research programs of nurse scientists.

NIH Extramural Funding of Medical Schools (2017) Compared to Total NINR Extramural Funding

We next examined the amount of NIH funding in 2017 that is received by individual medical schools compared to the NINR budget to further assess the impact on schools of nursing with doctoral programs since there are two times the number of nursing schools with doctoral programs (n=374) compared to medical schools (n=155) and both depend on funding to support scientific research and train the next generation of investigators. We found that 38 individual schools of medicine very closely equal or far surpass the *total* extramural funding capacity of NINR.

These 38 schools of medicine received $9,449,129,359 and would together, equal or require 78 times the amount of annual NINR extramural funding of $119,992,629 awarded in 2017 or 62 times the *entire* annual 2017 NINR Congressional appropriation of $150,273,000 that includes the NINR administrative and intramural budget. Thus, as graphically displayed in Figure 3, the annual extramural budget of NINR would be required to fund 4 schools of medicine (SOM); another 17 schools of medicine would require more >1X the annual extramural NINR budget; 10 schools of medicine would require 2X the annual extramural NINR budget; 6 schools of medicine would require 3X the annual extramural NINR budget; and 1 school of medicine would require more than 4 times the annual extramural NINR budget to fund research at any 1 of those schools of medicine. Funding for these 38 Schools of Medicine ranged from a low of $120,709,746 at the University of Miami School of Medicine to a high of $526,347,530 at the University of California San Francisco.

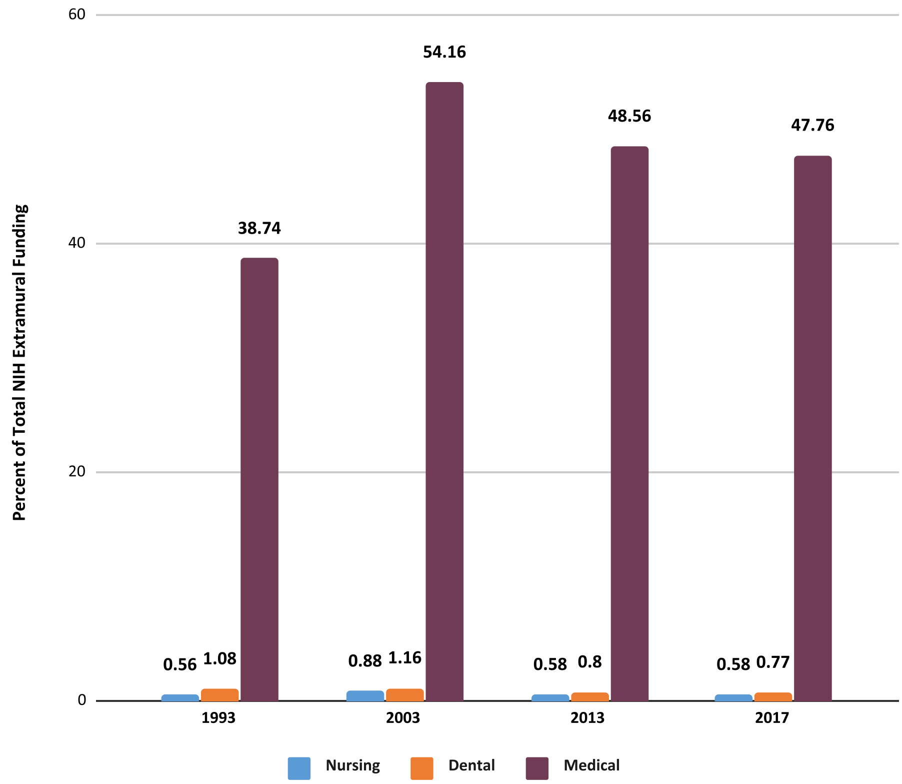

Figure 2 – Percent extramural NIH funding from all NIH institutes to nursing, dental and medical schools for 1993, 2003, 2013, and 2017.

The total amount of NIH extramural funding to 141, or 90%, of MD medical schools in 2017 was $12,589,754,346 with an average of $89,289,037 per funded medical school. In contrast, there are 497 doctoral nursing programs, where 347 were DNP and 143 were PhD programs, offered by 374 schools/colleges of nursing (some schools/colleges offer both DNP and PhD), but only 50 of these received funding. Our analysis indicates that the top 10 schools/colleges of nursing received $28,168,409 or about 52% of all NINR extramural funds awarded to schools/colleges of nursing in 2017.

Analyzed by the funds available per school/college of nursing over time, we found that when the NINR extramural budget was $30,320,747 in 1993, NINR funded research/training in 57 schools/colleges of nursing that translated into an average of $531,943 per school/college of nursing. Then in 2017, when NINR extramural funding was $54,198,006 among 50 schools/colleges of nursing receiving funds, the average per school/college translated into $1,083,960 per school. When funding from all NIH institutes is considered, then on average each school/college of nursing received $2,268,630. However, considering there were 374 schools/colleges of nursing with PhD and/or DNP programs, this means that only about 14% of schools/colleges of nursing with doctoral programs have *any* NIH funds available to educate the next generation of nurse scientists and practitioners.

Thus, on average, each school/college of medicine received a little more than 39 times the level of average NIH funding compared to the average of each school/college of nursing that was funded in 2017. The NIH funds about 90% of schools/colleges of medicine.

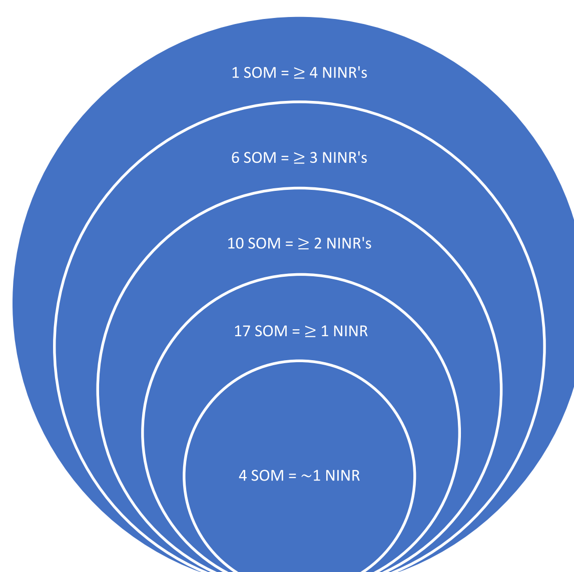

Figure 3 – NIH extramural funding of 38 medical schools compared to the total extramural NINR budget (2017).

Thus, if 90% of schools/colleges of nursing were each funded at $2,268,630 per school, a modest sum considering the cost of conducting impactful research, the level of the extramural funding to schools/colleges of nursing would need to rise to $763,620,858. This means that the NINR extramural budget alone would need to increase at least fivefold based on the 2017 Congressional appropriation.

NIH Funding Breakdown (1993–2017)

Nursing schools compete for and receive funding from other NIH institutes other than NINR. Over time, the amount of funding to schools/colleges of nursing increased, but in 2011, these schools/colleges started to receive over half their extramural NIH funding from other NIH institutes (all other NIH institutes excluding NINR; Figure 4). Other NIH institute funding has steadily risen since 1993, while NINR funding peaked in 2005, and today less than 50% of the NINR budget is awarded to schools/colleges of nursing. We make a distinction because unless funds flow to institutions with schools/colleges of nursing *only*, compared to health science schools where nursing is a component along with other allied health disciplines, then the ensuing benefits to faculty, trainees, and infrastructure are not necessarily strengthened for nursing. Other institutes surpass NINR funding to schools of nursing partly because of a constrained NINR budget (Figure 1). This means that currently most NIH support of schools/colleges of nursing comes from *other* NIH institutes rather than NINR. Data from 2017 indicate that the funding level by other NIH institutes/centers was $97,800,242 compared to $54,198,006 from NINR to schools/colleges of nursing. Thus, nursing research does not have a single institute funding base. Analysis of funding is important because both the direct and indirect costs associated with funded research support faculty, trainees, and build infrastructure. Here, we captured data for more than two decades to inform the historical context of the analysis.

NINR Extramural Funding and Doctoral Nursing Programs (PhD and DNP) 1993–2017

We examined the growth in the number of doctoral programs in nursing to assess the adequacy of NIH funding to schools/colleges of nursing over the decades in parallel with the NIH funding data. We examined growth for both research doctoral (PhD) and practice-focused (DNP) doctoral programs to achieve parity with other professional practice disciplines. These programs are similarly supported by medical/dental schools where the MD, DDS, DMD is a practice-focused doctoral degree and faculty/scientists in medical schools hold MD, MD/PhD, DDS, DMD, DDS/PhD, DMD/PhD, or PhD degrees. From 1993 to 2017, the number of research-focused PhD doctoral programs only saw modest growth from 50 to 143, while the number of practiced-focused doctoral programs (DNP)

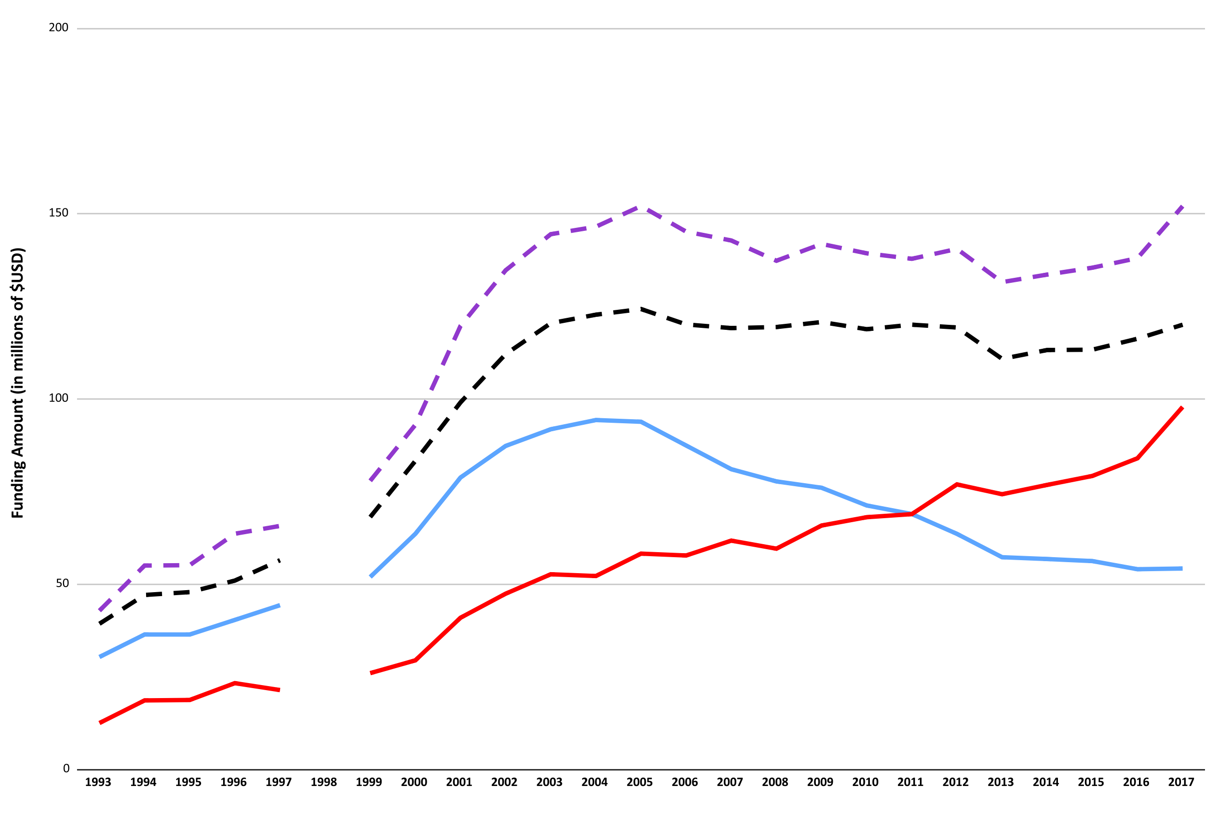

Figure 4 – Funding of schools/colleges of nursing by NINR versus all other NIH institutes (1993–2017).

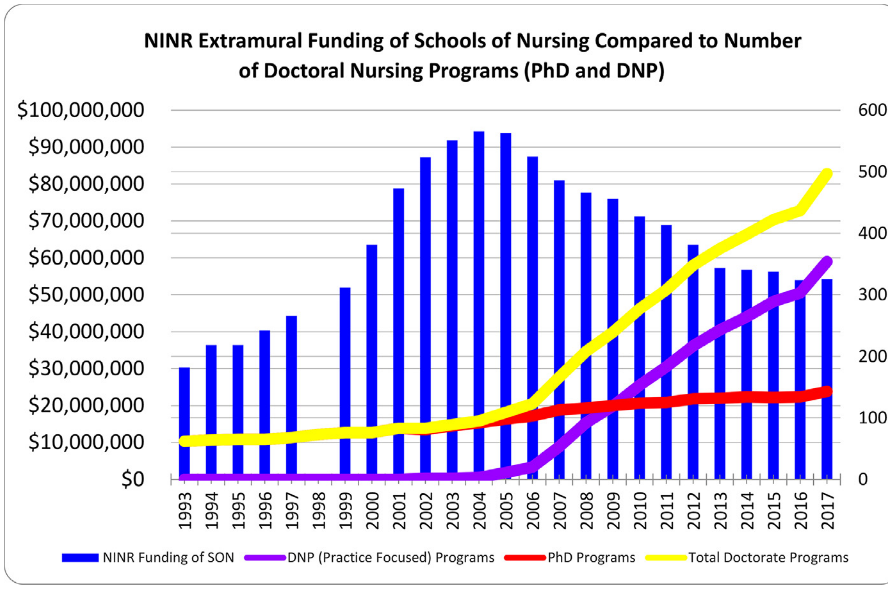

Figure 5 – NINR extramural funding to schools/colleges of nursing (1993–2017) relative to number of doctoral nursing programs (PhD and DNP).

over that same period started to rapidly increase beginning in 2006; there were no DNP programs in 1993; this number rose to 5 in 2006; and then to 354 in 2017 (Figure 5). Thus, the number of practice-focused doctoral programs (DNP) surpassed the number of medical schools in 2010, and became double the number of nurse PhD research-based programs in 2014. NINR extramural funding to schools/colleges of nursing over this period of explosive growth actually declined. Instead of rising to meet the needs of a growing research-based academic community, the amount of dollars awarded to schools/colleges of nursing declined almost 62% between 2006 and 2016, just when the boom in practice doctorate programs rose exponentially.

NINR awards funds to other non-nursing schools/colleges and entities. In 2017, the total amount of extramural funds awarded by NINR was $119,992,629 (million). Of that amount, $54,198,006 was awarded to schools/colleges of nursing while $65,794,623 was awarded to other programs: schools of public health, schools/colleges of medicine, etc. As can be seen in Figure 5, the extramural funds awarded to schools/colleges of nursing peaked in 2004 and2005 and then declined to the present levels where in 2017 less than half of extramural funds were awarded to schools/colleges of nursing. In 1993, 77% of the NINR budget ($30,320,747) was awarded to schools/colleges of nursing and this remained consistent through 2005 at 75% ($93,809,185), but in 2006 declined to 73% ($87,398,320) and then through 2017 further declined to 45% of the NINR budget ($54,198,006). Thus, both as a percent of the NINR budget and in actual dollars, the funds awarded by NINR to schools/colleges of nursing over time have declined since 2006.

A closer examination of the NINR funds awarded (numbers include both direct and indirect costs) to major entities categorized in the RePORT/ER database can be seen in Table 2. When considering all the awards made by NINR for 2017, the average award size was $346,780. Data indicate that in 2017, there were 199 awards made to schools/colleges of nursing with an average award size of $272,352 compared to 64 awards

Table 2 – Major Entities Receiving NINR Extramural Funds for 2017

Entity	Number of Awards	Amount (Direct + Indirect)	Average per Award
Schools of Allied Health	9	3,387,544	376,394
Schools of Arts and Sciences	7	3,188,882	455,555
Schools of Dentistry	1	671,540	671,540
Schools of Engineering	7	2,226,417	318,060
Schools of Medicine	64	29,436,021	459,937
Schools of Public Health	10	5,244,497	524,450
Research Institutes	6	3,406,706	567,784
Independent Hospitals	17	8,523,745	501,397
Domestic for Profit	10	4,685,204	468,520
Other Domestic Non-Profits	7	2,854,463	407,780
Other*	9	2,169,604	241,067
Total Other Organizations	147	65,794,623	447,582
Total Schools of Nursing	199	54,198,006	272,351

Awards include all “R,” “F,” “T,” “K,” and “P” types;

* Other was coded as “Graduate school” for five grants; “Unavailable” for one grant; “Hospital” for two grants; and “University Wide” for one grant by NIH.

Table 3 – NIH Funding to Schools of Nursing by All Other NIH Institutes in 1993 and 2017 Compared to NINR

NIH Institute	Number of Awards		Amount (Direct + Indirect) in Dollars		Average per Award	
Year	1993	2017	1993	2017	1993	2017
FIC	0	2	0	501,901	0	250,951
NCCAM; NCCIH	0	4	0	827,627	0	206,907
NCI	23	33	2,149,432	12,021,070	93,454	364,275
NHLBI	3	17	306,705	8,854,678	102,235	520,863
NIA	13	47	2,393,521	17,674,562	184,117	376,055
NIAAA	4	5	830,347	1,322,655	207,587	264,531
NIAID	1	8	360,834	4,239,492	360,834	529,937
NIAMS	3	3	209,719	1,300,787	69,906	433,596
NICHD	4	33	1,371,648	12,446,187	342,912	377,157
NIDA	7	20	1,096,822	8,302,775	156,689	415,139
NIDCD	0	1	0	264,350	0	264,350
NIDCR	0	2	0	1,147,830	0	573,915
NIDDK	2	10	295,822	3,684,507	147,911	368,451
NIEHS	0	3	0	1,612,180	0	537,393
NIGMS	1	3	321,008	560,955	321,008	280,478
NIMH	14	17	2,113,901	6,325,438	150,993	372,085
NIMHD	0	24	0	14,334,324	0	597,264
NINDS	1	3	89,069	354,396	89,069	118,132
NLM	3	1	410,143	530,470	136,714	530,470
OD	0	2	0	1,494,058	0	747,029
NCRR*	11	0*	548,985	0*	49,908	0*
Total Other	90	238	12,497,956	97,800,242	138,866	406,448
Total NINR	264	199	30,320,747	54,198,006	114,851	272,352

* The National Center for Research Resources (NCRR) was dissolved in 2012.

to Schools of Medicine with an average award size of $459,937, while the average RPG grant award for all of NIH was $520,429. The next highest number of awards was 17 made to independent hospitals with an average award size of $501,397. Examination of the table reveals that the average size of award varies across the entities receiving research funds; however, the lowest average award size is to schools/colleges of nursing.

In 2017, NINR awarded $54,198,006 (199 awards) to schools/colleges of nursing, while other NIH institutes (excluding NINR) awarded $97,800,242 (238 awards) to schools/colleges of nursing for a combined total of $151,998,248. Thus, *other* NIH institutes are funding almost twice as much in dollars as NINR on research and training awards to schools/colleges of nursing indicating that NINR funding is insufficient.

We examined which other NIH institutes fund research conducted in schools/colleges of nursing across the NIH for 2017 (Table 3). We found that NIA, NIMHD, NICHD, and NCI were major sources of funding to investigators in schools/colleges of nursing followed by NHLBI, NIDA, NIMH, NIAID, and NIDDK. This indicates that *other* NIH institutes are a major source of research funding based on total number, amount, and average per award to schools/colleges of nursing, but also indicates that investigators can successfully compete for funding from other NIH institutes.

ROI for Four Nursing Studies

Last, we performed a limited analysis of four nursing studies that were conducted across more than three decades to examine the potential ROI that can be obtained from nursing research studies (Table 4). To perform this analysis, we selected four landmark studies that generated considerable attention by the public and by nurses. Grant dollar award amounts were obtained from the NIH RePORTER database by summing the total direct and indirect costs for the grant award number cited in the article or from publicly available sources obtained via an Internet search. Our preliminary analysis indicates that for each grant dollar invested in the research study conducted the ROI ranged from $1:$202 to $1:$1,206. When compared to the standard rate of return for the Standard & Poor's 500 Index (S&P 500) of 10% for the past 90 years (1926–2018), the most commonly used economic measure of ROI success (Investopedia, 2019), this represents an incredible return for each dollar invested. Together, these four studies have an estimated total savings of $3.224 billion dollars to the health care system. This is almost the same as the entire NINR budget since the start of the NINR, that is from 1987 to 2017 of $3,009,577,000.

Discussion

Insufficient funding for nursing research has reached a critical chokepoint that is severely impeding the research agenda of nurse scientists across the nation. These chokepoints have reached a critical threshold that is now impeding the capacity of nurse scientists

Table 4 – Estimated ROI for Four Nursing Studies

Study	Investigator(s)	Estimated Potential Cost Savings in Dollars	Grant Award(s) Amount in Dollars	ROI
"Transitional care of older adults hospitalized with heart failure: A randomized controlled trial" J Am Geriatr Soc 2004; 52:675-684	Naylor, Brooten, Campbell, Maislin, McCauley, and Schwartz	$654,075,000 ($4,845 saved X 135,000 readmissions)	$2,588,230	1:252
"Effects of a school-based intervention to reduce cardiovascular disease risk factors in elementary-school children: The Cardiovascular Health in Children (CHIC) study" J Pediatr 1996; 128:797-805	Harrell, McMurray, Bangdiwala, Frauman, Gansky, and Bradley	$1,336,000,000 ($133.6 billion cost of cardiovascular disease in 1996 × 1% reduction)	$6,601,843	1:202
"Multi-site study of incidence of pressure ulcers and the relationship between risk level, demographic characteristics, diagnoses, and prescription of preventive interventions" J Am Geriatr Soc 1996; 44:22-30	Bergstrom, Braden, Kemp, Champagne, and Ruby	$900,000,000 ($9 billion X 10% reduction)	$1,205,324	1:746
"A randomized clinical trial of early hospital discharge and home follow-up of very-low-birthweight-infants" NEJM 1986; 315:934-939	Brooten, Kumar, Brown, Butts, Finkler, Bakewell-Sachs, Gibbons, and Delivoria-Papadopoulos	$334,000,000 ($18,560 × 230,000 if ½ of discharged infants used the program)	$276,860	1:1,206

to conduct research studies to improve human health. Federal funding for research conducted by nurse scientists in schools/colleges of nursing supported by NINR is declining and choking off the ability to conduct impactful research requiring substantive funding leading to advances in human health because of restricted resources. Schools/colleges of nursing received the lowest total dollar amount of federal funding in 2017 ($151 million [$54 million NINR; $97 million other NIH institutes/centers]) compared to other professional programs in medicine ($19 billion) and dentistry ($202 million). And, as a percent of the total NIH budget, NIH funding to schools/colleges of nursing has always been lower than either medicine or dentistry since 1993. Although, it should be noted that dentistry experienced a 40% decline from a high of 1.16% in 2003 of the NIH budget to 0.77% in 2017.

The budget of NINR stands in contrast to the budgets of other NIH institutes/centers where their budgets have on average surged ahead from a higher starting funding base amount upon founding. Federal research grants have associated indirect funds that are critical to support, build, and maintain infrastructure to conduct successful programs of research and to expand the capacity of school/colleges to conduct research directed at human health. As the level of funding to schools/colleges of nursing for scientific research by NINR has decreased, there has been a commensurate increase of funding by *other* NIH institutes/centers, indicating that grant applications submitted by faculty in schools/colleges of nursing is scientifically competitive.

Ada Sue Hinshaw (Cantelon, 2010) estimated that NCNR/NINR funding would need to be $132 million in 1994 at a time when NIDCD, a newer institute, was funded at $162.8 million while NINR was funded at $51 million, to achieve budget parity and to adequately support nurse scientists. It should be noted that this level of funding was finally achieved more than a decade later in 2004. More recently, the disparity in budgets can be seen in the 2018 budget where the NCI budget increased by $275 million for a total of $5.96 billion; while the NINR budget increased by $7.76 million to $158 million. Thus, the NCI budget increase *alone* was more than the entire NINR budget but indicates that significant funding increases can occur. Likewise, this same dramatic increase also occurred in the OD budget as noted previously and both indicate capacity to increase the NINR budget.

The lack of sufficient funding is especially critical relative to the dramatic growth in the number of doctoral programs, both PhD and DNP, in schools/colleges of nursing across the nation. These doctoral programs prepare both nurse scientists to generate new knowledge and advanced practitioners who rely on science to support their practice. The scholarly productivity of DNP, PhD, and DNP/PhD faculty is increasing as individuals with DNP degrees begin to swell faculty ranks. Data from the NIH Physician-Scientist Workforce Working Group Report in 2014 identified 341 NIH funded nurse scientists (degrees not identified) compared to NIH funding for about 8,000 physician scientists (National Institutes of Health, Physician-Scientist Workforce Working Group Report, 2014). The work group found that those who are MD/PhDs enjoy the highest success rate compared to MDs or PhD groups. This may foreshadow a future of higher success rates among nurses with both DNP and PhD degrees. Thus, we see these two levels of preparation as complementary and not competitive, both require research support and both are eligible to submit grant applications.

The top 10 schools of nursing receive nearly 50% of the NINR extramural budget awarded to schools/colleges of nursing and generate some of the most impactful research, but these same 10 schools alone cannot prepare all the numbers of new faculty needed with sufficient scientific depth and breadth to address all of the research needed. Or much less provide resources to "double" the number of doctorly prepared nurses to meet the IOM recommendation made in 2010. Even among these top 10 schools, only 6 had 10 or more grants in 2017. This research ranges from basic biomedical research to the types of psycho/social/behavioral, population, occupational, environmental, health economics, policy, and ethical studies across the lifespan required to successfully engage with all scientific disciplines to be sure that nursing scientists are adequately represented to contribute to the knowledge required to improve and maintain human health. All of this is occurring against a backdrop where science is becoming increasingly complex and yet integrated at times with convergence occurring in study designs where both the genetic basis of disease and social determinants of health are studied together.

The effect of insufficient funding capacity impacts faculty who seek to achieve tenure and the capacity of schools/colleges to maintain an adequate number of faculty in the ranks. Also, it affects the ability to provide sufficient training for the next generation of nurse scientists at the pre/postdoctoral levels. This is all occurring at a time when there is already a faculty shortage to support these doctoral programs (American Association of Colleges of Nursing, 2019; Dracup et al., 2009; Nardi & Gyurko, 2013).

Other effects of the insufficient level of funding and support of the grant-associated directs and indirects are on the ability of school/colleges of nursing to build sufficient infrastructure to provide the 30%–45% release time most assistant professors require to successfully launch their research careers and provide internal seed funding (Broome & Fairman, 2018; Minnick, Norman, & Donaghey, 2017). Newly hired assistant professors require the mentoring and support of successfully funded senior investigators to become proficient scientists. New faculty also require adequate start-up packages to pursue the program of research they plan to conduct over 3 to 5 years to achieve the necessary benchmarks in publishing and dissemination of results to achieve tenure. It is this same group of new investigators that will provide the capacity to serve as external grant reviewers, serve on editorial boards, and become members of public regulatory and policy boards (Broome & Fairman, 2018).

The 2017 RPG success rate of NINR was 8.9% compared to an overall success rate across NIH of 18.7%, the lowest among all institutes and along with the analysis performed here indicates that the budget of NINR is entirely insufficient to meet the research capacity among nurse scientists. Combined with the estimated 25% economic decline of the NIH budget in inflation adjusted dollars, this signals a further decline in real funding capacity (Dijkgraaf, 2017). These economic factors may be reflected in the average NINR grant award of $272,352 for grantees in schools/colleges of nursing compared to the average for grant awards by all other institutes/centers of $406,448. This is yet another factor that creates a chokepoint for research capacity among schools/colleges of nursing.

The intense pressure on faculty in schools/colleges of nursing to obtain grant funding when the NINR budget is not sufficient further contributes to the distress of faculty seeking to conduct impactful research to improve human health and as a pathway to tenure. It also likely acts as a deterrent to graduate students who witness the struggle of faculty to obtain funding and contemplate whether they should consider a career in academic nursing further leading to the faculty shortage.

The lack of sufficient funding to schools/colleges of nursing with only 14% of schools (50 out of 374 for 2017) funded means that graduate students at only a select number of schools/colleges of nursing benefit from high-quality training opportunities where they can engage with funded nurse scientists as a part of a research team. This raises concerns, voiced in the nursing community, that there are too many doctoral programs in schools without actively funded investigators with programs of research. While others point out that the number of potentially funded investigators has expanded more rapidly than available resources as evidenced by the data showing NINR had the lowest percent of funded scored grant applications compared to other ICs. Data for 2017 reveal that 17 or 12% of schools/colleges of nursing with PhD programs held NIH T32 training awards and 88% of these are at institutions with Clinical Translational Science Awards (CTSA). This is a slight decrease from a previous report (Wyman & Henly, 2015) where 20, or 15% of PhD programs, had NIH T32 training awards between 2008 and 2013. However, it is not clear if the benefits of the CTSA awards accrue to schools/colleges of nursing in a manner that is sufficient to meet training needs. The long-term outcome of this scenario is the inadequate scientific preparation of nurse investigators and diminished opportunities for postdoctoral training opportunities that are the gateway to launching a successful research career (Wysocki, 1998). This is a funding chokepoint that does not support the capacity to sustain excellence in doctoral nursing education (Breslin et al., 2015) to educate students, support postdoctoral training opportunities, and increase the funded research capacity across the nation.

One of the very bright spots revealed by our analysis is that nurse investigators are submitting competitively funded grant applications to other NIH institutes indicating that the scientific quality of these grants is on par with scientists from other disciplines. Currently, more nurse scientists are funded by other NIH institutes and when funded receive more robust grant awards based on the average grant size in dollar amount (Table 3). And our limited analysis examining the ROI of four nursing research studies revealed that some nursing studies yield an exceptional rate of return to American taxpayers and surpasses the investment benchmarks in the stock market by a wide margin. Although not all studies yield this rate of return, we suggest that the rate of return on nursing studies is likely to be higher than basic science studies because nursing studies are largely conducted on individuals, families, or communities and are more likely to have a direct clinical translation to benefit the health care system. However, funding of a more formal and comprehensive study is recommended beyond the analysis performed for this article to obtain a complete view and evaluate the impact of the contributions of nursing science. The fact that perhaps only four studies yielded enough ROI to fund the NINR since inception represents a fait accompli for nursing that should be disseminated to all members of Congress and leveraged to advocate for a substantial increase in the NINR budget.

Also of significant note in our analysis is the dramatic increase in the budget of the Office of Director (OD) of NIH with the establishment of the “Common Fund”. This may represent a significant shift in the power dynamics of the NIH campus where if the OD were now considered an “institute” would rank among the “largest” at NIH with a budget of $1.92 billion. As noted above, the year to year increase where the budget doubled in a single year indicates that doubling the NINR budget over a shorter time period is possible. Thus, the OD now ranks as the 8th largest “institute” at NIH and this calls into question the ability of the Director of NIH to be a fair and equitable voice for all of the institutes of NIH versus the ability of the Director to direct scientific priorities at the expense of smaller institutes or duplicate the efforts of other institutes and centers.

Thus, the sources of these chokepoints are the increasing number of faculty, the dramatic increase in research focused (PhD) and doctoral practice (DNP) programs since 2006, insufficient numbers of training opportunities, and the low RPG success rate while the growth in Federal research funds from the NINR to support the number of scientific investigators has largely stagnated since 2005. Critical to the health of all Americans is that the result of this chokepoint is a decrease in the capacity of nurse scientists to support new advances in the delivery of health care to maintain optimal health, prevent or mitigate the development of chronic health conditions, and restore health following medical or surgical interventions and treatment. Further, data from Table 2 indicate that the average grant size to schools/colleges of nursing is less and may impact the ability of nursing scientists/faculty to conduct impactful research with sufficient large sample sizes to increase generalizability to improve human health is constricted due to budget constraints that do not permit the conduct of longitudinal or large national sample size studies. Other outcomes of this restricted capacity are that the ability to educate the next generation of nurse investigators is severely constrained and that the infrastructure to support the conduct and dissemination of research is impaired.

We recommend, as have others (Devon, Rice, Pickler, Krause-Parello, & Richmond, 2016, Kerr, 2016), that the nursing community seek to significantly enlarge the funding base supporting nurse scientists. Increased funding is critical to progress and continuing to try to fit science into the inadequate level of funding will continue to act as a chokepoint or straight jacket to nurse scientists. We suggest several strategies: (1) conduct a more comprehensive and in-depth analysis of the ROI of funded nursing research studies to present to Congress; (2) conduct a more comprehensive and in-depth analysis of the exact level of increase in the NIH budget that is required by schools/colleges of nursing to support the capacity of nurse scientists across the nation and meet the research training needs for pre/postdoctoral students; (3) advocate to increase funds available to expand the number of individual and institutional training awards (F31, F32, and T32) to prepare competitive nurse scientists; (4) identify individuals and communities who have benefitted from scientific advances pioneered by nurse investigators to become advocates by writing congress or appearing at budget hearings as expert witnesses for NINR; (5) engage with the public to promote our research findings through radio, television, print, and social media and extend dissemination efforts beyond written research reports in peer-reviewed journals; and (6) continue to educate members of Congress and their staff about the outstanding advances by nurse scientists using data-based metrics and targets to drive the NINR budget higher to meet research and training needs. These efforts will require continuous, sustained, and unrelenting efforts by dedicated individuals across the spectrum of public and professional advocates to increase the NINR budget to the estimated $763 million outlined in this article. However, subsequent analyses may indicate that this level may actually fall short of what is required to advance the science and practice of nursing to improve the health of the nation.

Last, and most important, the greatest impact of the funding chokepoint identified here will be on the health of Americans who will not derive the benefits of research directed at preventing, improving, or ameliorating the effects of disease and disability resulting in increased health care costs, lower quality of care, and increases in morbidity and mortality. Thus, we conclude that federal funding for research by nurse scientists is not adequate to support advances in human health and call on all members of the nursing community to advocate with all members of Congress for an increase in the NINR budget.

Limitations

The major limitation of our analysis has been the gaps in the RePORT/ER database that prevented an analysis for all of the data points used. However, we included data from the earliest available time points because the long-term historical budget perspective is important to understand the data. Our analysis did not examine the credentials of the scientists awarded grants in schools/colleges of nursing or in other non-nursing schools/colleges/entities because this information was not coded in the RePORT/ER database. It was beyond the scope of this study to examine each award to determine its relevance to nursing and measure the extent of dissemination and translation to nursing practice. Analysis did not include award data from the Agency for Healthcare Research and Quality (AHRQ), Centers for Disease Control (CDC), Substance Abuse and Mental Health Services Administration (SAMHSA), or the Patient-Centered Outcomes Research Institute (PCORI) or other federal agencies as it was beyond the scope of this study and because this represents about 6% of funded research to schools/colleges of nursing based on already published data (Kerr, 2016). Some of the awards included in the NINR data included shared funding from other institutes for 2017, but in total dollar amount, this was negligible and did not impact our overall analysis. Another limitation is that our ROI analysis did not include an analysis using current dollars, correct for inflation, or determine if these interventions were fully implemented as these were beyond the scope of the data analyzed in this study. We also did not examine in detail the different types of grant awards (F, T, K, R, P, and U) made by NINR or the other institutes that support the training of individuals, the conduct of research, or the larger center grant award mechanisms.

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Supplementary materials

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