RESEARCH LETTER

Comparison of National Institutes of Health Grant Amounts to First-Time Male and Female Principal Investigators

Federal funding is associated with the quality of science and researchers' professional advancement.[1] Female junior faculty received less university start-up support than males in one study,[2] a factor associated with early-career attrition rates.[3] We investigated another potential association: the size of National Institutes of Health (NIH) grant awards to first-time awardees.

Methods | Using the public NIH Principal Investigators (PI) database, we analyzed grant amounts to first-time female and male grant awardees from 2006 to 2017. A PI's sex was determined algorithmically from first names. First-time PIs had no prior NIH awards as far back as 1985.

To examine factors related to funding, we first compared the median number of articles published per year, the median number of citations per article, and the number of areas of research expertise in published articles for first-time female and male PIs prior to their first NIH grant, using Microsoft Academic Graph (MAG). Areas of research expertise were estimated from the articles' research topic as reported in MAG. Only articles with the PI as the last author were counted.[4]

To further control for confounding, we examined awardees of the top 10 most highly funded grants awarded to individual PIs only, which represents $14 billion in funding or 58% of all NIH funds awarded to 19 559 first-time PIs. Also, we investigated awardees at the same 14 Big Ten and 8 Ivy League universities ($1.8 billion in funding or 7.5% of NIH funds awarded to 8039 first-time PIs), as well as the top 50 NIH most highly funded institutions ($9 billion in funding or 38% of funding awarded to 20 335 first-time PIs). The 2-sided Mann-Whitney test of medians (threshold $P < .05$) and Python software (version 2.7.12) were used in the analyses.

Results | From 2006 to 2017, 53 903 NIH grants were awarded to first-time PIs across all 225 NIH grant types and 2766 institutions (**Table 1**). Of first-time PIs, 43.6% were female, similar to the female enrollment level of 38% in US MD-PhD programs during the same period.[5]

Baseline performance measures were available for 73.4% of first-time PIs. No statistically significant differences by sex were found for baseline performance measures. The median number of articles published for men and women per year was 2.0 ($P = .64$), the median number of citations per article was 15 ($P = .99$), and the median number of research areas was 2.0 ($P = .90$).

For first-time PIs across all grant types and institutions, women received a median of $126 615 vs $165 721 for men (median difference, −$39 106 [95% CI, −$46 099 to −$35 675]; $P < .001$). For the 10 highest-funded grant types across all institutions, first-time female PIs received a median award amount of $305 823 vs $316 350 for male PIs (median difference, −$10 527 [95% CI, −$17 240 to −$3082]; $P = .002$), with the largest differences in N01 and U01 grants. However, women receiving R01 grants received $15 913 more than men ($P < .001$).

Female PIs at the Big Ten universities received a median of $66 365 vs $148 076 for male PIs (median difference, −$81 711 [95% CI, −$92 734 to −$67 450]; $P < .001$) (**Table 2**). Similarly, women at Ivy League universities received statistically significantly smaller grant amounts ($52 190 for women vs $71 703 for men; median difference, −$19 513 [95% CI, −$31 310 to

Table 1. Sex Differences in National Institutes of Health Grant Amounts to First-Time Principal Investigators (PIs) by Grant Type, 2006-2017

	No. of Grants (% Female PIs)	Total Funds, $		Median Funds, $		Median Difference (95% CI)	P Value
		Male PIs	Female PIs	Male PIs	Female PIs		
All grant types	53 903 (43.6)	14 299 086 366	9 602 869 550	165 721	126 615	−39 106 (−46 099 to −35 675)	<.001
10 Highest-funded grant types[a]							
N01	4294 (33.9)	5 127 062 990	2 431 489 767	758 015	631 753	−126 262 (−192 487 to −42 158)	.008
U2G	659 (40.2)	620 904 033	403 834 797	635 700	706 812	71 112 (−48 258 to 245 451)	.21
ZIA	473 (36.1)	251 977 313	161 597 279	593 777	541 648	−52 128 (−201 599 to 135 016)	.44
U01	1118 (40.9)	502 103 617	293 859 180	442 335	350 000	−92 335 (−138 305 to −24 242)	<.001
U19	289 (29.7)	99 530 085	38 978 847	287 250	260 842	−26 408 (−94 772 to 64 675)	.74
R21	4021 (39.1)	514 696 219	329 828 103	210 673	211 477	804 (−3173 to 4558)	.45
R01	6805 (35.1)	1 714 019 703	966 030 337	348 596	364 509	15 913 (8625 to 22 803)	<.001
P01	666 (27.6)	153 880 046	56 634 953	234 354	224 150	−10 204 (−50 026 to 18 305)	.07
P50	519 (31.2)	111 300 430	43 327 101	218 574	201 512	−17 062 (−46 741 to 18 278)	.17
P30	715 (34.7)	130 140 753	46 459 974	150 333	149 473	−860 (−22 017 to 17 127)	.69
Total	19 559 (35.7)	9 225 615 189	4 772 040 338	316 350	305 823	−10 527 (−17 240 to −3082)	.002

[a] Excluded U54 grants, which are generally institutional and not individual awards.

Table 2. Sex Differences in National Institutes of Health Grant Amounts to First-Time Principal Investigators (PIs) by Institution, 2006-2017

	No. of Grants (% Female PIs)	Total Funds, $		Median Funds, $		Median Difference (95% CI)	*P* Value
		Male PIs	Female PIs	Male PIs	Female PIs		
Big Ten University							
Total	4475 (43.2)	759 569 110	339 745 391	148 076	66 365	−81 711 (−92 734 to −67 450)	<.001
Michigan	910 (41.2)	141 026 696	65 961 692	159 600	120 960	−38 640 (−81 560 to −17 500)	<.001
Northwestern	611 (44.5)	87 073 063	39 627 399	77 250	52 172	−25 078 (−77 494 to −7259)	<.001
Wisconsin	569 (41.8)	137 528 574	40 251 054	105 694	53 971	−51 723 (−94 568 to −15 510)	<.001
Minnesota	566 (43.3)	106 537 748	45 162 305	139 870	56 042	−83 828 (−123 299 to −47 061)	<.001
Ohio State	342 (45.9)	46 967 702	36 622 204	187 777	130 869	−56 908 (−86 744 to −3736)	.03
Iowa	341 (40.2)	63 480 034	22 356 759	160 013	97 200	−62 908 (−130 710 to −24 651)	<.001
Penn State	298 (50)	55 777 776	16 459 133	149 157	47 114	−102 043 (−166 464 to −42 934)	<.001
Illinois	208 (42.3)	21 983 400	13 978 567	64 171	48 255	−15 916 (−38 387 to 1488)	.12
Michigan State	130 (50)	19 983 899	19 990 339	163 290	76 750	−86 540 (−148 787 to 76 019)	.32
Maryland	119 (47.1)	12 952 641	5 375 086	152 000	47 408	−104 592 (−178 234 to −20 000)	<.001
Rutgers	116 (40.5)	33 708 247	7 697 544	249 000	77 083	−171 917 (−247 750 to −47 350)	.004
Purdue	99 (39.4)	13 633 152	6 630 927	173 286	149 827	−23 459 (−94 849 to 34 916)	.34
Indiana	98 (38.8)	12 001 025	6 782 321	172 681	92 458	−80 223 (−174 882 to 92 180)	.57
Nebraska	68 (39.7)	6 915 153	12 850 061	146 419	70 426	−75 993 (−146 777 to 49 890)	.12
Ivy League University							
Total	3564 (41.4)	481 120 397	218 796 084	71 703	52 190	−19 513 (−31 310 to −6976)	<.001
Pennsylvania	914 (42.8)	114 250 899	46 932 468	78 681	52 154	−26 527 (−53 526 to −7150)	<.001
Harvard	835 (39.2)	92 162 114	44 437 929	53 318	47 606	−5712 (−9856 to −2822)	<.001
Yale	697 (44.3)	108 217 418	44 899 505	126 765	57 962	−68 803 (−86 285 to −13 109)	<.001
Cornell	498 (39.6)	65 519 644	36 179 905	49 646	52 190	2544 (−9112 to 13 588)	.75
Brown	203 (45.8)	23 502 947	10 323 364	125 719	49 214	−76 505 (−150 053 to −1127)	.004
Dartmouth	168 (39.9)	34 470 140	10 509 570	141 750	123 909	−17 841 (−87 065 to 50 130)	.17
Princeton	164 (37.2)	20 509 968	15 466 356	52 190	53 541	1351 (−2904 to 5644)	.39
Columbia	85 (35.3)	22 487 267	10 046 987	201 032	53 174	−147 858 (−238 188 to 53 063)	.20
All Top 50 Institutions							
Total	20 355 (43.7)	5 243 541 876	3 891 624 358	134 919	93 916	−41 003 (−47 052 to −31 316)	<.001

−$6976]; *P* < .001). At the top 50 NIH-funded institutions, first-time female awardees received significantly smaller grant amounts ($93 916 for women vs $134 919 for men; median difference, −$41 003 [95% CI, −$47 052 to −$31 316]; *P* < .001).

Discussion | This study found sex differences in the size of NIH funds awarded to comparable first-time female and male PIs, even at top research institutions. Funding disparities favoring men occurred among certain grant types, although for R01 grants, the most frequent award for first-time awardees, women received larger grants, as previously observed.[6] Although the analyses controlled for key factors, limitations include possible unmeasured confounding and no data on grant applications that were turned down. Further study of the institutions where inequalities were lowest may provide insight into the reasons for sex imbalances in grant amounts awarded during formative career stages.

Diego F. M. Oliveira, PhD
Yifang Ma, PhD
Teresa K. Woodruff, PhD
Brian Uzzi, PhD

Author Affiliations: Northwestern Institute on Complex Systems, Northwestern University, Evanston, Illinois (Oliveira, Ma); Feinberg School of Medicine, Northwestern University, Chicago, Illinois (Woodruff); Kellogg School of Management, Northwestern University, Evanston, Illinois (Uzzi).

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Corresponding Author: Teresa K. Woodruff, PhD, Women's Health Research Institute and Feinberg School of Medicine, Northwestern University, 303 E Superior St, Ste 10-121, Chicago, IL 60611 (tkw@northwestern.edu).

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COMMENT & RESPONSE

Weight Loss Interventions in Adults

To the Editor The US Preventive Services Task Force (USPSTF)[1] recommended high-intensity counseling for adults with obesity, followed by regular contact for maintenance of weight loss. The task force did not issue recommendations for pharmacotherapy because of (1) perceived lack of generalizability of the clinical trial findings, owing to stringent inclusion criteria and run-in periods; (2) high rates of dropout in the trials; and (3) lack of data "about the maintenance of improvement after discontinuation of pharmacotherapy."

In regard to this third point, the task force recommendation implies that medications to treat obesity should not be used on a long-term basis. However, all 4 medications approved by the US Food and Drug Administration (FDA) since 2012 for treatment of obesity have been approved for long-term use. In addition, the Endocrine Society guideline on pharmacotherapy for obesity[2] notes that medications are most appropriately used long-term. The guideline gives explicit direction for the conditions in which clinicians can use phentermine long-term (a drug that is not approved by the FDA for long-term use but is the most commonly prescribed medication in the United States for obesity).

Obesity is not a lifestyle choice but rather a chronic metabolic disease. Patients with obesity experience disproportionate reductions in metabolism with even modest weight loss. They also experience increases in hunger,[3,4] which persist over time. These increases in appetite provide a rationale for the long-term use of medications to treat obesity, even so-called reduced obesity (ie, a patient whose body mass index is ≥30 but who has lost ≥5% of his or her initial weight).

We believe that the task force should have addressed pharmacotherapy for obesity. In other diseases such as hypertension or type 2 diabetes, medications are given indefinitely to produce sustained improvements in blood pressure or blood glucose levels. Medications for weight reduction are similar. Although they may not be appropriate for every patient seeking treatment for their weight, they do help some individuals maintain a reduced body weight. Patients with the chronic relapsing disease of obesity deserve to be treated with the tools currently available for long-term management, which include behavioral treatment, pharmacotherapy, and, for some, bariatric surgery.

Adam G. Tsai, MD, MSCE
Caroline Apovian, MD
Lee Kaplan, MD, PhD

Author Affiliations: Department of Metabolic-Surgical Weight Management, Kaiser Permanente, Denver, Colorado (Tsai); Section of Endocrinology, Diabetes and Nutrition, Boston University School of Medicine, Boston, Massachusetts (Apovian); Weight Center, Massachusetts General Hospital, Boston (Kaplan).

Corresponding Author: Adam G. Tsai, MD, MSCE, Kaiser Permanente, 2045 Franklin St, Third Floor, Denver, CO 80205 (adam.tsai@kp.org).

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In Reply Dr Tsai and colleagues cite a guideline[1] on pharmacotherapy for obesity and state that the USPSTF should have addressed pharmacotherapy in its recommendation on adult obesity.[2] According to the authors, pharmacotherapy should be considered for long-term use because obesity is defined as a chronic disease.

In reviewing the evidence,[3] the USPSTF found that participants in trials who were randomized to medications plus behavioral interventions, compared with behavioral intervention alone, were more likely to lose 5% of their weight and maintain more of their weight loss.[2] Limited data from trials also found a reduced incidence of diabetes among participants at increased risk for type 2 diabetes. Intermediate outcomes, such as use of lipid-lowering and antihypertensive medications or the prevalence of the metabolic syndrome, were rarely reported and had mixed findings. Evidence on health outcomes (eg, cancer, cardiovascular disease, mortality) was lacking.

Despite some positive findings, pharmacotherapy trials had several limitations. Study participants were required to meet