

Evaluation of Research and Non-research Industry Payments to Endocrinologists in the United States: An Analysis of the Open Payments Database from 2014 to 2022

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August 25, 2023

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Twitter summary

Using the 2014-2022 Open Payments Database, this study found 50.5% to 68.0% of endocrinologists in the US received general payments from the healthcare industry each year.

Abstract

Objective: This study aimed to evaluate industry payments to endocrinologists and their institutions between 2014 and 2022.

Research Design and Methods: This serial cross-sectional study examined general and research payments (direct to individuals or associated research payments to institutions) made to endocrinologists registered in the National Plan and Provider Enumeration System in the United States, using the Open Payments Database between 2014 and 2022. Payment data were analyzed descriptively. Trends were evaluated by generalized estimating equations.

Results: Among 8002 active endocrinologists, 50.5% to 68.0% annually received general payments excluding those for ownership interests and royalties (GPEOR) between 2014 and 2022. The annual median GPEOR per physician declined from \$984 in 2014 to \$438 in 2022. Only top 10% of endocrinologists annually received 90.0% to 94.4% of all GPEOR. Despite 68.5% of all payments being for research, only 1.6% to 3.0% of endocrinologists directly received these annually, while 6.0% to 9.3% did through their institutions. Per-physician GPEOR decreased between 2014 and 2019, with a relative annual change of -4.4% (95% confidence

interval [CI]: -5.7% to -3.3%). The number of endocrinologists receiving research payments decreased by 3.5% (95% CI: -4.8% to -2.2%) between 2014 and 2019. Both GPEOR and research payments were significantly lower in 2020-2022 compared to 2014-2019 in the number of endocrinologists receiving payments and/or payment amounts.

Conclusions: Majority of endocrinologists accepted general payments from the healthcare industry, while less than 10% of endocrinologists received research payments (personally or to their institution) in the United States.

Highlights

- * This study examined industry payments to endocrinologists and their institutions using the Open Payments Database from 2014 to 2022.
- * Findings showed that 50.5%-68.0% of endocrinologists accepted non-research payments each year between 2014 and 2022, while less than 10% of endocrinologists received research payments annually.
- * Median per-physician annual payments varied, with \$438-\$984 in general, \$1710-\$4956 in direct research, and \$40,300-\$73,161 in associated research.
- * There was a decreasing trend in per-physician general payments between 2014 and 2019, with a relative annual change of -4.4% (95% confidence interval: -5.7% to -3.3%, $p < 0.001$).

Introduction

Financial collaborations between physicians and the healthcare industry can improve patient care through developing and implementing novel medications and medical devices and fostering research to combat diseases (1). However, these relationships might also negatively impact patient care, as evidenced by various medical scandals involving clinical trials and guideline recommendations (2,3). Increasing public demand for greater transparency in physician-industry relationships led the United States (US) to enact the 2010 Physician Payment Sunshine Act (4), mandating that pharmaceutical and medical device companies report all financial transfers made to physicians and teaching hospitals since 2013. The reported data is publicly disclosed under a federal transparency database, the Open Payments Database.

Endocrinology attracts substantial attention from pharmaceutical and medical device manufacturers due to the large and growing population of persons with obesity and diabetes (5,6), the development of novel medications for diabetes and endocrinological diseases, and expansion of indications for certain of these medications over the last decade (7).

Conflicts of interest are common among the Endocrine Society guideline authors (8). Irwig et al. reported that 74.3% of the Society's clinical-practice guideline authors received about \$5.5 and \$30.9 million in general and research payments, respectively, from pharmaceutical companies. Liu et al. reported that in 2014 the editors of *Diabetes Care*, an official journal of the American Diabetes Association, received the highest median personal payments from healthcare industries (\$19,618) of 52 US medical journals (9). While editors must declare any financial conflicts of interest, to the American Diabetes Association and their academic institutions, that information may not be readily available to the public. Studies have identified positive associations between payment amounts from pharmaceutical companies marketing diabetes medications and increases in physicians' prescriptions in the US and other developed countries (10-12).

Prior studies have not investigated the overall picture of financial relationships between the healthcare industry and endocrinologists since the establishment of the Open Payments Database in the US. This study aimed to shed light on the magnitude, prevalence, and trends in physician-industry financial relationships in endocrinology in the US.

Research Design and Methods

Study setting, participants, and payment collection

This serial cross-sectional study examined the magnitude and trends in industry payments to endocrinologists since the inception of the Open Payments Database. Starting August 1, 2013, the Sunshine Act mandated all pharmaceutical manufacturers, medical device manufacturers, and group purchasing organizations to disclose financial transfers to physicians in the Open Payments Database, which include three major types: general, research, and ownership payments. General payments included acquisitions (since 2021), charitable contributions, speaker fees, consulting fees, debt forgiveness (since 2021), education, entertainment, food and beverages, gifts, honoraria, long-term medical supply or device loans (since 2021), royalties and licenses, and travel and lodging. All categories of general payments were considered in this study, as this study aimed to evaluate overall size of the endocrinologists-industry financial relationships. As the 2013 data are partial disclosure of payments between August and December 2013, this study considered general and research payments provided to endocrinologists between 2014 and 2022. The analyses did not include data from ownership and investment payment files that are separately disclosed from the general payment files in the Open Payments, as these datasets contain information of status of ownership interests or stocks of healthcare companies hold by physicians each year. Therefore, these datasets do not indicate the transfer of payments. Meanwhile, general payment files contain information of transfer of payments made to physicians by healthcare industry including payments for ownership interests. Research payments include research costs such as medication supply and equipment used in clinical trials. Detailed definitions of each payment category and variables used for analysis in this study are described in Supplemental Material 1 and available on the Open Payments Database webpage (13).

This study defined endocrinologists as physicians whose primary specialty was “Allopathic & Osteopathic Physicians|Internal Medicine|Endocrinology, Diabetes & Metabolism” (health care provider taxonomy code: 207RE0101X) in the National Plan and Provider Enumeration System (NPPES) and extracted National Provider Identifier (NPI) numbers for all physicians classified as endocrinologists from the NPPES database which was last updated on April 9, 2023. All general and research payments data were downloaded from the Open Payments Database between 2014 and 2022 (14) and extracted all general and research payments they received between January 2014 and December 2022 matching their NPI number. Payment datasets in 2014-2015 were archived as of July 2023, but were downloadable from the Open Payments Database webpage (14). Before data analysis, the contents and nature of individual general payments over \$100,000 were checked by the corresponding author to exclude potential errors in these large payments. Three consulting fees and two compensation fees were recategorized as ownership payments, as these payments were made to an endocrinologist as registered stock units for compensations (Supplemental Material 2). The study excluded 2013 payments from this study, as these payments only represented August-December. Most research payments came indirectly via teaching hospitals and other third parties. Including only direct research payments to individual physicians leads to underestimating their magnitude (15,16); therefore, both associated research payments and direct research payments were included in this study (17-19). Associated research payments include any funding for research where the physician is a primary investigator. Direct research payments are those provided directly to the recipient. Of 9164 active endocrinologists registered in the NPPES, 1162 were newly activated after January 2014 and were excluded from the study sample. Therefore, 8002 endocrinologists were included in this study. The NPPES database only includes information for active physicians and does not include physicians who are currently deactivated due to death or retirement: thus, endocrinologists who were deactivated as of April 9, 2023, were not included in this study.

Statistical analyses

Descriptive analyses were performed on payment data. Per-physician payments were calculated only among endocrinologists receiving payments each year, as in previous studies (20-22). Regarding general payments, this study performed descriptive analyses, including calculation of per-physician payments and total amounts, for general payments excluding ownership interests and royalties and licenses (hereby GPEOR), because only several endocrinologists received large amounts of ownership interests and royalties and licenses (Supplemen-

tal Material 3). For associated research payments, per-physician payments were calculated as total payments divided by the number of principal investigators in a research payment, and total research payments were calculated by the number of endocrinologists times the payment per principal investigator because some research payments included principal investigators with other specialties. The author evaluated the share of payments by specific proportions of endocrinologists and the Gini index. The Gini index ranges from 0 (complete equality) to 1 (complete inequality) (21,23). Payment data were also analyzed by categories (20,24,25).

The study evaluated trends in GPEOR and research payments with interrupted time series analysis, using generalized estimating equations (GEE) of annual per-physician payment clustering individual endocrinologists, to adjust for the COVID-19 pandemic's influence since 2020. As the payment distribution was skewed, the study employed the negative binomial regression GEE model for changes in per-physician payments and modified linear regression GEE model with Poisson distribution for changes in the proportion of endocrinologists receiving payments from 2014-2022 (22,23,25,26). Relative annual mean percentage change was reported. The study excluded from the GEE trend analyses of GPEOR those payments for acquisitions, debt forgiveness, and long-term medical supply or device loans, because general payments for acquisitions, debt forgiveness, and long-term medical supply or device loans were only available for 2021-2021 data. Inflation was adjusted to 2022-dollar values by dividing the payment values each year by relative consumer price index (CPI) compared to 2022 from the US Bureau of Labor Statistics CPI Inflation Calculator (Supplemental Material 4).

Ethical clearance

As this study only included publicly available information and databases, informed consent from study participants was not required.

Data and resource availability

Data extraction and analyses were performed with Python 3.9.12 (Python Software Foundation, Beaverton, OR, USA), Microsoft Excel, version 16.0 (Microsoft Corp., Redmond, WA, USA), and Stata version 17.0 (StataCorp, College Station, TX, USA).

Results

Overview of industry payments to diabetologists and endocrinologists

Of the 8002 endocrinologists included in the study sample, 6901 (86.2%) received combined payments of \$2,063,671,856 in inflation-adjusted values from 891 pharmaceutical, medical device, and group purchasing companies between 2014 and 2022.

General payments

General payments, including those payments for ownership interests and royalties, accounted for 31.5% of all industry payments, totaling \$649.6 million over nearly nine years. Total amounts of GPEOR were \$617.2 million over the study period. A total of 6882 endocrinologists (86.0% of all NPPEs-registered endocrinologists) received one or more GPEOR during that period.

Table 1 shows yearly breakdown of GPEOR between 2014 and 2022. The annual number of endocrinologists accepting GPEOR peaked at 5437 (68.0%) in 2016 and has gradually declined since then, reaching 4043 (50.5%) in 2021. Among endocrinologists who received GPEOR each year, annual median per-physician GPEOR decreased from \$984 (interquartile range [IQR]: \$213-\$5,444) in 2014 to \$438 (IQR: \$96-\$1,896) in 2022. Annual mean GPEOR ranged from \$8,423 (standard deviation [SD]: \$28,493) to \$17,853 (SD: \$57,001). The Gini index for per-physician annual GPEOR was 0.915-0.941, indicating only a few endocrinologists received substantial GPEOR. Only top 1%, 5%, and 10% of all endocrinologists received 29.1%-38.3%, 71.6%-85.8%, and 90.0%-94.4% of all GPEOR each year.

Of payment categories of GPEOR, non-CME related speaking payments were the largest (\$413.0 million: 67.2%) in aggregate monetary value over the nine-year period (Supplemental Material 3). Payments for food and beverages were the most common, comprising 80.9% (2.0 million) of nine-year total number of GPEOR (Supplemental material 3). A total of 84.5% of all endocrinologists received one or more food and beverage payments. Of the nine-year total GPEOR paid to the top 10% of endocrinologists, non-CME-related speaking payments accounted for the largest share in monetary value (\$386.9 million 71.8%), followed by consulting fees (\$60.9 million: 11.3%) and travel and lodging expenses (\$58.1 million: 10.8%) (Figure 1A). On the other hand, food and beverage (\$27.2 million: 35.5%) and non-CME related speaking payments (\$26.1 million: 34.1%) accounted for the largest percentage of the total GPEOR paid to the other 90% endocrinologists over the 9-year period (Figure 1B).

Direct and associated research payments

Between 2014 and 2022, a total of 611 and 1220 endocrinologists, representing 7.6% and 15.3% of all endocrinologists, respectively, received one or more direct and associated research payments over the nine years. Direct and associated research payments totaled \$35.2 million (1.7% of all industry payments) and \$1.4 billion (66.8% of all industry payments) in inflation-adjusted values, respectively. Therefore, 68.5% of all industry payments to the endocrinologists were provided for research purposes. More than 99.9% (\$1,378.7 million) of associated research payments were distributed to teaching hospitals and other institutions. Of 1336 endocrinologists receiving direct or associated research payments, 1317 (98.6%) also accepted one or more GPEOR over the nine years.

Table 2 shows the annual direct and associated research payments to the endocrinologists. Only 1.6% to 3.0% of endocrinologists received direct research payments each year. Similarly, 6.0% to 9.3% of endocrinologists annually received associated research payments from the healthcare industry between 2014 and 2022. Median annual per-physician payments ranged from \$1,710 (IQR: \$532–\$7,160) to \$4,956 (IQR: \$1,865–\$26,679) in direct research payments and from \$40,300 (IQR: \$7,715–\$179,700) to \$66,163 (IQR: \$16,631–\$238,199) in associated research payments.

Annual payment trends from 2014 to 2022

After excluding several general-payment categories for acquisition, debt forgiveness, and long-term medical supply or device loans from GPEOR, the time series analyses showed that per-physician GPEOR significantly decreased by 4.4% (95% CI: -5.7% to -3.3%, $p < 0.001$), while there was no significant change in the number of endocrinologists receiving GPEOR between 2014 and 2019 (Supplemental Material 5). As compared to 2014-2019, the number of endocrinologists accepting GPEOR significantly decreased by more than half and per-physician GPEOR also decreased by approximately 20% during the COVID-19 pandemic period (2020-2022). There were slight increasing trends in both the number of endocrinologists receiving GPEOR and per-physician GPEOR increased between 2020 and 2022, although the number of endocrinologists receiving GPEOR (4358) and total amounts of GPEOR (\$37.2 million) in 2022 were still substantially under those (5034 and \$68.9 million) in 2019.

Median per-physician associated research payments were the lowest in 2021 at \$40,300 (IQR: \$7,715–\$179,700) and there were no significant trends in per-physician annual associated research payments before (2014-2019) and during the COVID-19 pandemic (2020-2022) (Supplemental Material 5). The time series analyses showed the number of endocrinologists receiving associated research payments decreased between 2014 and 2019 and showed more marked decreases at the beginning of the COVID-19 pandemic (2020). The number of endocrinologists receiving direct research payments also decreased at the beginning of the COVID-19 pandemic: however generally there were no significant changes in per-physician direct research payments over the study period.

Discussion

This study sheds light on physician-industry financial relationships in the field of endocrinology reported

under the Sunshine Act in the US. The study analyses show that US endocrinologists received a total of \$2.06 billion from 891 pharmaceutical and medical device companies during the 9 years between 2014 and 2022, and most industry payments were made for research purposes. Although 50.5% to 68.0% of all endocrinologists received at least one GPEOR each year, less than 10% of endocrinologists received associated research funding each year. Per-physician annual general payments decreased by 4.4% between 2014 and 2019. Industry general payments were disproportionately distributed to a small number of endocrinologists. Although prior studies have investigated the financial relationships between physicians and healthcare industries in specialties, few have been conducted in endocrinology.

The study found that endocrinologists received high median general (non-research) payments in the health-care industry, especially compared to other specialists and primary care physicians (4,16,25,28,29). This is consistent with a previous three-year analysis by Inoue et al. (28). According to a previous study by Tringale et al. (4), primary care physicians, who care for and manage most diabetes and obesity patients, received \$179 in median per-physician general payments in 2015. The prevalence of obesity and diabetes in the US have increased over the past several decades (6,30). Additionally, a previous study by Inoue et al. reporting approximately 92% of all general payments related to non-insulin glucose-lowering therapies such as sodium glucose co-transporter 2 (SGLT2) inhibitors and glucagon-like peptide-1 receptor agonists (GLP-1RAs) in the US were paid for these same two classes of medications (31).

The study found that large GPEOR were disproportionately concentrated among a few endocrinologists. Only 1% (80 endocrinologists) of physicians received 29.1%-38.3% of all GPEOR in endocrinology each year. As shown in previous studies (20,21,29), the healthcare industry made large consulting, speaking, and research payments to physicians with substantial clinical or research experience, often called “key opinion leaders” (KOLs) (32). KOLs frequently hold influential positions such as professional medical association leaders, clinical-practice guideline authors, and academic journal editors (16,33,34).

This study showed that more than 80% of GPEOR were made for food and beverage in the number of payments and about 10% of GPEOR paid to the top 10% endocrinologists were provided for travel and lodging. However, industry sponsorship for the sole purpose of travel, accommodation and meals associated with attending international or national conferences is not allowed in the US. Thus, reported travel expenses likely primarily reflect participation in company-sponsored consulting meetings, advisory boards, investigator meetings, rather than the provision of funds that did not involve a formal company activity.

The author recognize that the receipt of industry-sponsored research payments does not necessarily increase the risk of a biased outcome due to a conflict of interest. Industry-sponsored research expenses should be considered separately from general payments. The analysis shows that healthcare companies invested substantial amounts in research payments in the field of endocrinology. Although previous studies only analyzed research payments paid directly to individual physicians (16,28), this study included all research payments made to endocrinologists and their institutions, including research payments for trials where the principal investigators were endocrinologists. These estimates give a more comprehensive evaluation of industry research investment in endocrinology (18,19).

Research payments were distributed to only 6.0% to 9.3% of all endocrinologists each year and 15.3% over nine-years in the US, and per-physician research payments were substantially higher than other specialists (15,17,18,35-38). However, these payments should be viewed with caution because they include research costs at a time when many studies of SGLT2 inhibitors and GLP-1RAs were ongoing and nearly all of these funds were paid directly to institutions. An important caveat is also that the costs of trial medications sponsored by government organizations such as the National Institutes of Health NIH would have been included in the breakdown of research payments to principal investigators even though the medications were donated to the government organizations as part of a research agreement. The study was unable to discern which these may have been from the publicly available data. The high research payments in endocrinology indicate that companies are focused on this area. Prior work has suggested that industry-sponsorship can influence the outcome and interpretation of clinical trial findings (39,40).

Limitations

This study has several important limitations. First, there may be inaccuracies in classification of endocrinologists and reporting and attribution of the payments in the Open Payments Database and NPPES databases. These errors may have contributed to differences in trends since the Open Payments system was introduced in 2013. Second, there might be financial relationships between physicians and the healthcare industry not covered by the Open Payments Database. For example, information on free medication samples (15,17,18,35) and some small payments (<\$100/year) and discounts are not required to be reported. Third, primary specialty is self-declared by each physician so there may be misclassification. Fourth, in relation to the associated research payments, the Open Payments Database has important limitations in the transparency in research payment data and caution should be exercised in interpreting the results. Associated research payments include funding paid to affiliated institutions and are difficult to compare to amounts paid directly to individual physicians. Further, these research payments to teaching hospitals and other institutions where endocrinologists served as principal investigators do not include information about the internal allocation of research payments to physicians, nurses, staff, and research coordinators within the institutions. This is important as the study found that more than 99.9% of associated research payments were assigned to teaching hospitals and other institutions. Finally, as mentioned, the Open Payments Database contains indirect research costs for medications and medical supplies which were provided by the healthcare industry and were used in research sponsored by the public sectors such as NIH. Therefore, the study tabulations cannot discern the amount of research supported by the healthcare industry that was provided to the NIH as industry support for studies in which the named endocrinologists participated.

Conclusion

This study demonstrated that more than half of all endocrinologists accepted at least one GPEOR from the healthcare industry in the US each year, but only a few received substantial GPEOR. However, GPEOR had been decreasing annually since the inception of the Open Payments Database. The majority of industry payments were made to the small number of endocrinologists for research expenses individually or mostly through their institutions.

Acknowledgments: The author would like to thank Editage (www.editage.com) for English language editing. Anju Murayama is the guarantor of this work, and as such, had full access to all study data and takes responsibility for its integrity and the accuracy of the data analysis.

Funding:

The author did not receive any financial support for this study.

Conflicts of interest: The author declared no financial conflicts of interest.

Author contributions: Anju Murayama: Conceptualization; methodology; software; formal analysis; investigation; resources; data curation; writing - original draft; writing - review & editing; visualization; and supervision

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Table 1. Summary of annual general payments to endocrinologists excluding ownership and royalty payments between 2014 and 2022.

Variables	Payment year								
	2014	2015	2016	2017	2018	2019	2020	2021	2022
General payments^{a,b}									
Total payment amounts, \$	88,903,520	91,980,720	85,212,750	95,210,529	79,586,689	68,562,772	34,955,504	34,055,666	37,000,000
Total payment contracts, n	309,406	344,276	346,762	337,222	306,517	285,485	161,753	184,880	190,000
Number of physicians with payments, n (%)	4997 (62.5)	5290 (66.1)	5437 (68.0)	5333 (66.7)	5242 (65.5)	5034 (62.9)	4119 (51.5)	4043 (50.5)	4300 (54.0)
Payments per physician, \$^{b, c}									
Median (IQR)	984 (213–5,444)	927 (182–4,158)	822 (173–3,686)	784 (170–3,646)	688 (157–3,325)	667 (149–3,271)	452 (107–2,674)	534 (103–2,683)	430 (103–2,683)
Mean (SD)	17,791 (52,859)	17,388 (55,092)	15,673 (49,134)	17,853 (57,001)	15,183 (48,742)	13,620 (45,548)	8,486 (27,284)	8,423 (28,493)	8,500 (28,493)
Range	7–933,879	2–991,860	4–961,780	0.5–1,113,704	2–913,515	1–754,033	0.4–525,250	1–640,947	1–640,947
Proportion of payments hold by top endocrinologist, %^d									
Top 1%	29.1	31.2	29.3	30.6	30.8	34.0	36.6	38.3	37.0
Top 5%	71.6	73.2	74.0	74.7	76.3	78.6	81.1	82.2	85.0
Top 10%	90.0	90.4	90.6	91.6	92.2	92.5	93.3	93.2	94.0

Variables	Payment year								
Gini index	0.915	0.917	0.916	0.921	0.923	0.927	0.935	0.937	0.937

Abbreviations: interquartile range (IQR), SD (standard deviation)

^a General payments for ownership interests and royalties/licenses were excluded from the total amounts of general payments and per-physician general payments.

^b All payment values were converted to 2022-US dollar values.

^c Payments per physician were calculated among the physicians accepting the payments from the healthcare companies.

^d Proportions of general payments excluding those for ownership and royalties hold by top 1% (top 80 endocrinologists), 5% (top 400 endocrinologists), and 10% (top 800 endocrinologists) of endocrinologists include all 8002 endocrinologists who were eligible for this study.

Table 2. Summary of annual direct research payments and associated research payments to endocrinologists between 2014 and 2022.

Variables	Payment year	Payment year	Payment year	Payment year	Payment year	Payment year	Payment year	Payment year	Payment year
	2014	2015	2016	2017	2018	2019	2020	2021	2022
Direct re-search payments									
Total payment amounts, \$ ^a	3,350,746	3,520,908	4,195,310	6,290,159	4,773,922	3,861,696	3,648,135	2,557,473	2,900,000
Total payment contracts, no	1168	1181	1681	1647	1476	1186	1681	776	800
Number of physicians with payments, no (%)	188 (2.4)	192 (2.4)	198 (2.5)	240 (3.0)	177 (2.2)	179 (2.2)	169 (2.1)	125 (1.6)	170 (2.2)
Payments per physician, \$ ^{a,b}									
Median (IQR)	1,710 (532–7,160)	1,735 (317–7,582)	3,884 (1,392–13,493)	3,247 (658–18,994)	4,956 (1,865–26,679)	3,386 (1,056–12,908)	4,068 (1,229–11,611)	2,675 (688–10,368)	3,500 (1,000–16,000)
Mean (SD)	17,823 (54,394)	18,338 (70,020)	21,188 (52,951)	26,209 (101,489)	26,971 (48,973)	21,574 (75,292)	21,587 (64,855)	20,460 (66,113)	16,000 (28,000)
Range	20–453,778	18–759,773	11–508,101	14–1,190,748	19–339,644	86–767,627	16–526,988	1–477,769	31–210,000

Variables	Payment year	Payment year	Payment year						
Gini index	0.997	0.997	0.995	0.995	0.994	0.996	0.996	0.998	0.998
Associated re-search payments									
Total payment amounts, \$ ^a	152,664,185	177,347,747	172,387,576	170,581,666	149,034,668	168,989,253	132,365,689	135,302,217	120,000,000
Total payment contracts, no	41,926	48,144	38,142	31,517	27,679	19,071	30,708	26,234	49,000
Number of physicians with payments, no (%)	679 (8.5)	742 (9.3)	727 (9.1)	687 (8.6)	614 (7.7)	596 (7.5)	523 (6.5)	530 (6.6)	470 (5.8)
Payments per physician, \$ ^{a,b}									
Median (IQR)	63,072 (16,161–220,674)	65,354 (11,730–211,143)	73,161 (16,664–224,631)	66,163 (16,631–238,199)	52,067 (10,094–195,194)	50,806 (11,531–213,172)	54,350 (14,106–216,449)	40,300 (7,715–179,700)	49,000 (8,000–200,000)
Mean (SD)	224,837 (506,257)	239,013 (555,904)	237,122 (544,337)	248,299 (687,210)	242,727 (793,904)	283,539 (935,753)	253,089 (808,702)	255,287 (696,575)	250,000 (600,000)
Range	8–7,782,492	18–7,350,323	44–9,744,507	7–13,531,483	2–12,793,524	29–13,927,018	28–14,722,800	18–8,473,246	7–5,500,000
Gini index	0.977	0.977	0.975	0.978	0.984	0.985	0.985	0.987	0.987

Abbreviations: interquartile range (IQR), SD (standard deviation)

^a All payment values were converted to 2022-US dollar values.

^b Payments per physician were calculated among the physicians accepting the payments from the healthcare companies each year.

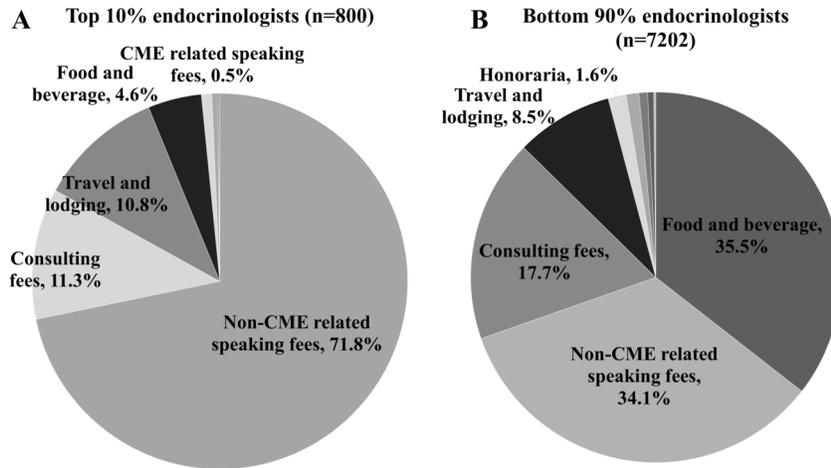


Figure 1: This is a caption

Figure 1. General payments excluding ownership and royalties to top 10% (1A) and the other 90% (1B) of endocrinologists by categories.

Legend: Non-CME related speaking fees included “compensation for services other than consulting, including serving as faculty or as a speaker at a venue other than a continuing education program.” CME speaking payments included “compensation for serving as faculty or as a speaker for an accredited or certified continuing education program” (applicable to program years 2013-2020), “compensation for serving as faculty or as a speaker for an unaccredited and non-certified continuing education program” (applicable to program years 2013-2020), and “compensation for serving as faculty or as a speaker for medical education program” (applicable beginning with program year 2021 and subsequent program years). General payments for ownership interests and royalties/licenses were excluded from the figure.

Supplemental Material 1. Terminology of the Open Payments Database used in this study.

Variables	Content, definition, and example
Payment types	
Associated research payment	Associated research payment is a research payment whose recipient is a covered recipient.
Direct research payment	Direct research payment is a research payment whose recipient is a covered recipient.
General payments	General payment is a payment for non-research, non-ownership payments.
Types of general payments	
Acquisition	Acquisition payment is a buyout payment made to covered recipient.
Charitable contribution	Charitable contribution is a payment or transfer of value made to a charitable organization.
Consulting fee	Consulting fee is a payment that a company makes to a physician.
Non-CME related speaking fee	Non-CME related speaking fees includes “compensation for services other than consulting, including serving as faculty or as a speaker at a venue other than a continuing education program.”
CME related speaking fee (CME speaking payment)	CME related speaking fee includes “compensation for serving as faculty or as a speaker for an accredited or certified continuing education program” (applicable to program years 2013-2020), “compensation for serving as faculty or as a speaker for an unaccredited and non-certified continuing education program” (applicable to program years 2013-2020), and “compensation for serving as faculty or as a speaker for medical education program” (applicable beginning with program year 2021 and subsequent program years).
Current or prospective ownership or investment interest	This payment includes ownership or investment interest currently held or to be held by a covered recipient.
Debt forgiveness	This payment type includes forgiving the debt of a covered recipient.
Education fee	Education fee is a financial transfer for educational activities, classes, or conferences.
Entertainment	Entertainment fee includes a cost for attendance at recreational, social, or entertainment activities.
Food and beverage	Food and beverage fee is a cost for lunch or dinner meal offered at a venue.
Gift	Gift is any item that does not fit into another payment category.

Grant	Grant is a payment to support a specific purpose or activity not
Honoraria	Honoraria is a payment for a brief, one-time activity, similar to a
Long-term medical supply or device loan	This payment includes the loan of supplies or a device for 91 day
Royalty or license	Royalty or license is a payment based on sales of medications or r
Travel and lodging	Travel and lodging fee is any compensation for costs associated w

The definition of payment categories was based on the nature of payments published on the Open Payments Database webpage (<https://www.cms.gov/OpenPayments/Natures-of-Payment>). Definition and content of each variable is detailedly described in the Open Payments Methodology Overview & Data Dictionary (<https://www.cms.gov/OpenPayments/Downloads/OpenPaymentsDataDictionary.pdf>).

Supplemental Material 2. General payments more than \$100,000 made to endocrinologists between 2014 and 2022.

Anonymized endocrinologist name	Company name making payments	Actual payment amounts, \$	Inflation-a
Endocrinologist A	Dexcom, Inc.	232,498	287,416
Endocrinologist B	AstraZeneca Pharmaceuticals LP	1,485,149	1,835,953
Endocrinologist B	AstraZeneca Pharmaceuticals LP	1,477,915	1,827,011
Endocrinologist B	AstraZeneca Pharmaceuticals LP	1,627,835	2,012,343
Endocrinologist A	Dexcom, Inc.	324,344	400,481
Endocrinologist B	AstraZeneca Pharmaceuticals LP	1,407,050	1,737,345
Endocrinologist B	AstraZeneca Pharmaceuticals LP	1,695,981	2,094,100
Endocrinologist B	AstraZeneca Pharmaceuticals LP	1,826,075	2,254,733
Endocrinologist B	AstraZeneca Pharmaceuticals LP	1,734,921	2,142,181
Endocrinologist A	Dexcom, Inc.	327,319	399,119
Endocrinologist B	AstraZeneca Pharmaceuticals LP	1,653,615	2,016,352
Endocrinologist B	AstraZeneca Pharmaceuticals LP	1,720,480	2,097,885
Endocrinologist B	AstraZeneca Pharmaceuticals LP	1,505,772	1,836,079
Endocrinologist B	AstraZeneca Pharmaceuticals LP	1,527,523	1,862,601
Endocrinologist B	AstraZeneca Pharmaceuticals LP	1,518,822	1,813,360
Endocrinologist B	AstraZeneca Pharmaceuticals LP	1,569,575	1,873,955
Endocrinologist B	AstraZeneca Pharmaceuticals LP	1,231,477	1,470,292
Endocrinologist B	AstraZeneca Pharmaceuticals LP	1,445,452	1,725,762
Endocrinologist A	Dexcom, Inc.	304,364	363,387
Endocrinologist B	AstraZeneca Pharmaceuticals LP	1,145,872	1,335,467
Endocrinologist B	AstraZeneca Pharmaceuticals LP	326,541	380,570
Endocrinologist A	Dexcom, Inc.	332,562	387,587
Endocrinologist D	Boehringer Ingelheim Pharmaceuticals, Inc.	116,888	136,229
Endocrinologist A	Dexcom, Inc.	331,025	378,930
Endocrinologist C	Medtronic MiniMed, Inc.	281,645	318,475
Endocrinologist A	Dexcom, Inc.	333,116	376,676
Endocrinologist A	Dexcom, Inc.	307,881	332,520
Endocrinologist A	Dexcom, Inc.	311,268	311,268

^a Five general payments of consulting fees and compensation were paid to endocrinologists as registered stock units in return for their membership on the board of directors of the company. Therefore, this study classified these payments as ownership payments in this study, as the compensations were made in the form

stocks.

Supplemental Material 3. Industry payments by payment categories between 2014 and 2022.

Payment categories	Monetary amounts, \$ (%)	Payment contracts, no (%)
General payments	649,638,180 (31.5) ^c	2,474,513 (88.4) ^c
Non-CME related speaking fees ^a	412,987,384 (67.2) ^d	212,242 (8.6) ^d
Consulting fees	74,392,858 (12.1) ^d	25,943 (1.0) ^d
Travel and lodging	64,588,533 (10.5)	186,509 (7.5)
Food and beverage	52,035,242 (8.5)	2,001,252 (80.9)
Royalty or license	31,022,822 (not calculated) ^e	48 (not calculated) ^e
Honoraria	6,027,916 (1.0)	2,557 (0.1)
CME related speaking fees ^b	3,024,745 (0.5)	1,917 (0.1)
Current or prospective ownership or investment interest	2,935,713 (not calculated) ^{d,e}	13 (not calculated) ^{d,e}
Education	1,264,534 (0.2)	41,465 (1.7)
Grant	1,150,106 (0.2)	142 (0.01)
Gift	163,406 (0.03)	2,363 (0.1)
Acquisitions	20,265 (0.003)	3 (0.0001)
Long-term medical supply or device loan	12,524 (0.002)	6 (0.0002)
Charitable contribution	5,783 (0.001)	5 (0.0002)
Debt forgiveness	5,568 (0.001)	24 (0.001)
Entertainment	781 (0.0001)	24 (0.001)
Research payments	1,414,033,684 (68.5) ^c	324,673 (11.6) ^c
Associated research payments	1,378,868,832 (97.5)	313,068 (96.4)
Direct research payments	35,164,852 (2.5)	11,605 (3.6)

^aNon-CME related speaking fees included “compensation for services other than consulting, including serving as faculty or as a speaker at a venue other than a continuing education program.”

^bCME speaking payments included “compensation for serving as faculty or as a speaker for an accredited or certified continuing education program” (applicable to program years 2013-2020), “compensation for serving as faculty or as a speaker for an unaccredited and non-certified continuing education program” (applicable to program years 2013-2020), and “compensation for serving as faculty or as a speaker for medical education program” (applicable beginning with program year 2021 and subsequent program years).

^c The proportion of general payments and research payments to all industry payments to the endocrinologists.

^d Five general payments of consulting fees and compensation were paid to endocrinologists as registered stock units in return for their membership on the board of directors of the company. Therefore, this study classified these payments as ownership payments in this study, as the compensations were made in the form stocks.

^e General payments for ownership and royalties/licenses were not included in the calculation of percentage share of each payment relative to the total general payments.

Supplemental Material 4. Annual average consumer price index values between 2014 and 2022 used in this study

Payment year	Annual average consumer price index (CPI)	Relative annual average CPI value
2022	292.655	1.00 (reference)
2021	270.97	0.925902513198135
2020	258.811	0.884355298901437
2019	255.657	0.873578103910748
2018	251.107	0.858030787104270
2017	245.12	0.837573251781108
2016	240.007	0.820102168081871
2015	237.017	0.809885359894757
2014	236.736	0.808925184944730

Data source from the United States Bureau of Labor Statistics (URL: <https://data.bls.gov/timeseries/CUUR0000SA0>)

Supplemental Material 5. Annual trends in number of physicians receiving payments and payments per physician since the inception of the Open Payments Database before and during the COVID-19 pandemic

Variables	Relative annual mean percent
Number of endocrinologists receiving payments ^a	Payments per physician
Overall (N = 8002) ^a	\$0.01–\$500 (n = 1332)
General payments ^b	
Pre-interruption trend since the inception of the Open Payments Database (2014-2019)	-0.03 (-0.3 to 0.3)
Level change by the COVID-19 pandemic (2014-2019 vs 2020-2022)	-24.4 (-26.1 to -22.7)***
Post-interruption trend since the COVID-19 pandemic (2020-2022)	2.9 (1.8 – 3.9)***
Direct research payments	
Pre interruption trend since the inception of the Open Payments Database (2014-2019)	-0.7 (-3.6 to 2.3)
Level change by the COVID-19 pandemic (2014-2019 vs 2020-2022)	-21.8 (-34.7 to -6.2)**
Post interruption trend since the COVID-19 pandemic (2020-2022)	2.7 (-5.8 to 11.9)
Associated research payments	
Pre interruption trend since the inception of the Open Payments Database (2014-2019)	-3.5 (-4.8 to -2.2)***
Level change by the COVID-19 pandemic (2014-2019 vs 2020-2022)	-9.5 (-16.1 to -2.4)**
Post interruption trend since the COVID-19 pandemic (2020-2022)	-0.8 (-4.6 to 3.0)

*p<0.05. **p<0.01. p<0.001.

^a Endocrinologists who were activated before January 2014 were included in the trend analyses and this study excluded endocrinologists who were deactivated and newly activated after 2014 to remove new or retired endocrinologists in the trend analyses.

^b This study excluded the payments for acquisitions, debt forgiveness, long-term medical supply or device loans, ownership interests, and royalties and licenses in the trend analysis of general payments, because this study observed substantial amounts of general payments for royalties and license in several years or these payment categories were newly-added in 2021.