



Impact of Income Inequality on the Nation's Health

Citation

Lopez, Diego. 2019. Impact of Income Inequality on the Nation's Health. Doctoral dissertation, Harvard Medical School.

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Scholarly Report submitted in partial fulfillment of the MD Degree at Harvard Medical School

Date: 26 January 2018

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Scholarly Report Title: Impact of Income Inequality on the Nation's Health

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Abstract

TITLE: Impact of Income Inequality on the Nation's Health

Diego B. López, Andrew P. Loehrer, David C. Chang

Purpose: Income inequality in the United States has been increasing in recent decades. It is unclear whether income inequality has an independent effect on health outcomes, or whether it simply correlates with increasing levels of poverty. The goal of this study was to evaluate whether income inequality is significantly associated with US county health care expenditures and health care use.

Methods: Cross-sectional analysis of county health expenditure data from the Health Resources and Services Administration's Area Resources File, county income inequality measures (Gini coefficient) from the Census' American Community Survey, and estimates of potentially preventable admissions and potentially discretionary procedures from the Nationwide Inpatient Sample (1998 to 2011). Datasets were linked via county Federal Information Processing Standard codes. Multivariable linear and Poisson regression analyses were performed at the county level adjusting for county characteristics.

Results: A total of 1,237 counties (of 3,144) were included. Income inequality was associated with higher health care expenditures, with each 1 percentage-point increase in county Gini coefficient associated with a US\$40,008 increase in annual county Medicare cost ($p = 0.003$), and an increase of 174.7 total county Medicare inpatient days per year ($p < 0.001$). Even after accounting for poverty level and county characteristics, counties with higher inequality had higher potentially preventable admission (eg 4.86 rate ratio for low-birth-weight hospital admissions in the top income inequality quartile compared with bottom quartile; $p < 0.001$) and a higher incidence of potentially discretionary procedures (eg 1.79 rate ratio for prostatectomy for benign prostatic hyperplasia in the top income inequality quartile compared with bottom quartile; $p < 0.001$).

Conclusions:

Income inequality is independently associated with higher health care expenditures and more health care use, with increases in both potentially discretionary procedures and in potentially preventable admissions.

Contribution to the Work:

I was directly involved in the design of the research question, the execution of the research, the analysis of the results, and the drafting of the now-published paper. Dr. David Chang, who mentored this research, was involved at all steps of the research process as well. Dr. Andrew Loehrer, who collaborated in this research, provided invaluable assistance during the design, analysis and writing portions of the project.

The published research study can be found below and attached to the appendix:

López DB, Loehrer AP, Chang DC. "Impact of Income Inequality on the Nation's Health." *Journal of the American College of Surgeons*. 2016 Oct;223(4):587-94.

<https://www-sciencedirect-com.ezp-prod1.hul.harvard.edu/science/article/pii/S1072751516306846>

Impact of Income Inequality on the Nation's Health



Diego B López, AB, Andrew P Loehrer, MD, MPH, David C Chang, PhD, MBA, MPH

BACKGROUND: Income inequality in the United States has been increasing in recent decades. It is unclear whether income inequality has an independent effect on health outcomes, or whether it simply correlates with increasing levels of poverty. The goal of this study was to evaluate whether income inequality is significantly associated with US county health care expenditures and health care use.

STUDY DESIGN: Cross-sectional analysis of county health expenditure data from the Health Resources and Services Administration's Area Resources File, county income inequality measures (Gini coefficient) from the Census' American Community Survey, and estimates of potentially preventable admissions and potentially discretionary procedures from the Nationwide Inpatient Sample (1998 to 2011). Datasets were linked via county Federal Information Processing Standard codes. Multivariable linear and Poisson regression analyses were performed at the county level adjusting for county characteristics.

RESULTS: A total of 1,237 counties (of 3,144) were included. Income inequality was associated with higher health care expenditures, with each 1 percentage-point increase in county Gini coefficient associated with a US\$40,008 increase in annual county Medicare cost ($p = 0.003$), and an increase of 174.7 total county Medicare inpatient days per year ($p < 0.001$). Even after accounting for poverty level and county characteristics, counties with higher inequality had higher potentially preventable admission (eg 4.86 rate ratio for low-birth-weight hospital admissions in the top income inequality quartile compared with bottom quartile; $p < 0.001$) and a higher incidence of potentially discretionary procedures (eg 1.79 rate ratio for prostatectomy for benign prostatic hyperplasia in the top income inequality quartile compared with bottom quartile; $p < 0.001$).

CONCLUSIONS: Income inequality is independently associated with higher health care expenditures and more health care use, with increases in both potentially discretionary procedures and in potentially preventable admissions. (J Am Coll Surg 2016;223:587–594. © 2016 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

Income inequality has recently gained prominence in public debates, with President Obama characterizing it as “the defining challenge of our time.”¹ This issue is often framed in terms of its effects on politics and the economy; its effects on health care are rarely discussed. The literature in this regard is far from settled, but previous studies

have reported negative associations between income inequality and a variety of measures, such as prevalence of depression, self-rated health, and even environmental quality.^{2–5}

A salient issue in this discussion is whether income inequality is independently associated with worse health outcomes, or whether it simply correlates with increasing levels of poverty. Although poverty and income inequality are often thought of as similar issues, they are not equivalent and can be independent of each other. Although the first has to do with the overall level of income in a region, the second has more to do with the way in which that income is distributed within the region. Two hypothetical regions can have the same overall level of income and have a markedly different income

Disclosure Information: Nothing to disclose.

Received March 9, 2016; Revised July 1, 2016; Accepted July 1, 2016.
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distribution. At one extreme, the income could be equally divided among persons in the region. At the other extreme, the same income could be flowing to a handful of people. The impact of income disparity on the health care system is unknown. It is possible that counties with high rates of poverty but an equal income distribution might be more likely to have a health care system in place that is able to meet the prevalent health needs of the population. Alternatively, counties with high rates of poverty and inequality might be better equipped to deal with health needs because the high-income sector of the population might support the health care needs of the overall region.

Given the complex interplay between socioeconomic dynamics and health outcomes, the primary objective of this study was to evaluate patterns of health care system use in counties with varying levels of income inequality. We hypothesized that income disparity negatively impacts health care expenditures, independent of the well-established link between socioeconomic status and health.

METHODS

Our analysis involved linking 3 separate datasets, the Health Resources and Services Administration's Area Resource File (ARF), the AHRQ Nationwide Inpatient Sample (NIS), and the US Census Bureau's American Community Survey. First, we performed a retrospective analysis of the NIS from 1998 to 2011. The NIS is the largest all-payer inpatient national database, and contains discharges from a 20% sample of all US hospitals. Inclusion of the NIS dataset allowed aggregation of patient-level data to estimate total county volume of potentially preventable or potentially discretionary hospitalizations. Potentially preventable admissions, meant to capture health care use at the poorer end of the socioeconomic spectrum, included critical limb ischemia, low birth weight, short-term complications of diabetes, long-term complications of diabetes, pneumonia, and dehydration, following AHRQ definitions.⁶ Potentially discretionary procedures, meant to capture health care services provided at the wealthier end of the socioeconomic spectrum, were defined per previous literature to include hysterectomy for fibroids (ICD-9 procedure codes 68.3 to 68.8 and diagnosis codes 218.0 to 219.9), prostatectomy for benign prostatic hyperplasia (ICD-9 procedure codes 60.2 to 60.69 and diagnosis codes 600 to 600.01), and lumbar fusion procedures (ICD-9 procedure codes 80.5 to 80.59 and 03.09).^{7,8} Because the NIS consists of a 20% sample of the population, we divided county population by 5 to use as the denominator for the purpose of estimating county-level population rates in [Table 1](#).

Our study similarly queried the ARF dataset during the same time period (1998 to 2011). This dataset contains comprehensive data on US county health resources and socioeconomic indicators. The outcomes of interest were distribution of health care resources and health care expenditures in each county, including actual inpatient Medicare costs, overall actual Medicare costs, total Medicare inpatient days, number of active physicians, specialists (cardiovascular and surgical), hospitals (both overall and teaching), hospital beds, and operating rooms per capita in US counties. County-level covariates extracted from the ARF file included racial composition (percentage of the county population identified as white), poverty rate (percentage of the county population in poverty), median household income, rate of uninsured, urbanicity (percentage of the county population living in a census tract identified as an urban area), age distribution, and county population. Values from years that were not included in the ARF database were estimated by calculating the mean values from available years. Counties that appeared in both the ARF and NIS datasets were linked via county Federal Information Processing Standard codes and included in the study.

The Gini coefficient of income inequality was extracted from the Census Bureau's American Community Survey and was included as a covariate. The American Community Survey is an ongoing survey providing yearly socioeconomic and demographic information for each county. The American Community Survey sampled population increases every year. Currently, it includes around 3.5 million housing units throughout the United States and Puerto Rico that are interviewed by phone, mail, internet, or personal visit.⁹ The Gini coefficient is commonly used to compare income inequality between regions, and can range from 0 (income equally distributed throughout everyone in a given county) to 1 (income completely held by one person in the county).¹⁰ For this study, figures from the American Community Survey 2011 5-year estimates for county Gini coefficients were included.¹¹

Unadjusted comparisons were performed using *t*-tests. Multivariable linear regression models were used whenever the end point was a measure of health care cost or health care resources. Multivariable Poisson regression models were used for procedure or admission volumes, with county population as the exposure variable. All regression models included adjustments for county characteristics (racial composition, poverty rate, median household income, uninsurance rate, urbanicity, age distribution, and county population). All analyses were performed using STATA SE, version 13.1 (Stata Corp).

RESULTS

Overall, 1,237 counties appeared in both the NIS and ARF datasets and were therefore included in the study. Median Gini coefficient was 43.2, with a median county population of 40,190. Gini indices ranged from 35.25 to 41.15 in the first (lowest income inequality) quartile, 41.15 to 43.14 in the second quartile, 43.15 to 45.28

in the third quartile, and 45.29 to 60.07 (highest income inequality) quartile. A summary of county characteristics can be found in [Table 1](#).

Unadjusted comparisons between the bottom and top quartiles of counties sorted by Gini coefficient revealed significant differences in county characteristics, resources, and health care use ([Table 2](#)). Counties with higher

Table 1. Sociodemographic, Health Care Resource, Health Care Use, and Procedure Volume Characteristics of US Counties from 1998 to 2011

Variable	Median	Interquartile range
County characteristic		
White population, %	91.4	80.5–96.1
Population in poverty, %	14.2	10.9–18.0
Median household income, \$	42,909.50	34,411.90–50,213.30
Population uninsured, %	15.8	11.9–19.4
Population urban, %	49.8	28.1–72.6
Population aged 1 to 18 years old, %	26.7	25.0–28.2
Population aged 18 to 35 years old, %	17.7	15.9–19.7
Population aged 35 to 65 years old, %	39.9	38.4–41.6
Population aged 65+ years old, %	15.2	12.7–17.6
Gini coefficient	43.2	41.2–45.3
County population (in 10,000s)	4.19	1.9–12.0
County resource (per 10,000 people)		
No. of cardiovascular disease specialists	0.2	0–0.6
No. of surgical specialists	2.5	0.9–4.4
No. of hospitals	0.3	0.2–0.6
No. of teaching hospitals	0	0
No. of hospital beds	27.0	16.3–42.1
No. of active MDs	12.1	6.7–20.9
No. of operating rooms	1.0	0.6–1.5
No. of hospitals with cardiac catheterization labs	0	0–0.1
No. of hospitals with cardiac surgery departments	0	0–0.01
County Medicare usage (per 10,000 people)		
Annual inpatient actual Medicare cost, \$	4,179,624	3,316,784–5,219,126
Total Medicare inpatient days	2,128.9	1,281.4–3,498.3
Annual actual Medicare cost, \$	7,800,280	7,195,292–8,685,766
County volume indicator (per 10,000 people), n		
Hysterectomies	21.6	1.9–48.9
Lumbar procedures	3.02	0–138.4
Prostatectomies	0	0–1.0
Critical limb ischemia admissions	9.0	0.4–37.5
Admissions for DM short-term complications	52.6	27.1–91.9
Admissions for DM long-term complications	89.2	42.0–150.6
Low-birth-weight admissions	0	0–2.7
Dehydration admissions	260.5	141.7–456.2
Pneumonia admissions	12.5	6.0–21.5

Summary of county characteristics for the 1,237 (39%) US counties included in the study. Demographic, county resource, and Medicare usage data were extracted from the Health Resources and Services Administration's Area Resources File database. Gini coefficients were extracted from the US Census Bureau's American Community Survey. County procedure and admission data were extracted from the Nationwide Inpatient Sample dataset. DM, diabetes mellitus.

Table 2. Unadjusted Comparison of Sociodemographic Characteristics, Health Care Resources, Health Care Use, and Procedure Volume Between the Top and Bottom Quartile Counties According to the Gini Coefficient of Income Inequality

Variable	Bottom quartile Gini (35.25–41.15)		Top quartile Gini (45.29–60.07)		p Value
	Mean	SD	Mean	SD	
County characteristic					
White population, %	91.3	9.1	76.0	19.7	<0.001
Population in poverty, %	11.3	3.9	19.2	6.9	<0.001
Median household income, \$	50,531.80	12,144.80	41,414.00	12,774.90	<0.001
Population uninsured, %	13.9	4.6	18.1	4.3	<0.001
Population urban, %	44.0	26.4	56.0	32.1	<0.001
Population aged 1 to 18 years old, %	27.8	3.2	26.5	3.2	<0.001
Population aged 18 to 35 years old, %	17.5	2.8	20.0	4.6	<0.001
Population aged 35 to 65 years old, %	40.1	2.9	38.9	3.4	<0.001
Population aged 65+ years old, %	14.7	3.9	14.6	3.7	0.8583
Gini coefficient	39.5	1.3	47.7	2.2	NA
County population (in 10,000s)	7.2	10.7	29.7	77.1	<0.001
County resource (per 10,000)					
No. of cardiovascular disease specialists	0.2	0.2	0.7	0.1	<0.001
No. of surgical specialists	1.7	1.7	4.8	5.5	<0.001
No. of hospitals	0.6	0.6	0.5	0.6	0.02
No. of teaching hospitals	0.00	0.00	0.01	0.03	<0.001
No. of hospital beds	29.3	28.5	44.1	39.7	<0.001
No. of active MDs	10.6	7.8	24.7	28.0	<0.001
No. of operating rooms	1.0	0.8	1.3	1.2	<0.001
No. of hospitals with catheterization labs	0.02	0.06	0.05	0.08	<0.001
No. of hospitals with cardiac surgery	0.01	0.03	0.04	0.07	<0.001
County Medicare usage (per 10,000)					
Annual inpatient actual Medicare cost, \$	3,803,779	1,350,535	4,585,372	1,574,336	<0.001
Total Medicare inpatient days	1,901.04	1,671.01	3,385.492	2,592.233	<0.001
Annual actual Medicare cost, \$	7,733,114	1,018,902	8,599,271	1,547,140	<0.001
County volume indicator (per 10,000)					
Hysterectomies	5.4	9.7	8.4	9.3	<0.001
Lumbar procedures	14.2	52.8	36.7	63.2	<0.001
Prostatectomies	0.09	0.30	0.26	0.69	<0.001
Critical limb ischemia admissions	4.3	14.8	9.3	13.9	<0.001
Admissions for DM short-term complications	10.7	14.7	17.6	15.9	<0.001
Admissions for DM long-term complications	17.9	27.6	30.8	25.3	<0.001
Low-birth-weight admissions	0.3	0.6	1.2	2.6	<0.001
Dehydration admissions	61.3	66.2	89.0	87.0	<0.001
Pneumonia admissions	2.8	3.3	4.1	3.8	<0.001

Unadjusted comparison between the top and bottom income inequality quartiles for the 1,237 (39%) US counties included in this study. Demographic, county resource, and Medicare usage data were extracted from the Health Resources and Services Administration's Area Resources File database. Gini coefficients were extracted from the US Census Bureau's American Community Survey. County procedure and admission data were extracted from the Nationwide Inpatient Sample dataset. Unadjusted comparisons performed using *t*-tests.

DM, diabetes mellitus; NA, not applicable (because comparison groups were sorted by Gini).

income inequality had significantly higher numbers of health care resources and health care professionals per capita. Likewise, Medicare expenditures and total Medicare inpatient days were significantly higher for counties in the top income inequality quartile. The volumes of

both potentially preventable hospital admissions and potentially discretionary surgical procedures were also significantly increased in high income inequality counties.

Table 3 shows multivariable linear regression coefficients corresponding to the Gini index of income

Table 3. Multivariable Linear Regression Analysis of County Healthcare Resources and County Medicare Usage

Variable	Gini index	p Value	95% CI
County resource (per 10,000)			
No. of cardiovascular disease specialists	0.062	<0.001	0.049–0.076
No. of surgical specialists	0.400	<0.001	0.329–0.471
No. of hospitals	0.018	0.001	0.007–0.029
No. of teaching hospitals	0.001	<0.001	0.001–0.002
No. of hospital beds	2.520	<0.001	1.739–3.302
No. of active MDs	1.992	<0.001	1.635–2.348
No. of operating rooms	0.076	<0.001	0.056–0.096
No. of hospitals with catheterization labs	0.003	<0.001	0.001–0.004
No. of hospitals with cardiac surgery	0.003	<0.001	0.003–0.005
County Medicare usage (per 10,000)			
Annual inpatient actual Medicare cost, \$	40,007.70	0.003	13,384.23–66,769.79
Total Medicare inpatient days	174.687	<0.001	126.890–222.475
Annual actual Medicare cost, \$	31,482.23	0.011	7,181.02–55,783.44

Multivariable linear regression analysis included the following covariates: percent of population that is white, percent of population that is in poverty, median household income, percent of population that is uninsured, percent of population that lives in an urban area, age distribution, and population for 1,237 US counties. Demographic, county resource, and Medicare usage data were extracted from the Health Resources and Services Administration's Area Resources File database. Gini coefficients were extracted from the US Census Bureau's American Community Survey.

inequality, with various measures of county health care resources and expenditures as outcomes. Income inequality was associated with higher Medicare expenditures. After accounting for poverty rate, percent minorities, household income, insurance rate, population size, urbanicity, and age distribution, a 1 percentage-point increase in county Gini coefficient was associated with a US\$40,007.70 increase in annual inpatient Medicare cost ($p = 0.003$), a US\$31,482 increase in annual actual Medicare cost ($p = 0.011$), and a 174.69 increase in annual county Medicare inpatient days ($p < 0.001$) per 10,000 people in a county. Income inequality was also associated with higher numbers of health care resources. After adjustment for county characteristics, a 10-percentage point increase in county Gini coefficient was associated with 25.2 more hospital beds per 10,000 people ($p < 0.001$), 19.92 more active physicians per 10,000 people ($p < 0.001$), 4.0 more surgical specialists per 10,000 people ($p < 0.001$), among others (Table 3).

Income inequality was consistently associated with increasing number of potentially preventable hospital admissions. Stratification of counties into Gini coefficient quartiles revealed marked differences in potentially preventable hospital admissions, with the largest impact of income inequality observed on low-birth-weight hospital admissions (rate ratio of 4.86 for the top quartile) (Fig. 1).

Interestingly, the rates of potentially discretionary procedures also increased with inequality. Counties placed in the top income inequality quartile had rate ratios of 1.53 for hysterectomy for fibroids (95% CI, 1.49–1.56;

$p < 0.001$), 1.64 for lumbar fusion procedures (95% CI, 1.62–1.66; $p < 0.001$), and 1.79 for prostatectomies for benign prostatic hyperplasia (95% CI, 1.55–2.06; $p < 0.001$) (Fig. 1).

DISCUSSION

In this nationwide study, we compared patterns of health care use in US counties across the income inequality spectrum. We found that county-level income inequality was positively associated with higher total county health care expenditures, as measured by total and inpatient costs covered by Medicare. Additionally, we found income inequality to be associated with higher numbers of surgical procedures performed and higher numbers of potentially preventable hospital admissions. These observations suggest that income inequality is independently associated with higher total expenditures, even after adjusting for poverty level; and this cost-increasing effect occurs at both ends of the income spectrum, with the wealthy segment of the socioeconomic spectrum receiving more services (in the form of potentially discretionary procedures), as well as the poorer segment requiring more services (in the form of potentially preventable admissions).

This association between income inequality and increased health care expenditure and use can be explained by a variety of mechanisms. Inequality can worsen the health status of poorer segments of the population beyond the effect of poverty. Previous studies, for example, have reported associations between income

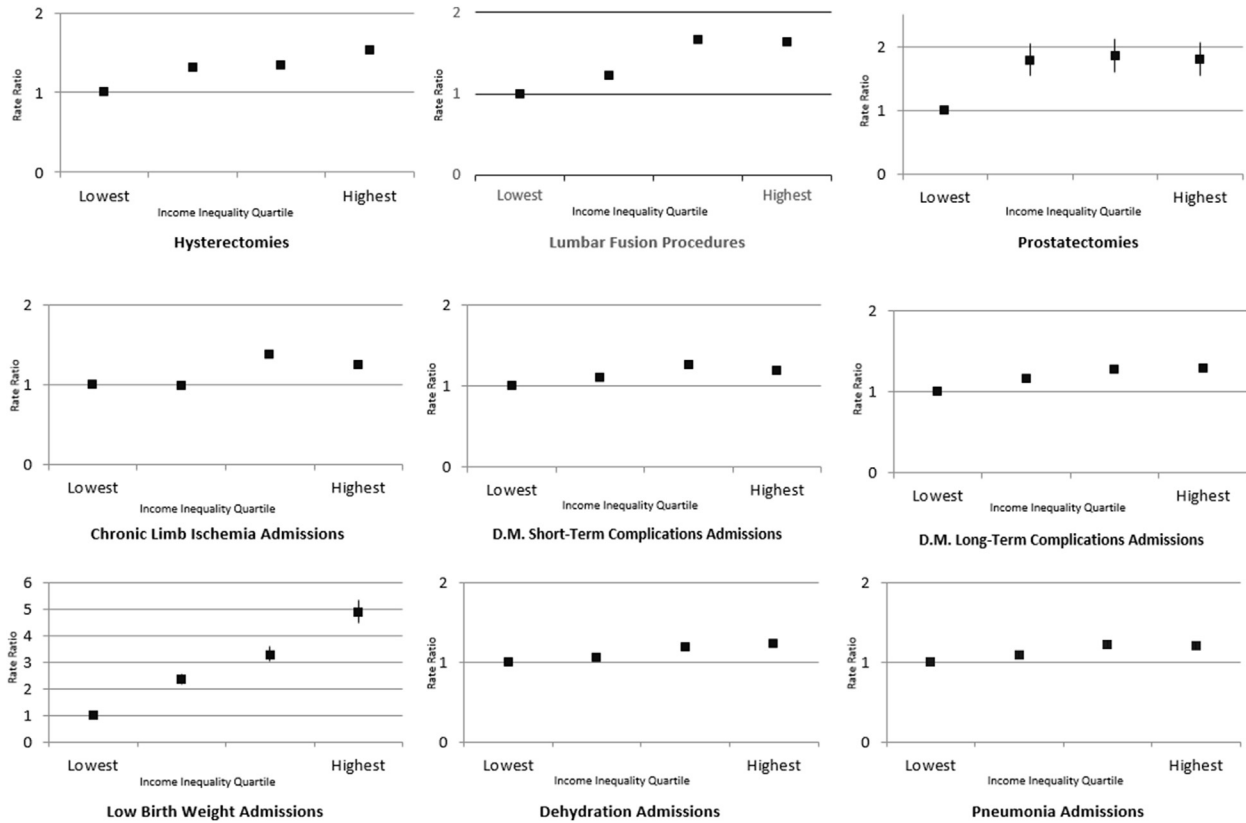


Figure 1. Rate ratios of potentially discretionary procedures and potentially preventable hospital admissions in US counties across income inequality quartiles from 1998 to 2011. Multivariable Poisson regression model was adjusted for percent of population that is white, percent of population that is in poverty, median household income, percent of population that is uninsured, percent of population that lives in an urban area, age distribution, and population for 1,237 (39%) of US counties. Reference quartile is the lowest income inequality quartile. Demographic, county resource, and Medicare usage data were extracted from the Health Resources and Services Administration's Area Resources File database. Gini coefficients were extracted from the US Census Bureau's American Community Survey. DM, diabetes mellitus.

inequality and total mortality.^{2,12,13} Some have hypothesized that income inequality can increase social class differences, augmenting the effect of socioeconomic status on health.¹⁴ Removing the Gini coefficient from our models increases the coefficient of other covariates, such as median household income, county poverty rate, and county racial population, suggesting that some of the effects of socioeconomic status might be mediated or modified by inequality (data not shown). It has been hypothesized that income inequality can independently reduce social mobility and social cohesion. Unlike poverty, lack of social cohesion could potentially affect both the poor and the well-off sectors of society.¹⁵

Alternatively, local governments in high inequality regions might lack resources or political will for adequate funding of social services, leading to underinvestment in public health, education, and safety net programs.¹⁶

This, in turn, can lead to higher disease prevalence, delayed care, worsened stage at presentation, and the observed increase in preventable admissions.

Additionally, above-average concentration of wealth within unequal regions can lead to greater concentration of health care resources. Higher resource density and hospital competition could be exerting a net upward force on health care use.¹⁷ Geographic concentration of hospitals, for example, increases hospital competition and has been linked to higher hospital charges, possibly through an increase in medically unnecessary services (the so-called "medical arms race").¹⁸ Our findings similarly suggested an association between concentrated wealth and higher use of potentially discretionary procedures.

One alternative explanation for the observed differences between counties is that resources and health outcomes can be mediated by poverty and communities'

socioeconomic status, not specifically by income inequality. Although there is a correlation between poverty and income inequality, socioeconomic status is unlikely to confound this study; the ARF dataset allowed us to adjust regression models for both county poverty rate and county median household income.

Interestingly, the median Gini coefficient for US counties was 43.2. This places the United States among the most unequal developed countries, and suggests comparative international studies of health care delivery through the lens of income inequality could be instructive. Additionally, we found considerable variation in income inequality, with the Gini index for all US counties ranging from 35.25 to 67.07. The causes and consequences of these regional variations warrant additional research. Although this investigation focused primarily on the association between income inequality and increased health care system use, it indirectly also assessed patient outcomes in the form of preventable admissions, which reflects the outcomes of the pre-hospital primary care system. Future investigations could examine whether this adverse association of income inequality is also found with outcomes of in-hospital clinical care.

This study is strengthened by the use of 2 nationally representative datasets that allowed comprehensive adjustment for county characteristics. Additionally, the use of American Community Survey data enabled querying the effect of income inequality, a rarely studied determinant of health. We must acknowledge the limitations associated with the datasets that were used. Our study captures only 1,237 counties (of 3,144) in the United States. This is primarily due to the fact that NIS is only available in those counties. However, this is unlikely to affect the generalizability of our findings to the US population, because the Healthcare Cost and Utilization Project, on which the NIS database is based, now captures 97% of the inpatient population in the United States. Therefore, the seemingly large proportion of counties that were not captured in this study have small populations and even smaller numbers of inpatient admissions, which has a negligible impact on the generalizability of our study findings. The NIS dataset is also susceptible to coding discrepancies, and the lack of clinical granularity prevents exhaustive evaluation of health care appropriateness. Additionally, use of ARF variables means that we rely solely on the Gini coefficient rather than multiple measures of income inequality. Alternative ecologic factors that were not present in the datasets, and are therefore not measures in the

current analysis, can influence health and health care delivery.

CONCLUSIONS

The effect of income inequality on health, let alone health care, is rarely studied. Our findings call for continuing investigation of the effect of income inequality on health and on health care delivery. Although perceptions of income inequality are inevitably influenced by political persuasions, we should strive for health systems that are resilient against such sociopolitical forces. Ultimately, population health should be responsive to community needs, not to ever-changing political dynamics.

Author Contributions

Study conception and design: López, Loehrer, Chang
 Acquisition of data: López, Chang
 Analysis and interpretation of data: López, Loehrer, Chang
 Drafting of manuscript: López, Loehrer, Chang
 Critical revision: López, Loehrer, Chang

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