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COMPARATIVE ANALYSIS OF ENVIRONMENTAL JUSTICE IN US HISPANIC COMMUNITIES OF PUERTO RICO AND NEW MEXICO STATE

Abstract:

Environmental Justice (EJ) seeks to uncover the disproportionate distribution of environmental harm among ethnic/racial minorities and low-income groups. This paper compares the state of EJ in the Commonwealth of Puerto Rico (PR) to the state of New Mexico (NM). The two states have similar populations (3.2 and 2.1 million residents, respectively) and the USA's highest percentage of Hispanic-origin residents (49.9% in NM and 98% in PR).

Previous economic research has found links between ethnicity and exposure to toxic environmental factors that harm human health. However, no studies were conducted to compare PR to other US states with a large Hispanic population. PR is a unique subject for EJ analysis for several reasons: it is large, ethnically homogeneous (98% Hispanic), geographically autonomous, and has a high level of poverty.

Although PR is subject to strict environmental compliance regulations in the United States, enforcement may be less effective. Our analysis reveals that the Puerto Rican population has been more adversely impacted by environmental pollution than the majority of Hispanic districts in the southern United States, with a greater impact on Health Equity. Overall, the findings confirm that geospatial factors (rural residence) and socioeconomic status challenges have a greater negative impact on majority-Hispanic communities. The majority of Hispanic areas in New Mexico suffer from high median diabetes prevalence and socioeconomic challenges that are significantly higher than the US average.

Keywords:

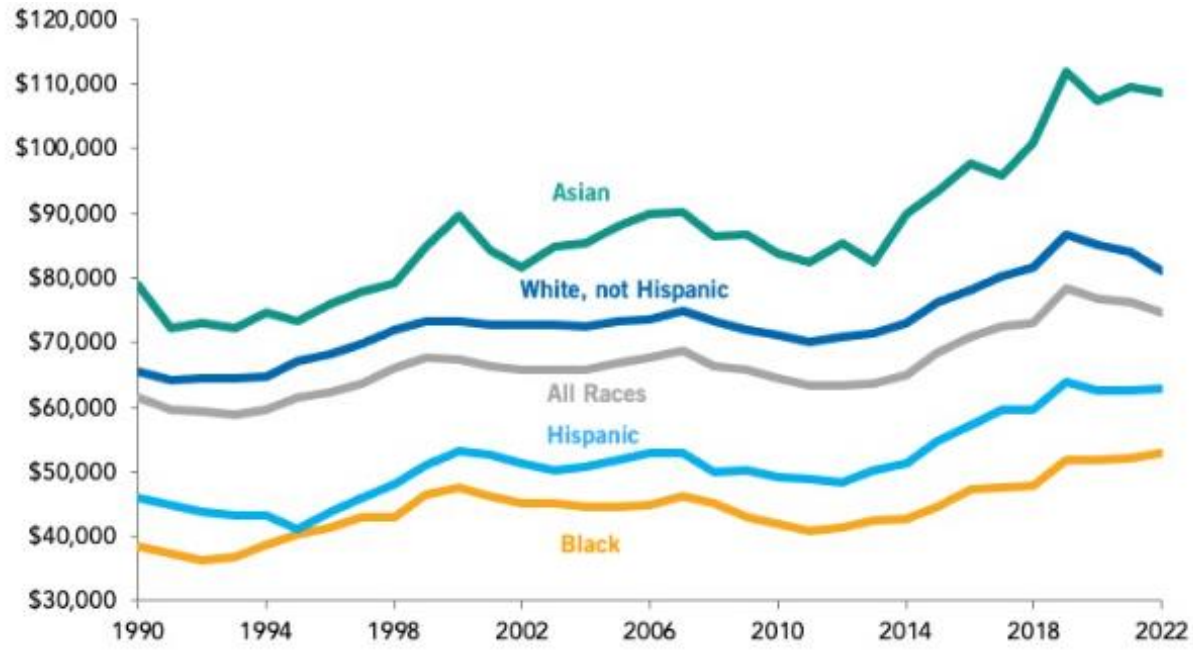
Environmental justice; Health disparities, Hispanics, Race/Ethnicity

JEL Classification: Q53, Q56

1. INTRODUCTION

The right to a safe and healthy environment is a universal human right, although healthy standards vary around the world. At the most basic ecological level, everyone has the right to breathe fresh air, drink clean water, and eat healthy, nutritious food. While each right is vital in itself, the ultimate goal of Environmental Justice (EJ) is to provide comparable protection from environmental effects for "all people, regardless of income, race, color, national origin or disability" (US EPA, 2024). More effective environmental protection is expected to translate into incrementally positive health outcomes: lower prevalence of chronic diseases and healthier, longer life expectancy (Banzhaf, 2019a, b). While some progress has been achieved in the past decades, society is far from achieving this goal. Hence, the EJ movement needs to maintain its positive momentum, supported by robust academic socio-economic environmental research. The main focus should be on identifying developing trends in the quality of human ecosystems, advising on social and political influences for differential outcomes, and highlighting remaining areas of environmental injustice.

Figure 1. Median Household Income by Ethnicity of the Household Head (2022 dollars)



Source: Authors' presentation based on data from US Census (2020),

Historically, EJ research has focused on assessing the proximity of environmental hazard sources (toxic pollutants in the air, soil, and water) to ethnic or socially disadvantaged communities (Antonczak, 2023; Hausman & Stolper, 2021). The majority of EJ studies have used linear correlation or regression to assess the significance of the relationship between environmental risk indicators and population characteristics such as race, ethnicity, and income (Chakraborty, 2011; Casey, 2023).

According to Casey (2023), two groups of factors received the most attention in published research, with 35% each: 1) race/ethnicity and 2) socioeconomic status, followed by rural/urban comparisons (15%). These factors are likely to remain dominant subjects of future research, with increased data granularity and clarity on their interdependence. EJ researchers have primarily focused on race and ethnicity (Chakraborty, 2017).

EJ scientists are particularly interested in identifying sources of environmental pollution (air, water, soil, and food), the impact of pollution exposure on different population groups, and health consequences, as measured by the prevalence of major diseases (Chakraborty, 2011). All of the data presented above should be analyzed both in absolute and relative terms, with EJ aiming to achieve an equitable distribution of positive and negative factors. Of course, the overarching goal is not only to redistribute but also to reduce humanity's overall negative environmental impact. Such progress has been observed around the world, particularly in the United States (EPA 2024).

Air pollution is the most visible and global factor, as toxic emissions can travel hundreds or thousands of miles across regions and nations via air currents. Some notable examples include transnational acid rain and CO2 emissions, which began locally but became global issues. Another major source of air pollution is transportation (cars and trucks), which has a more local impact on human health. According to Liu (2021), between 1990 and 2010, air pollution levels fell, as did absolute (and, to a lesser extent, relative) racial/ethnic exposure disparities. As of 2010, disparities in racial/ethnic exposure to several pollutants persisted across income levels, urban and rural regions, and all states. (Liu, 2021). It is encouraging that significant progress has been made in the last dozen years (2010-2022), as air pollution from all major sources has decreased despite continued traffic growth: NO2 levels have decreased by 21%, CO by 27%, SO2 by 75%, and small dust particles (PM2.5) by 16% (EPA 2024).

Adverse birth outcomes (19%), mortality (14%), and cardiovascular and respiratory diseases (10%) were the most common causes of health disparities (Casey, 2023). Collectively, these health outcomes determine the quality and length of human life. Removing environmental hazards is one way to achieve the Health Equity goal. Some health professionals define health outcomes as a combination of length of life (years lost before the age of 75) and quality of life (based on self-reported health status and the proportion of low-birthweight newborns) (County Health Ranking, 2023).

Geographically, the majority of EJ studies (59%) were conducted in just a few US states with 31.6% of the population: California (21% of studies, 11.8% of the US population), New York (11% and 6%, respectively), Massachusetts (11% and 2.1%), Michigan (8%, 3%), and Texas (8%, 8.7%), according to Casey (2023). This regional focus may be explained by the presence of major EJ academic research centers in those states.

Smaller regions with high Hispanic prevalence, such as Puerto Rico and New Mexico, have not been studied despite having the highest percentage of Hispanics in their populations (98.7% and 49.9%, respectively). Our study seeks to fill this significant gap in the EJ literature.

Table 1 shows significant differences in income strata across ethnicities, highlighting Puerto Rico's highly anomalous income distribution.

Table 1. Cumulative % distribution of US household income by ethnicity (2022)

Annual Household Income, $K	White, not Hispanic	Asian	Black	Hispanic (any race)	Puerto Rico	Comments
< 15	7%	8%	14%	10%	36%	
15 - 25	14%	12%	24%	18%	55%	**Poverty**
25 - 35	21%	17%	34%	27%	67%	
35 - 50	31%	24%	47%	40%	79%	
50 - 75	47%	36%	65%	58%	90%	**Median US**
75 - 100	59%	46%	76%	72%	95%	
100 - 150	77%	65%	88%	86%	98%	
150 - 200	87%	77%	94%	93%	99%	**> 2x Median**
> 200	100%	100%	100%	100%	100%	
< 25 (Poverty)	14%	12%	24%	18%	55%	
< 75 (Median)	57%	36%	65%	58%	90%	
> 150 (2x Median)	24%	36%	12%	14%	2%	

Source: Authors' calculations based on data from US Census (2020)

2. METHODOLOGY

Selection of Independent Variables

Three groups of independent variables were chosen:

1) Proximity to environmental pollution sources: Diesel particulate matter exposure (percentile); Proximity to hazardous waste sites, NPL (Superfund) sites, Risk Management Plan (RMP) facilities, and Wastewater Discharge.

2) Diseases: current asthma, diagnosed diabetes, coronary heart disease – all among adults over the age of 18 years (percentile), and low life expectancy.

3) Economic Challenges: Unemployment, the percentage of individuals living below 200% and 100% of the US Federal poverty level, and the percentage of individuals over the age of 25 without a High School degree. All values were expressed in relative terms as percentiles within the USA.

The dataset was extremely robust, with over 1,050 Census tracts, representing over 5 Million people. The margin of error in the US Census databases is typically +/- 0.3-0.4%.

Cumulatively, Hispanic Health Index (HHI) hypotheses result in a following equation for a tract *i*

$$HHI_i = \beta_0 + \beta_1 * DPM + \beta_2 * HW + \beta_3 * NPL + \beta_4 * RPM + \beta_5 * WW + \beta_6 * UEMPL + \beta_7 * PVRT + \beta_8 * WHSD + \varepsilon_{it} \quad (1)$$

Where the dependent variable is HHI_i = Average of percentiles of Diseases (Asthma, Diabetes and Heart Diseases, equally weighted).

Independent variables are denoted as follows: DPM = Diesel Particles Matter in the air, HW = Proximity of Hazardous Waste Sites, NPL = Proximity to Superfund NPL Sites, RPM = Proximity to Risk Management Plan RPM facilities, WW = Waste Water Discharge location, UEMPL = Unemployment, PVRT = Poverty rate, WHSD = Adults without a high school diploma.

All proximity and other values are expressed in percentiles within the United States, with a higher value indicating closer proximity or a higher prevalence of disease. As a result, higher values have a greater negative impact on population. This approach greatly simplifies the interpretation of variables and conclusions.

3. RESULTS AND DISCUSSION

Previous economic research has found links between ethnicity and exposure to toxic environmental factors that harm human health (Mikati, 2018, Jose, 2023). However, no studies were conducted to compare PR to other US states with a large Hispanic population.

PR is a unique subject for EJ analysis in several reasons: it is large, ethnically homogeneous (98% Hispanic), geographically completely autonomous, with a high level of poverty (Shrider, 2023). New Mexico is the most similar to PR in several aspects, including having the highest (49.9%) Hispanic percentage in the mainland US.

Recent studies have found a higher prevalence of diabetes in the diverse Hispanic community (Schneiderman, 2014), resulting in higher mortality rates (Errisuriz, 2024). This could be due to lifestyle, diet, and some historical and generic factors for Hispanics in Mexico and Central America (Fernandez, 2021). Our dataset contained sufficient data to investigate these trends in the Puerto Rican and New Mexican Hispanic communities.

Table 2. The Commonwealth of Puerto Rico (pair correlation of variables)

	Variables =>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
					A				B							
1	% Hispanic		-40%	-38%	-46%	-45%	-16%	40%	32%	38%	-9%	51%	51%	32%	44%	C
2	Diesel Particles			89%	74%	82%	-2%	43%	-45%	-44%	31%	-28%	12%	-5%	39%	
3	Hazard Waste Sites				52%	83%	23%	41%	-31%	-37%	21%	-40%	2%	4%	28%	
4	Superfund (NPL)		D			58%	-22%	7%	-60%	-61%	21%	-37%	-20%	-39%	5%	
5	RPM Facilities						16%	34%	-36%	-43%	12%	-20%	4%	-3%	32%	
6	Waste Water Discharge							-31%	-25%	-21%	-31%	-54%	-13%	15%	-33%	
7	Asthma %-tile								-5%	7%	32%	30%	74%	49%	78%	E
8	Diabetes %-tile									90%	-27%	25%	34%	66%	2%	
9	Heart disease %-tile								F		-21%	35%	42%	72%	13%	
10	Low Life Expectancy %											7%	-4%	-14%	9%	G
11	Unemployment												47%	23%	46%	
12	% Poverty (<200%)													67%	80%	
13	% Poverty (<100%)														38%	
14	ex-HS															
	Variables =>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
	MAX	100%	18	95	99	98	99	90	98	94	95	99	99	99	99	
	MIN	79%	0	0	0	0	0	10	38	8	2	0	25	25	0	
	MEAN	98%	3	32	57	55	54	69	82	54	50	88	96	95	84	
	MEDIAN	99%	1	25	60	58	54	73	87	57	58	96	98	97	88	H
	St. Dev	2%	4	23	26	26	22	17	16	25	24	19	7	7	14	
	St. Dev / Mean	0.02	1.36	0.73	0.46	0.47	0.40	0.24	0.20	0.47	0.48	0.22	0.07	0.07	0.16	

Source: Authors' calculations based on data from the US Census (2020), CDC, EPA

Table 2 shows the results of pair correlations of all variables, with the following key observations:

A There is negative correlation between Hispanic prevalence and environmental pollution, explained that urban areas have lower Hispanic % (more diverse population) and higher pollution.

B Positive correlation of Hispanics with a prevalence of chronic diseases.

C Significant positive correlation of Hispanics with socio-economic status (SES) challenges

D Very high positive correlations among several environmental contaminants

E Very high positive correlations among diseases and SES challenges

F Very high positive correlation between diabetes and heart disease

G Surprising lack of correlation between diseases and life expectancy

H Puerto Rico Hispanics have a higher prevalence of diseases and more SES challenges

Table 3. The state of New Mexico: Total Population

	Variables =>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
					A				B							
1	% Hispanic		23%	2%	14%	22%	3%	-4%	31%	-7%	16%	8%	36%	33%	49%	C
2	Diesel Particles			76%	61%	54%	26%	3%	-28%	-42%	15%	-5%	-5%	0%	-16%	
3	Hazard Waste Sites				54%	37%	16%	-10%	-46%	-48%	2%	-17%	-23%	-17%	-35%	
4	Superfund (NPL)		D			34%	27%	5%	-19%	-32%	2%	-7%	0%	4%	-10%	
5	RPM Facilities						25%	16%	-14%	-30%	16%	4%	3%	5%	8%	
6	Waste Water Discharge							14%	2%	-8%	-4%	9%	2%	3%	-4%	
7	Asthma %-tile								49%	41%	53%	44%	74%	69%	58%	E
8	Diabetes %-tile									87%	40%	36%	73%	71%	70%	
9	Heart disease %-tile							F			28%	30%	54%	53%	47%	
10	Low Life Expectancy %											29%	52%	51%	48%	
11	Unemployment												43%	42%	37%	G
12	% Poverty (<200%)													89%	73%	
13	% Poverty (<100%)														67%	
14	No High School Diploma															
	Variables =>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
	MAX	99%	96	94	99	94	99	99	98	99	99	99	99	99	99	
	MIN	0%	0	0	0	0	0	0	0	0	0	0	0	1	0	
	MEAN	46%	34	34	45	25	51	48	55	50	49	57	63	63	56	
	MEDIAN	45%	24	28	43	17	59	45	57	49	48	59	68	69	59	H
	St. Dev	23%	32	27	31	25	31	23	27	26	27	29	25	25	28	
	St. Dev / Mean	1.02	0.40	0.62	0.54	0.50	0.69	0.90	0.41	0.48	0.59	0.56	0.49	0.51	0.56	

Source: Authors' calculations based on data from US Census (2020), CDC, EPA

Table 3 highlights key conclusions for the entire New Mexico population:

A Positive correlation between Hispanic prevalence in NM and environmental pollution

B Positive correlation between Hispanic prevalence in NM and diabetes, but not asthma

C Positive correlation between Hispanic prevalence in NM and SES challenges

D Very high positive correlation among several environmental contaminants

E Very high positive correlation among diseases and SES challenges

F Very high positive correlation between diabetes and heart disease

G Strong positive correlation between Unemployment and other SES challenges

H Moderately higher median values of diseases and SES challenges vs. the average US

Table 4. New Mexico: Focus on areas of Majority (>75%) Hispanic population

	Variables =>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
					A							B				
1	% Hispanic		8%	7%	-14%	-4%	22%	20%	4%	-5%	-26%	-14%	18%	22%	24%	C
2	Diesel Particles			56%	65%	56%	25%	33%	-32%	-35%	30%	-8%	4%	-13%	21%	
3	Hazard Waste Sites				54%	21%	39%	10%	-12%	-12%	16%	-28%	5%	0%	14%	
4	Superfund (NPL)					42%	15%	3%	-20%	-26%	5%	-33%	-11%	-17%	-8%	
5	RPM Facilities						37%	39%	-13%	-22%	10%	11%	-6%	-3%	27%	
6	Waste Water Discharge							48%	16%	6%	-33%	-10%	19%	21%	49%	
7	Asthma %-tile								5%	11%	4%	35%	61%	50%	78%	D
8	Diabetes %-tile									93%	-12%	38%	43%	64%	14%	
9	Heart disease %-tile										-7%	44%	48%	65%	15%	
10	Low Life Expectancy %											26%	4%	1%	5%	
11	Unemployment												39%	40%	26%	
12	% Poverty (<200%)													75%	57%	
13	% Poverty (<100%)														42%	
14	No High School Diploma															
	Variables =>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
	MAX	99%	90	80	99	94	98	86	97	95	96	98	98	97	99	
	MIN	76%	0	1	2	1	0	10	13	4	0	0	48	46	53	
	MEAN	84%	38	27	51	33	65	53	75	51	56	66	82	81	85	
	MEDIAN	83%	32	24	51	34	76	59	84	55	57	75	86	85	87	E
	St. Dev	6%	30	18	35	27	30	20	21	25	24	27	12	12	12	
	St. Dev / Mean	0.07	0.14	0.41	0.27	0.56	0.86	1.31	0.22	0.55	0.86	0.61	0.33	0.35	0.26	

Source: Authors' calculations based on data from US Census (2020), CDC, EPA

Table 4 highlights key conclusions for the Majority Hispanic areas of New Mexico:

A Among Hispanic-majority districts, there is no correlation with environmental toxins. This is probably due to counter impacts from mix of urban and rural areas, with vastly different intensity of pollution.

B Small negative correlation of Hispanic percentage with unemployment implying that Hispanics tend to have lower unemployment than other population

C Significant positive correlation of Hispanic prevalence with SES challenges

D High positive correlation between diseases and SES

E Majority-Hispanic areas are negatively impacted by high median diabetes prevalence and significantly higher than the US average SES challenges. These observations are in agreement with Schneiderman (2014), Fernandez (2021) and Errisuriz (2024)

Table 5. **Linear multi-variable regression analysis for Hispanic Health Index in New Mexico**

	Coefficients	*t Stat*	*P-value*	*P-Significance*
Intercept	14.6345	7.4612	0.0000	* * *
Diesel Particles	-0.0545	-1.7308	0.0841	*
Hazard Waste Sites	-0.0939	-2.8450	0.0046	* * *
Superfund (NPL)	-0.0432	-1.9064	0.0572	*
RPM Facilities	-0.0708	-2.5952	0.0097	* * *
Waste Water Discharge	0.0488	2.9627	0.0032	* * *
Unemployment	0.0638	3.0478	0.0024	* * *
% Poverty (<100%)	0.4933	16.4802	0.0000	* * *
No High School Diploma	0.1626	5.8986	0.0000	* * *

Source: Authors' calculations based on data from US Census (2020), CDC, EPA

Note that P-values are marked in their statistical significance as the following: * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$.

Table 5 summarizes the results of multivariant linear regression analysis for New Mexico's Hispanic residents. The dependent variable was the Hispanic Health Index (HHI), which was calculated as an equal-weighted average of the prevalence of three chronic diseases: asthma, diabetes, and cardiovascular disease. Because all of these chronic diseases can have serious, even fatal, effects on a patient's health, they were weighted equally without an alternative weighing method.

Several environmental pollution factors showed a slightly negative correlation with HHI. This finding does not imply that human proximity to pollution sources, and thus exposure to toxins, helps reduce the prevalence of chronic diseases. Other intercorrelations appear to play a role in this case. Lower air pollution indicates lower traffic volume and fumes in rural areas, which frequently lack sufficient and adequate healthcare facilities, negatively impacting the health index of New Mexico's rural population. According to the NM Senate report, the state already has the oldest physician workforce in the United States and is expected to have the second-largest physician shortage by 2030. SES factors have stronger positive correlations with HHI outcomes, particularly poverty, lack of a high school diploma, and unemployment. This finding is consistent with Liu's (2021) and Jose (2023) studies.

Overall, the findings confirm that geospatial factors (rural residence) and socioeconomic challenges have significant negative impact on majority-Hispanic communities.

4. CONCLUSIONS

This paper uncovered a few important observations in environmental, health and economic aspects for the Hispanic community:

1) Hispanic Population percentage in a given area is indeed positively associated with a higher value of proximity (closer) proximity to environmental pollution sources with a very high degree of statistical significance ***p<0.001.

2) Hispanic Population percentage in a US Census tract is positively associated with a higher prevalence of diabetes and shorter life expectancy in that tract. However, correlations were insignificant for asthma and heart disease.

3) Hispanic population percentage in a tract is positively associated with a higher percentage of poverty, with a high degree of statistical significance (***p < 0.001 in multi-variable correlation analysis).

LIST OF ABBREVIATIONS:

CDC	US Center of Disease Control, a US Federal Government Agency
Census	US Census, the main US Federal Agency in charge of demographic statistics
DOT	US Department of Transportation
EJ	Environmental Justice
EPA	US Environmental Protection Agency
NM	New Mexico (a US state)
PR	Puerto Rico (a US territory)
SES	Socio-Economic Status

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest.

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