



Government Insurance Programs and Their Role in Equitable Healthcare Access

“An overwhelming body of evidence points to an inextricable link between race and health disparities in the United States” (Macias-Konstantopoulos et al., 2023).

- **HIV/AIDS:** “*Actionable Steps*: Increase access to HIV testing and referrals to PrEP and post-exposure prophylaxis.”
- **Viral Hepatitis:** “*Actionable Steps*: Increase access to HCV testing and referrals to DAA treatment.”
- **STI’s:** “*Actionable Steps*: Increase access to STI testing and ED-based treatment.”
- **Pandemic Respiratory Viral Infection:** “*Actionable Steps*: Increase access to viral testing, educate patients and parents about transmission mechanisms and mitigation strategies (eg, masks, isolation, vaccination), and consider offering vaccination in the ED when necessary and reasonable.”

Do government insurance programs (e.g., Medicaid, Medicare) reduce disparities in healthcare system utilization across demographic groups?

Data

- **MIMIC-IV**
 - *admissions* and *patients* datasets
 - 546,028 unique hospitalizations
 - 223,452 unique individuals
- **Outcome:** # of hospital visits per year, per patient
- **Main Predictors:** insurance type, race/ethnicity
- **Controls:** age, marital status
- Count data poses challenges with confounding

	subject_id	admit_year	num_visits	insurance	race	marital_status	gender	anchor_age	anchor_year_group	race_simple
1	10000032	2180	4	Medicaid	WHITE	WIDOWED	F	52	2014 - 2016	White
2	10000084	2160	2	Medicare	WHITE	MARRIED	M	72	2017 - 2019	White
3	10000117	2181	1	Medicaid	WHITE	DIVORCED	F	48	2008 - 2010	White
4	10000117	2183	1	Medicaid	WHITE	DIVORCED	F	48	2008 - 2010	White
5	10000161	2163	1	Medicaid	WHITE	SINGLE	M	60	2020 - 2022	White
6	10000248	2192	1	Private	WHITE	MARRIED	M	34	2014 - 2016	White
7	10000280	2151	1	Private	OTHER	NA	M	20	2008 - 2010	Other
8	10000560	2189	1	Private	WHITE	MARRIED	F	53	2008 - 2010	White
9	10000635	2136	1	Medicare	BLACK/AFRICAN AMERICAN	WIDOWED	F	74	2014 - 2016	Black
10	10000635	2143	1	Medicare	BLACK/AFRICAN AMERICAN	WIDOWED	F	74	2014 - 2016	Black
11	10000690	2150	3	Medicare	WHITE	WIDOWED	F	86	2008 - 2010	White
12	10000690	2152	1	Medicare	WHITE	WIDOWED	F	86	2008 - 2010	White
13	10000719	2140	1	Private	WHITE	SINGLE	F	34	2008 - 2010	White
14	10000764	2132	1	Medicare	WHITE	SINGLE	M	86	2014 - 2016	White
15	10000826	2146	3	Private	WHITE	SINGLE	F	32	2008 - 2010	White
16	10000883	2124	2	Private	WHITE	SINGLE	M	20	2008 - 2010	White
17	10000904	2180	1	Private	WHITE	SINGLE	F	22	2011 - 2013	White
18	10000935	2183	2	Medicare	BLACK/AFRICAN AMERICAN	SINGLE	F	52	2008 - 2010	Black
19	10000935	2187	3	Medicare	BLACK/AFRICAN AMERICAN	SINGLE	F	52	2008 - 2010	Black
20	10000947	2121	1	Private	BLACK/AFRICAN AMERICAN	MARRIED	M	60	2020 - 2022	Black
21	10000969	2112	1	Medicaid	WHITE	SINGLE	M	48	2020 - 2022	White
22	10000980	2188	1	Medicare	BLACK/AFRICAN AMERICAN	MARRIED	F	73	2008 - 2010	Black
23	10000980	2189	1	Medicare	BLACK/AFRICAN AMERICAN	MARRIED	F	73	2008 - 2010	Black
24	10000980	2190	1	Medicare	BLACK/AFRICAN AMERICAN	MARRIED	F	73	2008 - 2010	Black
25	10000980	2191	3	Medicare	BLACK/AFRICAN AMERICAN	MARRIED	F	73	2008 - 2010	Black
26	10000980	2193	1	Medicare	BLACK/AFRICAN AMERICAN	MARRIED	F	73	2008 - 2010	Black
27	10001176	2186	1	Medicare	WHITE	MARRIED	F	64	2011 - 2013	White
28	10001186	2188	2	Private	WHITE	MARRIED	F	46	2011 - 2013	White

Exploratory Data Analysis

Patient Insurance Count

insurance	count
Medicare	154,139
Private	126,429
Medicaid	64,708
Other	9,875
No charge	299

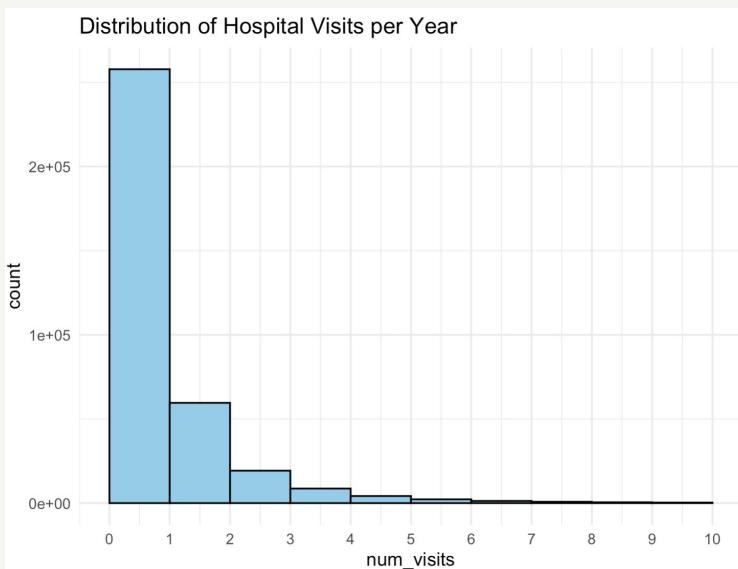
Mean Visits by Gender

gender	mean_visits
F	1.471209
M	1.566190

Exploratory Data Analysis

Visits Per Year Summary

mean_visits	median_visits	min_visits	max_visits	mean_age	median_age
1.515	1.000	1.000	54.000	56.847	59.000



Exploratory Data Analysis

Mean vs Variance

mean_visits var_visits

1.515088 1.549352

Cramer Correlation Matrix

var1	insurance	race	marital_status	gender	anchor_year_group	race_simple
insurance	1.000	0.149	0.232	0.050	0.030	0.131
race	0.149	1.000	0.128	0.102	0.140	1.000
marital_status	0.232	0.128	1.000	0.184	0.022	0.114
gender	0.050	0.102	0.184	1.000	0.045	0.092
anchor_year_group	0.030	0.140	0.022	0.045	1.000	0.082
race_simple	0.131	1.000	0.114	0.092	0.082	1.000

Models

- **Poisson Regression Model**
 - Mean = Variance
 - No Over or Under Dispersion
 - Assumes independence
- **Negative Binomial Regression Model**
 - More forgiving for overdispersed data
 - Assumes independence
- **Quasi - Poisson Regression Model**
 - More forgiving for both under and overdispersed data
 - Assumes independence

```
# Poisson model
poisson_model <- glm(
  num_visits ~ insurance * race_simple + anchor_age + marital_status + gender,
  family = poisson(link = "log"),
  data = train_data
)

# Quasi-Poisson model
quasi_model <- glm(
  num_visits ~ insurance * race_simple + anchor_age + marital_status + gender,
  family = quasipoisson(link = "log"),
  data = train_data
)

# Negative Binomial model
nb_model <- MASS::glm.nb(
  num_visits ~ insurance * race_simple + anchor_age + marital_status + gender,
  data = train_data
)
```

PLAN: Fit all three models, compare evaluation metrics and coefficients to draw conclusions.

Evaluation

- **Dispersion**

- **Poisson:** None Detected
- Negative Binomial: None Detected
- Quasi-Poisson: Overdispersion Detected

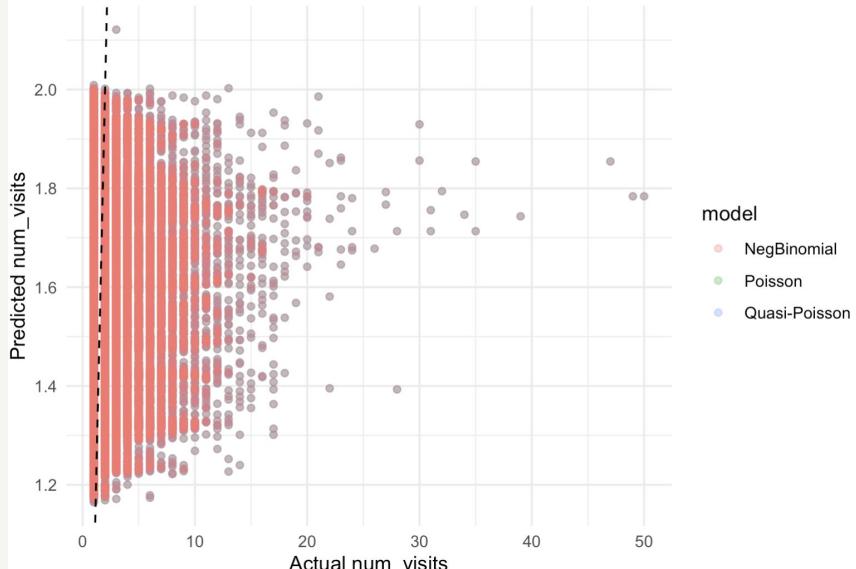
Root Mean Squared Error

Model	RMSE
Poisson	1.243527
Quasi-Poisson	1.243527
NegBinomial	1.243527

Alkaline Information Criterion

	df	AIC
poisson_model	38	685455.7
nb_model	39	685452.5

Predicted vs Actual Counts by Model



Results

Poisson Model: Insurance Effects						
model	term	estimate	std.error	statistic	p.value	percent_change
Poisson	insuranceMedicaid	0.167	0.007	25.023	0.000	18.100
Poisson	insuranceMedicare	0.128	0.005	23.842	0.000	13.600
Poisson	insuranceOther	0.028	0.014	2.022	0.043	2.900
Poisson	insuranceNo charge	0.138	0.075	1.845	0.065	14.800
Poisson	insuranceMedicaid:race_simpleAsian	-0.054	0.022	-2.424	0.015	-5.200
Poisson	insuranceMedicare:race_simpleAsian	0.042	0.022	1.927	0.054	4.300
Poisson	insuranceOther:race_simpleAsian	-0.006	0.056	-0.104	0.918	-0.600
Poisson	insuranceNo charge:race_simpleAsian	0.164	0.342	0.480	0.631	17.800
Poisson	insuranceMedicaid:race_simpleBlack	0.041	0.013	3.233	0.001	4.100
Poisson	insuranceMedicare:race_simpleBlack	0.148	0.011	13.175	0.000	16.000
Poisson	insuranceOther:race_simpleBlack	0.137	0.028	4.974	0.000	14.700
Poisson	insuranceNo charge:race_simpleBlack	-0.067	0.151	-0.444	0.657	-6.500
Poisson	insuranceMedicaid:race_simpleHispanic	0.010	0.019	0.561	0.575	1.100
Poisson	insuranceMedicare:race_simpleHispanic	0.160	0.019	8.304	0.000	17.400
Poisson	insuranceOther:race_simpleHispanic	-0.012	0.037	-0.338	0.736	-1.200
Poisson	insuranceNo charge:race_simpleHispanic	0.012	0.278	0.043	0.966	1.200

What we're looking for

Insurance Coefficients

- I.e Medicaid coef = 0.167 (log odds)
- $e^{0.167} = 1.18$
- Percent Change = 18% (compared to Private)

Holding all other factors constant, patients on [INSURANCE] are expected to have [PERCENT CHANGE] more hospital visits per year compared to patients with private insurance.

- Positive percent change → more hospital usage
- Negative percent change → less hospital usage

Insurance x Race Coefficients

- I.e Medicaid x Black coef = 0.041 (log odds)
- $e^{0.041} = 1.042$
- Percent Change = 4.2% (compared to Private x White)

The combination of [INSURANCE] coverage and identifying as [RACE] is associated with an additional [PERCENT CHANGE] higher expected number of hospital visits per year, beyond the effects of [INSURANCE] and [RACE] race alone.

- Percent Change = 0% → no disparity
- Taking historical and systemic inequities into account
 - Positive percent change → reduced disparities in hospital usage

Interpretation

Insurance

- Reference = Private
- Medicaid Percent Change = 18.1%
- Medicare Percent Change = 13.6%

So, in general, government insurance programs are associated with a significantly increased utilization of the healthcare system.

Statistical Conclusion

Government insurance programs are associated with increased hospital usage among minority groups, with a greater effect on senior populations.

Insurance x Race

- Reference = Private x White
- Medicaid x Black Percent Change = 4.2%
- Medicare x Black Percent Change = 16%
- Medicaid x Hispanic = 1.1%
- Medicare x Hispanic = 17.4%
- Medicaid x Native American = 7.8%
- Medicare x Native American = 12.1%

Inferred Conclusion

Government insurance programs reduce disparities in access to healthcare across demographic groups OR historical inequities in access to healthcare have led to increased hospitalization of minority patients.

Limitations

- **Selection Bias**
 - Data only includes those using the healthcare system
- **Structural Inequities**
 - Historical and systemic disparities can influence who ends up in the dataset
- **Confounding**
 - Many factors beyond insurance and race influence hospital utilization such as health status, comorbidities, housing, transportation, education
 - Many of these factors are systemically linked to race, though
- **Measurement Limitations**
 - Using hospital/ED visits as a measure for access to care is imperfect
 - High ED use may indicate poor primary care access
- **Race as a Proxy**
 - Race is a social construct, not a biological determinant
 - Observed disparities often reflect **structural inequities**

Future Improvements

- **Zero-Inflated or Hurdle Model**
 - Regression model used in situations where majority of response variable is 0
 - Can be modified for this situation where majority is 1
- **Reduce Selection Bias**
 - Include those who don't use the healthcare system via survey, etc.
- **Reduce Confounding**
 - Find how to include confounding variables that exist on an admission level
- **Reduce Measurement Limitations**
 - Include other healthcare system utilization factors, like primary care visits

References

Macias-Konstantopoulos, W. L., Collins, K. A., Diaz, R., Duber, H. C., Edwards, C. D., Hsu, A. P., Ranney, M. L., Riviello, R. J., Wettstein, Z. S., & Sachs, C. J. (2023). *Race, healthcare, and health disparities: A critical review and recommendations for advancing health equity*. West Journal of Emergency Medicine, 24(5), 906–918.
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