Unlocking Public Health Insights: Leveraging Air Quality Data to Develop Social Determinants of Health Metrics Linked to Asthma Medication Ratio

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Background

- Social determinants of health (SDOH) are economic, environmental and social factors that can impact individual and group differences in health. SDOH can be grouped into five domains: Economic Stability, Education Access and Quality, Health Care Access and Quality, Neighborhood and Built Environment, and Social and Community Context.[1]
- The Neighborhood and Built Environment domain includes the neighborhoods and communities that people live in that can impact a person's health and quality of life. This domain includes crime rate, internet access, access to bike and walking lanes, water quality, as well as air quality.
- Environmental conditions such as air quality can impact lung health, making it a dire SDOH with exaggerated implications for patients with chronic lung diseases, such as asthma. Air pollutants can increase inflammation of lung tissue, contribute to coughing, and exacerbate asthmatic symptoms.
- Asthma medication ratio (AMR) is a National Committee for Quality Assurance (NCQA) quality metric that corresponds to the ratio of controller medications to total asthma medications. Research has found a significant association between AMR and increased emergency department visits and hospitalization in both adolescents and adults.[2,3] These research findings along with others support the use of AMR as a quality measure for asthmatic patients.

Objectives

- To detail how publicly available data can be used to create measures of SDOH related to Neighborhood and Built Environment
- To assess the association of derived metrics with AMR
- To discuss how the derived Neighborhood and Built Environment SDOH metrics can impact AMR and how understanding a patient's SDOH can inform care plans and patient engagement

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Methods

Data

- Publicly available U.S. Environmental Protection Agency (EPA) pre-generated data sets were used to create measures of SDOH pertaining to Neighborhood and Built Environment.
- EPA data from the 2022 calendar year was aggregated by Core-Based Business Statistical Area (CBSA).
- Using the EPA data, the following SDOH measures were calculated:
  - Median Air Quality Index (AQI): AQI is an indicator detailing the level of cleanliness and pollution of outdoor air. The higher the AQI, the more polluted the air, and the greater the health concerns **(Table 1).**
  - Proportion of good days: AQI between 0-50
  - Proportion of moderate days: AQI between 51-100
  - Proportion of unhealthy days for sensitive groups: AQI between 101-150
  - Proportion of days in which each toxin was responsible for the highest AQI value:
    - Carbon monoxide (CO)
    - Nitrogen dioxide (NO_2)
    - Ozone (O_3)
    - Airborne Particle Matter 2.5 ($PM_{2.5}$)
    - Airborne Particle Matter 10 (PM_{10})

Study sample

- The study sample was derived using paid commercial pharmacy claims data
- The following inclusion criteria was applied:
  - 18+ years of age as of Jan. 1, 2022
  - Continuously enrolled during the 2022 calendar year
  - 4+ claims for asthma medications (controller and rescue medications) to mimic the Healthcare Effectiveness Data and Information Set (HEDIS) AMR inclusion criteria for dispensing events
  - 2+ claims for an asthma controller on 2+ different dates of service, with the first date of service being 91 days prior to year end
  - Patients with a hospice residency code were excluded
  - Patients without a valid residential address were excluded from this analysis
- 14,322 patients were identified as meeting the inclusion criteria.
- Demographic characteristics were assessed for the identified sample.
- The identified sample was 62.1% female (n = 8,895), had a mean age of 47.0 years (SD = 12.3) and a mean Chronic Disease Score (CDS) of 3.5 (SD = 2.3) **(Table 2).**
- The proportion of days covered (PDC) to asthma controllers was assessed for the sample. Mean PDC was 74.8% with 84.3% of the sample adherent to their asthma controllers based on a PDC threshold of 80%.
- AMR was calculated as the ratio of the quantity of asthma controller medications to the total quantity of asthma medications (controllers and rescue medications). Higher AMR has been found to be associated with better patient outcomes and reduced emergency hospital utilization.[4]

Data Aggregation and Analysis

- Patient claims data was joined to EPA data using a CBSA to zip code crosswalk.
- Patients that resided in an area in which there was not an EPA site were excluded from the analysis. Patients that resided in multiple zip codes during the 2022 calendar year had their EPA data averaged across zip codes for all metrics.
- Regression models were used to assess outcomes individually (α = 0.05). All models were controlled for demographic differences (gender, age, CDS and adherence to controller medications).

Table 1

US EPA air quality index chart and health recommendations[5]

US AQI Range	Level of Health Concern	Health Recommendations
0-50	Good	Air quality is satisfactory, and air pollution poses little to no risk to the public.
51-100	Moderate	Air quality is acceptable. However, there may be a risk for some individuals, especially those that may be sensitive to air pollution.
101-150	Unhealthy for Sensitive Groups	Members of sensitive groups may experience health effects.
151-200	Unhealthy	Some individuals of the public may experience negative health effects. Individuals belonging to sensitive groups may experience more serious health effects.
201-300	Very Unhealthy	Health alert. The risk of health effects is increased for everyone.
301+	Hazardous	Health warning of emergency conditions. Everyone is at risk of being affected.

Table 2

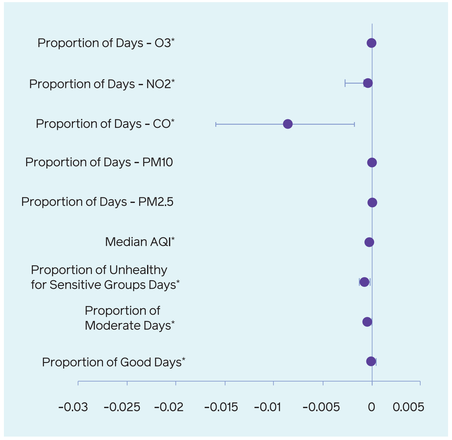
Study population characteristics

n	14,322
Female (%)	8,895 (62.11%)
Age, in years	47.10 (12.34)
Chronic Disease Score	3.54 (2.25)
PDC – Asthma Controller Medications	74.79% (0.25)
%Patients Adherent (PDC ≥ 80%) – Asthma Controller Medications (n)	54.29% (7,775)
Median 2022 Annual AQI	44.94 (10.13)
Proportion of Good Days (AQI 0-50)	66.64% (20.39)
Proportion of Moderate Days (AQI 51-100)	30.11% (15.62)
Proportion of Unhealthy for Sensitive Groups (AQI 101-150)	0.45% (1.50)
AMR	0.86 (0.19)
%Compliant – AMR ≥ 0.50 (n)	93.70% (13,419)
%Compliant – AMR ≥ 0.75 (n)	76.53% (10,961)

Values are listed as mean (sd) unless otherwise indicated

Figure 1

Forest plot of parameter estimates with 95% confidence interval for each neighborhood and built environment SDOH measure



Note: *Statistically significant (P < 0.05)
SDOH = Social Determinants of Health
AQI = Air Quality Index
All associations were controlled for demographic differences (age, gender, Chronic Disease Score and adherence to controller medications).

Results

- Mean AMR was 0.86 (SD = 0.2) with 93.7% (n = 13,419) of the sample compliant based on an AMR threshold of 0.50, and 76.5% (n = 10,961) compliant based on an AMR threshold of 0.75.
- Significant associations were observed for median AQI (β=-0.0003, p=0.03) and the proportion of good (β=0.0002, p<0.0001), moderate (β=-0.0003, p<0.0001), and unhealthy for sensitive group days (β=-0.0007, p=0.01).
  - Median AQI – AMR decreases as AQI increases. This suggests that on average, patients that reside in a community with the worst air conditions (AQI gets higher), utilization of rescue medication increases for patients that reside in this area (AMR gets lower).
  - Proportion of good days – AMR increases as the proportion of good days increases.
  - Proportion of moderate and unhealthy for sensitive group days – AMR decreases as the proportion of moderate/unhealthy for sensitive group days increases.
- Additionally, significant associations were observed for the following toxins: CO (β=-0.0132, p=0.02), NO_2 (β=-0.0005, p<0.0001), and O_3 (β=-0.0001, p=0.03). For all significant associations, as the proportion of days responsible for the highest AQI value increases (air quality worsened), on average, patients tend to use their rescue medications more frequently **(Figure 1).**

Limitations

- The study population was limited to the commercial line of business and results may not generalize to other lines of business (e.g., Medicare and Medicaid).
- The study uses pharmacy claims data only; therefore, we were unable to confirm an asthma diagnosis with diagnosis codes.

Conclusion

- Publicly available AQI data can be combined with pharmacy claims data to create SDOH metrics specific to Neighborhood and Built Environment.
- The created metrics were found to be associated with AMR within a commercially insured population.
- The developed measures can be used to predict AMR and to pre-emptively identify patients that may not have their asthmatic condition under control so that targeted interventions can occur to boost maintenance medication adherence, encourage patients to limit outdoor activity during adverse air conditions, and to plan outdoor activities when pollution levels are typically at their lowest (morning or evening).

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