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# Association Between Unconventional Natural Gas Development in the Marcellus Shale and Asthma Exacerbations.

Rasmussen SG<sup>1</sup>, Ogburn EL<sup>2</sup>, McCormack M<sup>3</sup>, Casey JA<sup>4</sup>, Bandeen-Roche K<sup>2</sup>, Mercer DG<sup>5</sup>, Schwartz BS<sup>6</sup>.

## Author information

- 1 Department of Environmental Health Sciences, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland.
- 2 Department of Biostatistics, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland.
- 3 Department of Medicine, Johns Hopkins School of Medicine, Baltimore, Maryland.
- 4 Robert Wood Johnson Foundation Health and Society Scholars Program, University of California, San Francisco, and University of California, Berkeley.
- 5 Center for Health Research, Geisinger Health System, Danville, Pennsylvania.
- 6 Department of Environmental Health Sciences, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland3Department of Medicine, Johns Hopkins School of Medicine, Baltimore, Maryland5Center for Health Research, Geisinger Health System, Danville, Pennsylvania.

## Abstract

**IMPORTANCE:** Asthma is common and can be exacerbated by air pollution and stress. Unconventional natural gas development (UNGD) has community and environmental impacts. In Pennsylvania, UNGD began in 2005, and by 2012, 6253 wells had been drilled. There are no prior studies of UNGD and objective respiratory outcomes.

**OBJECTIVE:** To evaluate associations between UNGD and asthma exacerbations.

**DESIGN:** A nested case-control study comparing patients with asthma with and without exacerbations from 2005 through 2012 treated at the Geisinger Clinic, which provides primary care services to over 400 000 patients in Pennsylvania. Patients with asthma aged 5 to 90 years (n = 35 508) were identified in electronic health records; those with exacerbations were frequency matched on age, sex, and year of event to those without.

**EXPOSURES:** On the day before each patient's index date (cases, date of event or medication order; controls, contact date), we estimated activity metrics for 4 UNGD phases (pad preparation, drilling, stimulation [hydraulic fracturing, or "fracking"], and production) using distance from the patient's home to the well, well characteristics, and the dates and durations of phases.

**MAIN OUTCOMES AND MEASURES:** We identified and defined asthma exacerbations as mild (new oral corticosteroid medication order), moderate (emergency department encounter), or severe (hospitalization).

## RESULTS:

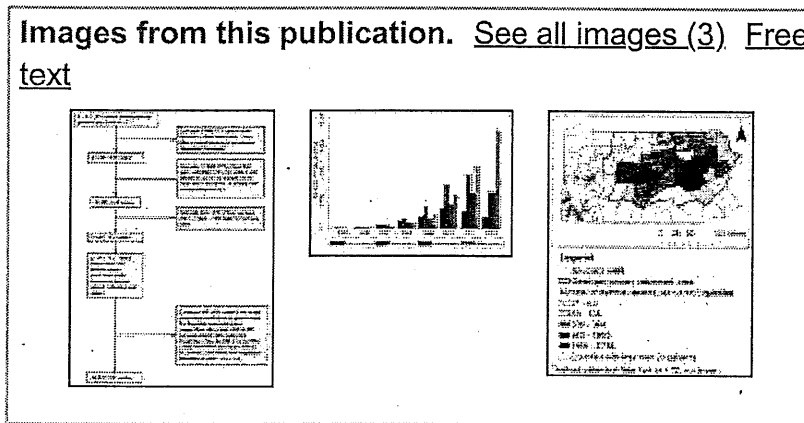
We identified 20 749 mild, 1870 moderate, and 4782 severe asthma exacerbations, and frequency matched these to 18 693, 9350, and 14 104 control index dates, respectively. In 3-level adjusted models, there was an association between the highest group of the activity metric for each UNGD phase compared with the lowest group for 11 of 12 UNGD-outcome pairs: odds ratios (ORs) ranged from 1.5 (95% CI, 1.2-1.7) for the association of the pad metric with severe exacerbations to 4.4 (95% CI, 3.8-5.2) for the association of the production metric with mild exacerbations. Six of the 12 UNGD-outcome associations had increasing ORs across quartiles. Our findings were robust to increasing levels of covariate control and in sensitivity analyses that included evaluation of some possible sources of unmeasured confounding.

**CONCLUSIONS AND RELEVANCE:** Residential UNGD activity metrics were statistically associated with increased risk of mild, moderate, and severe asthma exacerbations. Whether these associations are causal awaits further investigation, including more detailed exposure assessment.

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## Unconventional Gas and Oil Drilling Is Associated with Increased Hospital Utilization Rates.

Jemielita T<sup>1</sup>, Gerton GL<sup>2</sup>, Neidell M<sup>3</sup>, Chillrud S<sup>4</sup>, Yan B<sup>4</sup>, Stute M<sup>4</sup>, Howarth M<sup>2</sup>, Saberi P<sup>2</sup>, Fausti N<sup>2</sup>, Penning TM<sup>2</sup>, Roy J<sup>1</sup>, Propert KJ<sup>1</sup>, Panettieri RA Jr<sup>2</sup>.

### Author information

- 1 Department of Biostatistics, University of Pennsylvania Perelman School of Medicine, Philadelphia, Pennsylvania, United States of America.
- 2 Center of Excellence in Environmental Toxicology (CEET), Airways Biology Initiative, University of Pennsylvania Perelman School of Medicine, Philadelphia, Pennsylvania, United States of America.
- 3 Department of Health Policy and Management, Mailman School of Public Health, Columbia University, New York, New York, United States of America.
- 4 Lamont-Doherty Earth Observatory of Columbia University, Palisades, New York, United States of America.

### Erratum in

Correction: Unconventional Gas and Oil Drilling Is Associated with Increased Hospital Utilization Rates. [PLoS One. 2015]

### Abstract

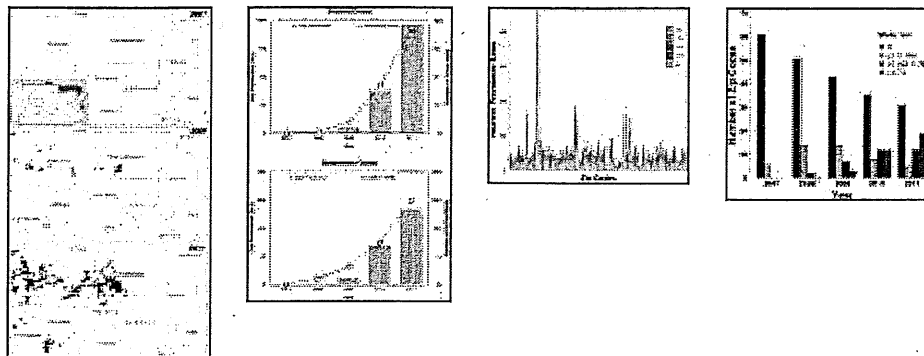
Over the past ten years, unconventional gas and oil drilling (UGOD) has markedly expanded in the United States. Despite substantial increases in well drilling, the health consequences of UGOD toxicant exposure remain unclear. This study examines an association between wells and healthcare use by zip code from 2007 to 2011 in Pennsylvania. Inpatient discharge databases from the Pennsylvania Healthcare Cost Containment Council were correlated with active wells by zip code in three counties in Pennsylvania. For overall inpatient prevalence rates and 25 specific medical categories, the association of inpatient prevalence rates with number of wells per zip code and, separately, with wells per km<sup>2</sup> (separated into quantiles and defined as well density) were estimated using fixed-effects Poisson models. To account for multiple comparisons, a Bonferroni correction with associations of  $p < 0.00096$  was considered statistically significant. Cardiology inpatient prevalence rates were significantly associated with number of wells per zip code ( $p < 0.00096$ ) and wells per km<sup>2</sup> ( $p < 0.00096$ ) while neurology inpatient prevalence rates were significantly associated with wells per km<sup>2</sup> ( $p < 0.00096$ ). Furthermore, evidence also supported an association between well density and inpatient prevalence rates for the medical categories of dermatology, neurology, oncology, and urology. These data suggest that UGOD wells, which dramatically increased in the past decade, were associated with increased inpatient prevalence rates within specific medical categories in

Pennsylvania. Further studies are necessary to address healthcare costs of UGOD and determine whether specific toxicants or combinations are associated with organ-specific responses.

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