

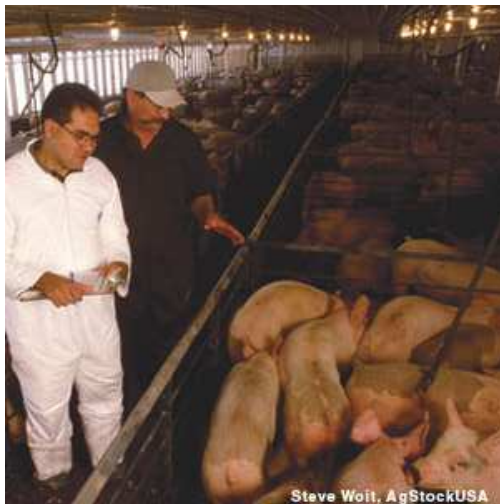
Power Analysis in Association between Source-Specific Swine Markers and Acute Changes in Health Status Measures

Yingqi Zhao

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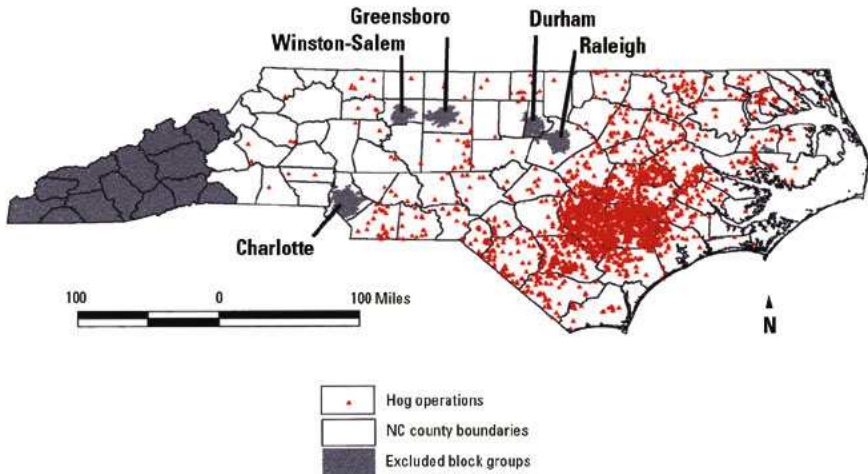
Distribution of Swine Operations in North Carolina

Table: Shift in NC hog production from 1986-2000

Year	Number of Operations	Number of Hogs
1986	15,000	2.4 million
2000	3,600	9.5 million

Source: NC Department of Agriculture & Consumer Services, 2007

Distribution of Swine Operations in North Carolina



Significance of the Study

- ▶ An association between school proximity to swine CAFOs(Confined Animal Feeding Operations) and children's respiratory health;
- ▶ Swine malodor has also been shown to have immunosuppressive effect on mucosal immunity.
- ▶ Interruption in neighbors' daily activities by odorant compounds from swine CAFOs.

No source-specific information linking the odor to industrial swine operation emissions nearby!

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- ▶ Project: Community Health Effects of Industrial Hog Operations.
 - ▶ 12 communities, each communities followed by 14 days.
 - ▶ 12-hour PM filters(twice a day), 323 available in total.
 - ▶ 1497 report diaries matched with filters.
- ▶ Specific Aims of the Study.
 - ▶ Source tracking for exposure assesment.
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Steps for the Study

- ▶ Exposure analysis for each of 12 CHEIHO communities.
- ▶ Determine the number of sites with detectable source-specific exposure markers of fecal pollution.
- ▶ Sampling plan: nested case-control or cohort?
- ▶ Relationships between PM exposure marker data and acute changes in the risk of physical symptoms (irritation and upper respiratory symptoms).

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Exposure Assessment and Sampling Design

1. Initial screening of PM filter samples.
2. Sampling Design
 - ▶ No source-specific molecular markers detected: exposure analysis including wider genera of fecal Methanogens on the remaining PM filters.
 - ▶ Source-specific swine markers infrequently detected: cohort study design.
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Case Control Sampling

- ▶ 310 archived PM filter samples available for analysis.
- ▶ Sample filters.
 - ▶ Case time periods: half-days with highest symptom prevalence.
 - ▶ Control time periods: half-days with lowest symptom prevalence.

Model

$$\text{logit}(E(R_{ijk}|b_i, b_{ij})) = \beta_0 + \beta_1 \text{Marker}_{ik} + \beta_2 \text{PM}_{2.5ik} + \beta_3 \text{SVPM}_{10ik} + b_i + b_{ij},$$

i : communities,

j : individuals in a site,

k : time periods,

R_{ijk} : record of j^{th} person in the i^{th} site during k^{th} half day

$\text{PM}_{2.5}$, SVPM_{10} : co-pollutants $\text{PM}_{2.5}$ and semi-volatile PM_{10} ,

$b_i \sim N(0, \sigma_1^2)$: random effects for communities,

$b_{ij} \sim N(0, \sigma_2^2)$: random effects for individuals.

Diary Counts per Site

Site	# of Diaries	# with Irritation Symptoms	# with Upper Respiratory Symptoms
A1	181	2	11
A2	115	9	15
A3	105	13	13
B1	186	25	27
C1	141	49	81
C2	135	26	21
C3	138	16	39
D2	127	8	27
G1	189	12	13
R1	82	36	59
Y1	117	6	16

Example: Irritation Case, Control Periods for Site C2

Filter Start Time	Freq	% with Irr. Sym.	Ref: % with Upper Res. Sym.	Case Period	Control Period
Apr 23,05,13:40	5	0	0		Yes
Apr 24,05,01:40	5	0	0		
Apr 24,05,13:40	5	0	0		Yes
Apr 25,05,01:40	5	20	20		
Apr 25,05,13:40	5	20	20		
Apr 26,05,01:40	5	20	20		
Apr 26,05,13:40	5	0	0		Yes
Apr 27,05,01:40	5	0	0		
Apr 27,05,13:40	5	40	40	Yes	
Apr 28,05,01:40	2	0	50		
Apr 28,05,11:56	4	25	0		
Apr 28,05,23:56	5	40	0		
Apr 29,05,11:56	5	20	0		

Example: Irritation Case, Control Periods for Site C2

Filter Start Time	Freq	% with Irr. Sym.	Ref: % with Upper Res. Sym.	Case Period	Control Period
Apr 29,05,23:56	5	40	40	Yes	
Apr 30,05,11:56	5	0	0		Yes
Apr 30,05,23:56	5	40	20	Yes	
May 01,05,11:56	5	20	60		
May 01,05,23:56	5	40	20	Yes	
May 02,05,11:56	5	0	0		Yes
May 02,05,23:56	6	33.3	16.7		
May 03,05,11:56	4	25	0		
May 03,05,23:56	5	20	40		
May 04,05,11:56	5	40	40	Yes	
May 04,05,23:56	5	20	0		
May 05,05,11:10	5	20	20		
May 05,05,23:10	5	20	40		

Model Parameters

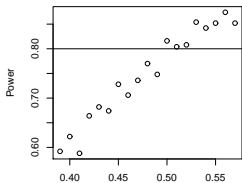
- ▶ $\beta_0 = -2.19$: the community with no source-specific swine markers, $PM_{2.5}$ and $SVPM_{10}$, and $b_i = 0, b_{ij} = 0$, then the probability of people experience irritation symptoms are 0.1.
- ▶ $\beta_2 = 0.049, \beta_3 = 0.043$: the change in the log odds of a participant reporting having experienced irritation symptoms associated with a 1 unit increase in $PM_{2.5}$ (semi-volatile PM_{10}) would be 0.049(0.043).
- ▶ $\sigma_1^2 = 0.25$: most estimated exposure prevalence for the community in the range (0.04, 0.23)
- ▶ $\sigma_2^2 = 1.5$: people experiencing irritation symptoms in the range of (0.01, 0.55) given $b_i = 0$.

Simulation Assumptions

- ▶ Source-specific swine markers detected in 11 communities.
- ▶ 13 case time period filters and 13 control time period filters.
- ▶ There are 5 people in each site, and no missing record during the study period.

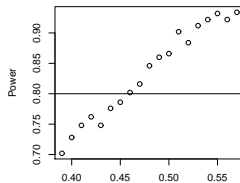
Power to Detect Different Marker Effects

Exposure Prevalence=0.2



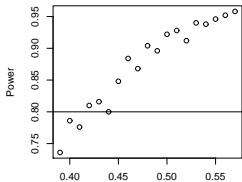
Coefficient of Source-Specific Swine Marker

Exposure Prevalence=0.3



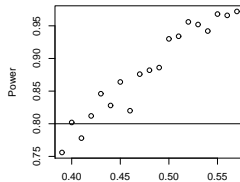
Coefficient of Source-Specific Swine Marker

Exposure Prevalence=0.4



Coefficient of Source-Specific Swine Marker

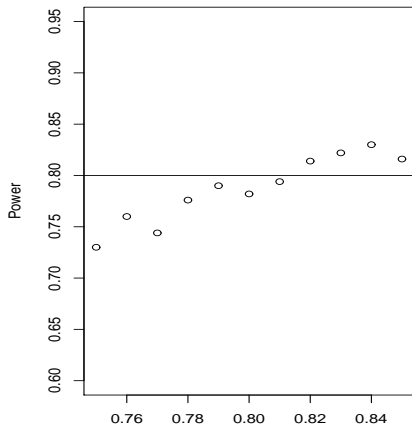
Exposure Prevalence=0.5



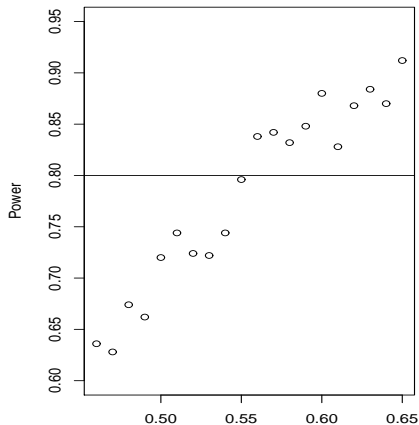
Coefficient of Source-Specific Swine Marker

Power to Detect Different Marker Effects, Rare Exposure

Exposure Prevalence=0.06



Exposure Prevalence=0.1



Discussion

- ▶ Analysis based on other symptom outcomes.
- ▶ Correlation between source-specific exposure markers and other co-pollutants.
- ▶ Exposure markers based on continuous scale.

Thank You!

