



Respiratory Symptoms in Infants Associated with Indoor Heating Sources

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ABSTRACT

The purpose of this study is to examine effects of indoor heating sources on infant respiratory symptoms during the heating season of the first year of life. Mothers who delivered babies between 1993 and 1996 at 12 hospitals in Connecticut and Virginia were enrolled. Daily infant symptoms and heating source use information was obtained every two weeks during the first year of life. Heating sources included fireplace, wood stove, kerosene heater, and gas space heater use. Four health outcomes were analyzed by reporting period: days of wheeze; episodes of wheeze; days of cough; and episodes of cough. A large percentage of infants in the study had at least one episode of cough (88%) and wheeze (33%) during the heating season of the first year of life. Wood stove, fireplace, kerosene heater, and gas space heater use was intermittent across the study period. In adjusted Poisson regression models controlling for important confounders, gas space heater use was associated with episodes and days of wheeze. Wood stove use was associated with total days of cough, and kerosene heater use was associated with episodes of cough. Fireplace use was not associated with any of the respiratory symptoms in these infants. Use of some heating sources appears related to respiratory symptoms in infants. This abstract is funded by: NIH ES07456 and ES05410.

INTRODUCTION

- Infants in the first year of life spend most of their time breathing the indoor air of the home environment and have frequent respiratory symptoms.
- Exposure to particulate matter has been linked to increases in hospital admissions for respiratory diseases, acute respiratory symptoms, lower respiratory illness, and decreases in pulmonary function.
- The complex nature of the ambient aerosol and strong correlations among ambient concentrations of PM₁₀, PM_{2.5}, SO₄²⁻, and H⁺ make it difficult to untangle the role that different physical and chemical aerosol attributes play in observed effects.
- Heating sources such as gas, kerosene, wood and tobacco products are important producers of particulate matter in the home. No studies have accounted for intermittent use patterns of these sources over the course of the heating season.
- This study was specifically designed to examine in detail the effects of secondary home heating devices on respiratory symptoms. We tested the hypothesis that use of unvented kerosene heaters, gas space heaters, fireplaces, or wood stoves in the home increases the rate of respiratory symptoms during the heating season of the first year of life.

METHODS

Study population

- Enrolled: 918 infants born to non-smoking mothers in Connecticut and Virginia 1993 - 1996. Out of 17,447 mothers screened, all women who used a kerosene heater at least once a week in the winter were invited to participate as well as a random sample of non-users in a ratio of 2:1.
- Current analysis: 890 infants for whom symptom information was available for the winter heating season (Oct 15 - Apr 15, 1994 - 1997).
- Data collection: at home interview 3-5 months after infant's birth [health histories of mother and infant, demographic data, use of secondary heating sources]; by telephone interview at approx. biweekly intervals for 1 year (median = 16 days; IQR = 13 - 19 days) [daily respiratory symptoms (wheeze and cough)].

Exposure assessment

- "Biweekly" interviews included questions on frequency of use of each secondary heating source during that monitoring period. Hrs of use multiplied by the number of heating devices was used to calculate average source use in hrs per day during the reporting period.

Health outcomes

- Infant respiratory symptoms were measured as counts (i.e., number of days of symptoms) summed over each monitoring period.

RESULTS

Table 1. Percent of monitoring periods source was used among users of secondary heating sources^a.

Heating Source	n^b	Median % of monitoring periods	25th-75th percentile	Range (min-max)
Fireplace	219	25%	10%-50%	6%-100%
Gas space heater	25	18%	9%-44%	7%-100%
Kerosene heater	160	36%	15%-71%	7%-100%
Wood stove	155	60%	31%-82%	7%-100%

^a The home heating season (October 15 through April 15, 1994 - 1997) would include 12, 2-week long monitoring periods, or a theoretical total of 10,680 monitoring periods for 890 infants. Due to missing data and variability in length of monitoring periods, the median number was 11, and the total for 890 infants was 9807. Our analysis is focused on 9783 (91.6%) of these periods for which infant respiratory symptom information is available.

^b Number reporting use of source on at least one monitoring interview during the winter heating season.

RESULTS CONT'D

Table 2. Percent of monitoring periods infant had cough or wheeze^a.

Symptom	n^b	Median % of monitoring periods^c	25th-75th percentile	Range (min-max)
Cough	784	27%	17%-42%	6%-100%
Wheeze	295	10%	8%-18%	6%-90%

^aFor each monitoring period, the number of days the infant experienced the symptom and the number of new episodes of the symptom were summed. An episode is defined as having reported a symptom for one or more days after having had two consecutive symptom-free days.

^b Number of infants with symptom during at least one monitoring period of the winter heating season.

^c Among infants with at least one day of symptom during winter season.

RESULTS CONT'D

Table 3. Unadjusted rate ratios (RR) and 95% confidence intervals (CI) from Poisson regression analysis of source use and symptoms. RR and 95% CI's based on an 8 hr/day increase in source use

Ave use (hr/day)	Wheeze				Cough			
	Episodes		Total Days		Episodes		Total Days	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
Fireplace	0.35	(0.08-1.47)	0.19	(0.03-1.24)	0.30	(0.06-1.45)	1.03	(0.79-1.35)
Wood stove	1.07	(0.91-1.26)	1.04	(0.83-1.30)	1.06	(0.91-1.25)	1.08	(1.00-1.16)
Gas space heater	1.20	(0.94-1.52)	1.16	(0.93-1.45)	1.26	(0.96-1.63)	0.93	(0.75-1.14)
Kerosene heater	0.85	(0.60-1.22)	0.89	(0.66-1.22)	0.85	(0.60-1.21)	0.96	(0.87-1.05)

RESULTS CONT'D

Table 4. Estimates of rate ratios (RR) and 95% confidence intervals (CI) from Poisson regression models of source use and respiratory symptoms in infants adjusted for socioeconomic and infant care factors. RR and 95% CI's based on an 8 hr/day increase in source use.

	Wheeze				Cough			
	Episodes		Total Days		Episodes		Total Days	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
Heating source (Ave use, hrs/day)								
Fireplace	0.28	(0.05-1.42)	0.25	(0.04-1.43)	0.97	(0.80-1.17)	0.99	(0.81-1.21)
Wood stove	1.11	(0.94-1.30)	1.08	(0.87-18.39)	1.05	(0.97-1.14)	1.10	(1.02-1.19)
Gas space heater	1.28	(0.99-1.67)	1.25	(1.05-1.50)	0.95	(0.72-1.26)	0.94	(0.75-1.18)
Kerosene heater	0.85	(0.59-1.21)	0.90	(0.64-1.25)	1.07	(1.00-1.15)	1.01	(0.93-1.10)
Dwelling type								
1- to 3-family	ref		ref		ref		ref	
4-family or larger	1.43	(1.09-1.86)	1.47	(1.03-2.09)	1.09	(0.97-1.22)	1.05	(0.92-1.20)
Mother has allergies	1.25	(0.98-1.59)	1.33	(0.95-1.85)	1.20	(1.08-1.33)	1.22	(1.08-1.38)
Mother has asthma	1.51	(0.98-2.35)			1.10	(0.93-1.31)	1.17	(0.96-1.42)
Avg daycare (hrs/day)					1.19	(1.03-1.38)	1.27	(1.07-1.51)
Mother's education								
HS or less			1.58	(1.07-2.34)	0.84	(0.73-0.96)	0.82	(0.69-0.96)
Some college			1.32	(0.88-1.98)	0.90	(0.79-1.03)	0.91	(0.78-1.05)
College graduate+			ref		ref		ref	
Season of birth								
Winter	ref				ref			
Spring	0.93	(0.67-1.30)			1.08	(0.94-1.25)		
Summer	1.48	(1.05-2.08)			1.19	(1.03-1.38)		
Fall	1.05	(0.72-1.53)			1.13	(0.98-1.31)		
Gas source in home	0.80	(0.62-1.03)	0.74	(0.52-1.06)				
# other children in household								
None	0.77	(0.55-1.07)			0.84	(0.74-0.97)	0.86	(0.73-1.01)
One	0.91	(0.63-1.24)			1.01	(0.88-1.16)	1.01	(0.86-1.18)
2+	ref		ref		ref		ref	
Breastfeeding months								
None	1.07	(0.81-1.41)	1.06	(0.74-1.52)	0.96	(0.84-1.10)	1.04	(0.89-1.21)
< 5 months	1.28	(0.95-1.72)	1.33	(0.89-2.00)	1.08	(0.95-1.23)	1.21	(1.04-1.40)
> 5 months	ref		ref		ref		ref	
Infant gender								
Girl	ref		ref		ref		ref	
Boy	1.40	(1.09-1.80)	1.47	(1.05-2.06)	1.14	(1.03-1.26)	1.27	(1.12-1.44)

RESULTS CONT'D

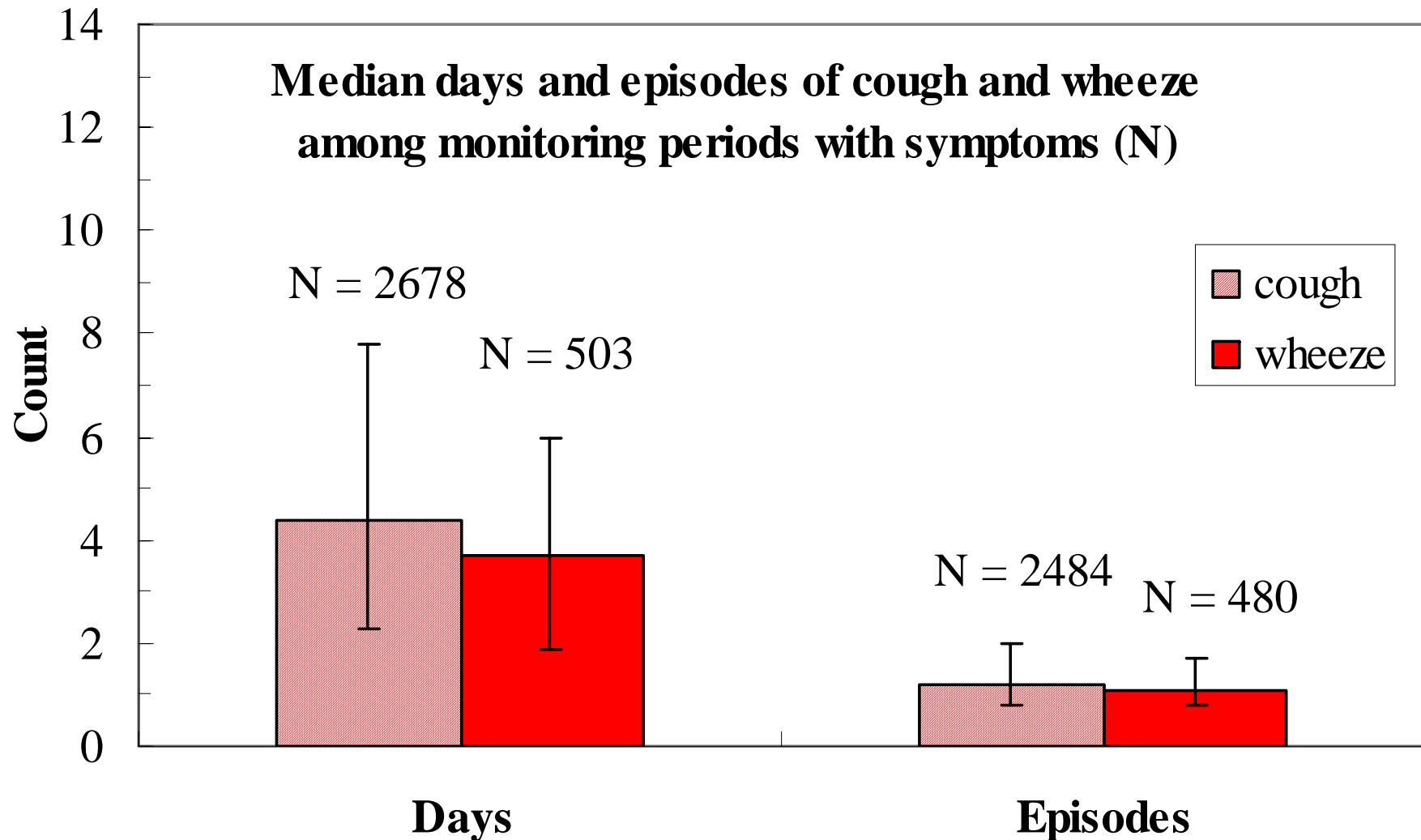


Figure 1. Medians and interquartile ranges (IQR) for episodes and days of wheeze and cough in the infant-monitoring periods with at least one day of symptoms. For example, among the 2678 infant-monitoring periods with at least one day of cough, the median days of cough per 14 days of follow-up was 4.4 (IQR=2.3-7.8), and the median number of episodes of cough per 14 days at risk was 1.2 (IQR=0.8-2.0).

SUMMARY

- Gas space heater use, despite the small number of users, is associated with episodes and days of wheeze.
- Rates of wheeze episodes and days increased approximately 25% for every 8-hour increase in gas space heater use (e.g., 3% increase for every additional hour of use per day).
- An 8-hour per day increase in wood stove use increased rates of cough days by 10% (e.g., 1.2% increase for every additional hour of use per day), while kerosene heater use increased rates of cough episodes 7% for every 8-hour per day increase in use (e.g., approximately 1% for every additional hour of use per day).

CONCLUSIONS

Major study strengths include:

- extensive demographic and household characteristic information,
- prospective information on respiratory symptoms in infants,
- frequent and regular ascertainment of source use information,
- use of a large sample of infants (a potentially sensitive subgroup of the population),
- limiting the population to non-smoking households, thus eliminating the effect of smoking which has been found to be strongly associated with respiratory symptoms,
- accounting for the intermittent source use patterns in the analysis.

Use of wood stoves, gas space heaters and kerosene heaters has a moderate, yet significant effect on wheeze and cough in infants.

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