



Reduction in emergency department visits for children's asthma, ear infections, and respiratory infections after the introduction of state smoke-free legislation



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ABSTRACT

Despite the benefits of smoke-free legislation on adult health, little is known about its impact on children's health. We examined the effects of tobacco control policies on the rate of emergency department (ED) visits for childhood asthma ($N = 128,807$), ear infections ($N = 288,697$), and respiratory infections ($N = 410,686$) using outpatient ED visit data in Massachusetts (2001–2010), New Hampshire (2001–2009), and Vermont (2002–2010). We used negative binomial regression models to analyze the effect of state and local smoke-free legislation on ED visits for each health condition, controlling for cigarette taxes and health care reform legislation. We found no changes in the overall rate of ED visits for asthma, ear infections, and upper respiratory infections after the implementation of state or local smoke-free legislation or cigarette tax increases. However, an interaction with children's age revealed that among 10–17-year-olds state smoke-free legislation was associated with a 12% reduction in ED visits for asthma (adjusted incidence rate ratios (aIRR) 0.88; 95% CI 0.83, 0.95), an 8% reduction for ear infections (0.92; 0.88, 0.97), and a 9% reduction for upper respiratory infections (0.91; 0.87, 0.95). We found an overall 8% reduction in ED visits for lower respiratory infections after the implementation of state smoke-free legislation (0.92; 0.87, 0.96). The implementation of health care reform in Massachusetts was also associated with a 6–9% reduction in all children's ED visits for ear and upper respiratory infections. Our results suggest that state smoke-free legislation and health care reform may be effective interventions to improve children's health by reducing ED visits for asthma, ear infections, and respiratory infections.

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1. Introduction

The global expansion of smoke-free legislation has improved population health with reductions in hospital admissions for coronary events and heart disease (Callinan et al., 2010; Tan and Glantz, 2012). Although more recent evidence suggests that these benefits may also extend to respiratory diseases, including asthma, the majority of research has focused on adults (Tan and Glantz, 2012). Despite decreases in second-hand smoke over the past decade in the US, children continue to have higher levels of exposure than adults (Homa et al., 2015). Children's principal source of exposure occurs in the home, particularly for young children (US Department of Health and Human Services, 2006). While one third of US children live with at least one smoker, half of

children from low-income households live with two or more smokers (King et al., 2009).

The US Surgeon General (US Department of Health and Human Services, 2006) and other systematic reviews (Tinuoye et al., 2013; Jones et al., 2011; Burke et al., 2012; Jones et al., 2012) have concluded that parental smoking increases children's risk for prevalent and incident asthma and wheeze, middle ear disease (including acute and chronic ear infections), and lower respiratory illnesses. However, only a few studies have examined the impact of smoke-free legislation on children's health. Two longitudinal studies, in Scotland and England, have shown reductions in hospital admissions for childhood asthma after country-wide bans on smoking in public places (Mackay et al., 2010; Millett et al., 2013). Other studies have found decreases in hospital admissions or emergency department (ED) visits for asthma after the introduction of state or local smoke-free legislation among all ages together, (Naiman et al., 2010; Herman and Walsh, 2011) adults and children separately, (Rayens et al., 2008; Landers, 2014) or an effect among adults and not children (Shetty et al., 2011). However, methodological limitations include the lack of a control group, (Mackay et al., 2010;

Abbreviations: ED, emergency department; IRR, incidence rate ratios.

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Millett et al., 2013; Herman and Walsh, 2011; Rayens et al., 2008) not accounting for other tobacco control policies, (Mackay et al., 2010; Millett et al., 2013; Naiman et al., 2010; Herman and Walsh, 2011; Rayens et al., 2008) or not distinguishing state from local policies (Herman and Walsh, 2011; Shetty et al., 2011). More recent studies have found reductions in hospitalizations for children's respiratory tract infections, primarily attributed to decreases in lower respiratory infections, after the introduction of country-wide smoke-free legislation (Been et al., 2015; Lee et al., 2016). Despite plausible mechanisms, (US Department of Health and Human Services, 2006) we are not aware of any studies that have examined the effects of secondhand smoke exposure on children's hospital admissions or ED visits for ear infections.

Tobacco control programs often take a multi-pronged approach, (World Health Organization, 2003) highlighting the importance of considering the impact of multiple policies rather than examining them in isolation. Cigarette taxes have been very effective at improving population health by reducing the uptake of smoking and encouraging smokers to either quit or reduce tobacco consumption (Chaloupka et al., 2012). In 2006, Massachusetts enacted health care reform legislation, which included a provision for Medicaid recipients to gain access to low-cost or free tobacco cessation medications and counseling and widespread promotional efforts to increase provider and patient awareness (Commonwealth of Massachusetts; Massachusetts Department of Public Health Tobacco Cessation and Prevention Program). Land and colleagues found that in the 30 months post-implementation, nearly 40% of Medicaid smokers used the benefit and smoking decreased approximately 26% (Land et al., 2010a). Medicaid recipients who utilized the benefits were also less likely to have inpatient hospital claims for coronary events and heart disease post-implementation compared to pre-implementation (Land et al., 2010b). However, studies in Massachusetts have not evaluated potential downstream effects of these policies on children's health.

To address these limitations in the literature, we conducted a quasi-experimental study to examine the effects of state and local smoke-free legislation on the rate of ED visits for childhood asthma, ear infections, and respiratory infections in Massachusetts, New Hampshire, and Vermont, controlling for cigarette taxes and health care reform legislation.

2. Methods

The Massachusetts Center for Health Information and Analysis, (Massachusetts Division of Health Care Finance and Policy) New Hampshire Department of Health and Human Services, (New Hampshire Department of Health and Human Services) and Green Mountain Care Board (Vermont Department of Banking, Insurance, Securities and Health Care Administration) collect patient-level data on all ED visits as required by law. In Massachusetts, 74 acute care hospitals report data. We obtained the ED database from January 1, 2001 through September 30, 2010, which captured all ED visits in Massachusetts' acute care hospitals and satellite emergency facilities that did not result in admission to an inpatient or outpatient observation stay. In New Hampshire, all 26 acute care hospitals report data. We obtained the restricted inpatient and outpatient hospital discharge files from January 1, 2001 through December 31, 2009. In Vermont, all 14 acute care hospitals report data. We obtained the restricted hospital discharge files for ED visits, which were extracted from the inpatient and outpatient data files, from January 1, 2002 through December 31, 2010. As inpatient and outpatient visits account for approximately 2% of all visits in New Hampshire and 3% in Vermont, both types were included.

The Boston College Institutional Review Board reviewed this study and considered it exempt; each participating state also approved the protocol.

We limited the analyses to children age 0–17 years who presented to the ED in each state. All three states used the International Classification of Diseases ninth revision, clinical modification (ICD-9-CM) to code diagnoses associated with hospital utilization (National Center for

Health Statistics, Centers for Disease Control and Prevention). We identified all ED visits with a principal diagnosis of: asthma as code 493; ear infections as codes 381 and 382 (including nonsuppurative and suppurative otitis media and Eustachian tube disorders); acute lower respiratory infections as codes 466, 480–488, including bronchitis, pneumonia, and influenza; and acute upper respiratory infections as codes 460–465. For each patient contact, we extracted the month/year of visit, age (0–4, 5–9, 10–17 years), sex (female, male), and zip code (linked to municipality of residence). Data on race was not consistently collected across states. We also created a health insurance indicator because of increasing rates of children covered by public insurance over the study period (Racine et al., 2014). We calculated the fraction of visits covered by Medicaid versus commercial insurance at the state-age-year level for accidents (codes 800–999), as patients are unlikely to be turned away based on their ability to pay.

2.1. Policy measures

Table 1 presents the date that smoke-free legislation, cigarette tax changes, and health care reform legislation came into effect in Massachusetts, New Hampshire, and Vermont. Using the month/year of each child's ED visit, we identified whether the visit occurred before or after each policy came into effect and the current cigarette tax.

2.2. Smoke-free legislation

We obtained the effective dates of 100% smoke-free legislation for workplaces and restaurants for each state and municipality from the American Nonsmokers' Rights Foundation (American Nonsmokers' Rights Foundation). In Massachusetts, restaurants and workplaces became 100% smoke-free in July 2004. Prior to state-wide implementation, 94/351 municipalities had 100% smoke-free restaurant policies and 65/351 had 100% smoke-free workplace policies (American Nonsmokers' Rights Foundation). Since 108 municipalities had either restaurant or workplace policies (51 had both), we coded exposure to any local smoke-free policy. In New Hampshire, restaurants became

Table 1

Dates that cigarette taxes, smoke-free legislation, and health care reform legislation came into effect in Massachusetts, New Hampshire and Vermont.

	Massachusetts	New Hampshire	Vermont
2001	Tax \$0.76	Tax \$0.52	Tax \$0.44
2002	Tax \$0.76	Tax \$0.52	Tax \$0.44
2003	Tax \$1.51 (7/25/02)	Tax \$0.52	Tax \$0.93 (7/1/02)
2004	Tax \$1.51 7/5/04: Smoke-free workplaces, restaurants	Tax \$0.52	Tax \$1.19 (7/1/03)
2005	Tax \$1.51	Tax \$0.52	Tax \$1.19 9/1/05: Smoke-free restaurants
2006	Tax \$1.51 07/1/06: Medicaid recipients receive low-cost tobacco cessation therapies as part of Health Care Reform	Tax \$0.80 (7/1/05)	Tax \$1.19
2007	Tax \$1.51	Tax \$0.80 9/17/07: Smoke-free restaurants	Tax \$1.79 (7/1/06)
2008	Tax \$1.51	Tax \$1.08 (7/1/07)	Tax \$1.79
2009	Tax \$2.51 (7/1/08)	Tax \$1.33 (10/1/08)	Tax \$1.99 (7/1/08) 7/1/09: Smoke-free workplaces
2010	Tax \$2.51	Tax \$1.78 (7/1/09)	Tax \$2.24 (7/1/09)

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