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## Original Research

# Factors affecting ambulance utilization for asthma attack treatment: understanding where to target interventions

L.H. Raun <sup>a,b,\*</sup>, K.B. Ensor <sup>a</sup>, L.A. Campos <sup>a</sup>, D. Persse <sup>c,d</sup><sup>a</sup> Rice University, Department of Statistics, Houston, TX, USA<sup>b</sup> City of Houston Health and Human Services Bureau of Pollution Control and Prevention, Houston, TX, USA<sup>c</sup> City of Houston Emergency Medical Services, Houston, TX, USA<sup>d</sup> Medicine and Surgery, Baylor College of Medicine, Houston, TX, USA

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## ABSTRACT

**Objectives:** Asthma is a serious, sometimes fatal condition, in which attacks vary in severity, potentially requiring emergency medical services (EMS) ambulance treatment. A portion of asthma attacks requiring EMS ambulance treatment may be prevented with improved education and access to care. The aim of this study was to identify areas of the city with high rates of utilization of EMS ambulance for treatment, and the demographics, socio-economic status, and time of day associated with these rates, to better target future interventions to prevent emergencies and reduce cost.

**Study design:** A cross-sectional study was conducted on individuals in Houston, TX (USA) requiring ambulance treatment for asthma attacks from 2004 to 2011.

**Methods:** 12,155 EMS ambulance-treated asthma attack cases were linked to census tracts. High rate treatment areas were identified with geospatial mapping. Census tract demographic characteristics of these high rate areas were compared with the remainder of the city using logistic regression. The association between case level demographics and the time of day of asthma attack within the high rate area was also assessed with logistic regression.

**Results:** EMS ambulance-treated high rate areas were identified and found to have a utilization incidence rate over six times higher per 100,000 people than the remainder of the city. There is an increased risk of location in this high rate area with a census tract level increase of percent of population: earning less than \$10,000 yearly income (RR 1.21, 1.16–1.26), which is black (RR 1.08, 1.07–1.10), which is female (RR 1.34, 1.20–1.49) and have obtained less than a high school degree (RR 1.02, 1.01–1.03). Within the high rate area, case level data indicates an increased risk of requiring an ambulance after normal doctor office hours for men compared with women (RR 1.13, 1.03–1.22), for black compared with Hispanic ethnicity (RR 1.31, 1.08–1.59), or for adults (less than 41 and greater than 60) compared with children.

\* Corresponding author. Rice University, Department of Statistics, PO Box 1892, MS 138, Houston, TX 77251-1892, USA. Tel.: +1 713 417 1896; fax: +1 713 348 5476.

E-mail address: [raun@rice.edu](mailto:raun@rice.edu) (L.H. Raun).

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**Conclusions:** Interventions to prevent asthma emergencies should be targeted in the high rate area and towards groups identified most at risk. Consideration should be given to improved access to care after normal doctor office hours in these locations. While ambulance treatment reflects the most urgent care needs, these interventions are also expected to reduce the need for emergency room visits.

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## Introduction

Asthma is a growing national concern, affecting more than 25 million Americans including an estimated seven million children.<sup>1</sup> In 2009, there were 1.9 million asthma related emergency department visits and 479,300 hospitalizations.<sup>2</sup> Moreover, in the last decade the number of people living with asthma rose by nearly 15%.<sup>3</sup> In 2010, there were 3404 deaths from asthma nationwide, and in 2007 there were 198 adult and 16 child deaths in the state of Texas alone.<sup>4,5</sup>

Asthma attacks vary in severity sometimes requiring emergency medical service (EMS) ambulance treatment. A recent review summarizing existing systematic reviews of asthma-related interventions (not medication) that could be carried out by community asthma control programs indicated two intervention methods had the strongest record of effectiveness: self-management education, and more general, comprehensive home-based multitrigger reduction interventions.<sup>6</sup> However, the uptake of these interventions is weak. Of people with asthma, only 12.2% report taking a management class and 49.3% receive counselling on reducing triggers at work or home.<sup>3</sup> Given that effective interventions have been identified but not fully implemented, researchers have emphasized the importance of future efforts geared towards communities suffering from a disparate asthma burden.<sup>6</sup> Additionally, preventing an asthma health emergency would preserve EMS resource availability for other urgent needs and potentially reduce health care costs. Each EMS response has a baseline cost of approximately 1400 dollars (Dr. David E. Persse, personal communication, August 1, 2013) in the study area.

Rates of asthma hospitalization are known to vary by and within states,<sup>7</sup> but spatial variation of asthma attack rates requiring EMS ambulance treatment within city has not been documented. Because cardiac arrest rates are known to vary across a city according to neighbourhood characteristics, it is expected that spatial variation of asthma attack rates requiring EMS intervention also exists.<sup>8–14</sup> The location of this study is Houston, Texas. Houston is the fourth largest city in the United States. Houston EMS ambulance responded to 12,644 emergency calls for asthma from 2004 to 2011. The goal of this study was to evaluate if the rate of asthma attacks requiring EMS ambulance response varied across a large metropolitan city, and if so, provide this information to public health officials to target interventions toward high-rate areas. In addition to spatial information, understanding the demographics of those who have required EMS ambulance response for an asthma attack and when attacks are most likely to occur may further inform officials of how to target

interventions. It has been hypothesized that a portion of asthma attacks requiring EMS ambulance treatment may be prevented with improved education and access to care. This is the first study to evaluate EMS ambulance-treated asthma attack cases by space, time, and demographic with the intent of targeting prevention.

## Methods

### Study design and setting

All cases in which an EMS ambulance team designated the working assessment in the field as asthma and the patient was treated with nebulized albuterol were considered in the study. In 2012, the asthma incidence data was obtained from Houston Fire Department calls spanning an eight-year period from 2004 to 2011. Due to missing variables such as age or time of incidence, 3.9% of the data was removed from the study. After removing the incomplete cases, the database consisted of  $n = 12,155$  (9593 adults and 2562 children under 18) cases of EMS treated asthma. Both Rice University and Baylor College

**Table 1 – EMS ambulance-treated asthma attacks in Houston, Texas from 2004 to 2011. Case level statistics.**

Characteristic	Adult No. of events	Child No. of events
<b>Total cases (%)</b>	9593 (100)	2562 (100)
<b>Sex (%)</b>		
Female	5684 (59)	925 (36)
Male	3909 (41)	1637 (64)
<b>Race/Ethnicity (%)</b>		
Asian	148 (2)	28 (1)
African American	6639 (69)	1879 (73)
Hispanic	1033 (11)	509 (20)
Indian	52 (1)	13 (1)
Unknown	40 (0)	10 (0)
Caucasian	1681 (18)	123 (5)
<b>Median age</b>	46	8
<b>Average age (SD)</b>	47 (18)	8 (4)
<b>Year (%)</b>		
2004	1014 (11)	233 (9)
2005	1127 (12)	292 (11)
2006	1104 (12)	310 (12)
2007	1386 (14)	342 (13)
2008	1342 (14)	360 (14)
2009	1186 (12)	326 (13)
2010	1229 (13)	349 (14)
2011	1205 (13)	350 (14)

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