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Childhood asthma resolution of environmental symptoms (CARES) during general summer camp attendance: a pilot study

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CHILDHOOD ASTHMA RESOLUTION OF ENVIRONMENTAL SYMPTOMS (CARES) DURING GENERAL SUMMER CAMP ATTENDANCE: A PILOT STUDY

by

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ABSTRACT

Background: The CDC estimates that asthma affects over 7 million American children. Children that live in urban settings bear more of the asthma burden in regards to morbidity and mortality than their suburban and rural counterparts. Theories as to the cause of this disparity are varied and complex. There is consensus that some interaction of home and outdoor exposures coupled with a genetic predisposition to make urban children more at risk for suffering asthma symptoms.

Objective: The CARES (Childhood Asthma Resolution of Environmental Symptoms) pilot study seeks to investigate the role home environment play in urban childhood asthma by measuring asthma symptoms before and after a 2 week stay at a residential summer camp in the suburban Duxbury, MA.

Methods: Asthma Control Tests™ were administered to campers at the start and end of their 2 week stay at camp. These results were correlated with demographic information that parents supplied during enrollment. ACT score improvements were tested for significance against particular polled home exposures or demographics.

Results: 53 campers enrolled in the pilot study with 96% completing induction and follow-up. While both age groups saw a general increase of ACT scores during their stay at camp (p=.009 and p=.006), there was no significant difference of ACT score

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increase between groups that had a particular exposure (e.g. smoker in the home) and those that did not (p=.275 and p=.945).

**Conclusion:** While we cannot attribute the general asthma improvement seen in Participants to a particular exposure or demographic status, this pilot study highlighted important ideas for future investigations with more statistical power that may give us better answers to the cause of increased urban asthma burden among children.
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LIST OF ABBREVIATIONS

ACT .......................................................... Asthma Control Test™

PPB .......................................................... Persons per Bedroom
INTRODUCTION

Asthma

Asthma is a disease characterized by a chronic inflammation response to particular stimuli. Following exposure to an allergen, bronchial constriction occurs, making breathing difficult and creating the familiar wheeze associated with asthmatics ("Asthma," 2008). While asthma is most frequently associated with children, adults also suffer from the disease. Children make up the majority of asthmatics seen in the Emergency Room as well as those hospitalized every year (Gergen, 2005). Children accounted for double the asthmatic hospital admissions as adults in 2000 (Figure 1). This high utilization of health care resources contributes to the elevated cost of asthma related medical care in the United States (Gergen, 2005). It is estimated by the Centers for Disease Control that Asthma costs the United States $56 billion every year. This includes dollars spent on health care as well as lost days at school and work (CDC, 2012). Asthma is a leading cause of absence from school, and a strongly contributing cause of missed work. In 2008 10.5 million school absences and 14.2 million missed workdays were attributable to asthma (CDC, 2012). There are, of course, ripple effects as parents of asthmatic children must take off work to care for their child or take them to the doctor. Other studies put Asthma’s estimated cost at over $70 billion (Jang, Gary Chan, Huang, & Sullivan, 2013). Recent asthma spending trends have seen a large jump in medication costs, specifically in adolescents (Figure 2). Asthma patients are often on more than one medication to control symptoms long-term and relieve acute attacks (Gergen, 2005).
Figure 1: Health Service Use and Death Rates in Asthmatic Adults and Children. Taken from Gergen (2005). Children account for more Asthmatic hospitalizations, Emergency Room Visits, and Office Visits every year than adults.

Figure 2: Five year Average Costs of Asthma Care Allocated by Category for All Age Groups and Patients Ages 6-17, 2000-2004 and 2005-2009. Figure taken from Jang et al. (2013). Asthma costs attributable to adolescents rose $3.5 billion from 200-2004 to 2005-2009.
Asthma Burden of Urban and Minority Populations

While asthma affects individuals at all levels of society, children living in urban environments suffer a higher incidence and severity of asthma (Gergen, 2005; Togias, Fenton, Gergen, Rotrosen, & Fauci, 2010; Unger, 2013). Studies have pointed toward both indoor and outdoor exposures, as well as social influences as contributing factors to the Urban Asthma Disparity (Holt, Theall, & Rabito, 2013; Medjo et al., 2013a; Pearlman et al., 2006; Schwartz & Pepper, 2009; Vesper et al., 2013; Wu & Takaro, 2007).

Indoor Environment Factors

Many factors have been offered to account for the fact that those from poorer, inner-city neighborhoods are more likely to have asthma than their rural or suburban-dwelling counterparts. Particular types of housing, such as public housing or apartment buildings have been associated with higher asthma incidence (Northridge, Ramirez, Stingone, & Claudio, 2010). Public housing and apartments are common in lower socioeconomic sections of cities. Characteristics of these particular types of housing make them prone to containing allergens that frequently exacerbate asthma (Eggleston, 2007). Buildings in poor repair are more likely to contain pests and mold, as well as provide poor ventilation (Hill, Graham, & Divgi, 2010; Wu & Takaro, 2007).

In a study by Northridge et al. (2010), public housing was found to have a higher incidence of current asthma in residents. Public housing was more likely to be in disrepair and more likely to have elevated levels of nitrogen dioxide, an asthma trigger. Even after correcting for factors like Socioeconomic Status and indoor allergen presence,
public housing residents still had higher odds of asthma (Northridge et al., 2010).

**Figure 3: Characteristics of Inner-City Children with Asthma.** Figure taken from Gergen (2005). Race, Socioeconomic Status and Allergies are all factors involved in Urban Asthma Incidence.

*Outdoor Environment Factors*

Outdoor pollution is also believed to contribute to increased urban asthma incidence. Traffic-related air pollutants have increased in cities over recent decades (Pénard-Morand et al., 2010). These compounds are known to trigger asthma in individuals already suffering from asthma, but their role in asthma development is still not fully understood (Pénard-Morand et al., 2010). While certain exposures might cause the increased asthma reports in cities, lack of other exposures may also contribute to the problem. Children living in rural environments are frequently exposed to antigens that
lead to robust immune development including livestock and soil microbes (Gern, 2010). Inner-city children may not be getting enough challenge to their immune systems to prevent them from engaging in hypersensitivity reactions.

Social Influences

Racial and social factors may also play a role in the high asthma levels seen in cities. More than 50% of children living in urban areas have at least person in their home who smokes (Eggleston, 2007). The increased level of obesity observed in the inner city can also be correlated with higher asthma morbidity (Togias et al., 2010). In addition to physical factors like smoking and obesity, psychological challenges also come into play. Children who experience more stress are more likely to have poor lung health (Hill et al., 2010). Urban populations are more likely to experience poverty, housing transience and exposure to crime (Hill et al., 2010; Pearlman et al., 2006; Togias et al., 2010).
Figure 4: Urban Asthma Social Factors and Exposures. Figure taken from Eggleston (2007). The causes and contributing factors of Urban Asthma incidence are diverse and complex.

Specific Aims of the Present Study

While the higher incidence of asthma in inner city children is well documented, the causal risk factors are still being determined. Indoor and outdoor pollution, allergen exposure, race, genetic factors and limited access to health care have all been implicated in the increased asthma burden of urban children. The interaction of so many elements makes determining a clear causal path of asthma development complicated. The question of whether removing the child from their home environment for a period of 14 days
would improve their asthma has not been previously investigated. Previous studies have been conducted investigating the results of asthmatic children attending Asthma Camps, where there is an asthma educational component (Kaminsky et al., 2008). The CARES (Childhood Asthma Resolution of Environmental Symptoms) pilot study is novel in that it will be conducted at a general summer camp with no targeted asthma program. By observing children with asthma from the inner city in the suburban environment of summer camp, we hope to learn more about how these factors act to contribute to asthma symptoms.
MATERIALS AND METHODS

Overview of Methods

During this pilot study our aim is to determine if the change in environment of children with asthma leads to the lessening of their asthma symptoms relative to what they experience at home. Parents of study participants will complete a survey describing the child’s home environment including any allergen sources and the management of their child’s asthma. The participants (asthmatic campers) will complete an Asthma Control Test™ at the beginning and end of their stay at camp. Results of the symptom survey will be correlated against housing information including address, type of housing (private home, public housing etc.) and home allergen exposures.

Study Design

Camp Wing in Duxbury, MA served as the recruitment pool for Participants. The population served by Camp Wing is primarily urban, with an established high prevalence of asthma. The study utilized the Asthma Control Test™ developed by QualityMetric Inc. and The Childhood Asthma Control Test developed by GlaxoSmithKline in a pilot investigation to determine if urban children experienced asthma symptom improvement while attending summer camp in the suburbs. Standard demographic questions were adapted from the Children’s HealthWatch Survey©. The study was reviewed by the Boston University Medical Center Institutional Review Board and approved as an expedited study.
**Study Participants**

CARES Study participants were campers aged 6 to 13 years of age who had been diagnosed with Asthma by their doctor. Participants had to have a parent present to consent to their participation in the study, and to fill out questions about the camper’s demographics as well as answer ACT™ questions for participants under the age of 12. Both Participants and their guardians had to speak English and campers had to remain at camp for the full 14 days.

**Recruitment and Enrollment**

Campers and their families were approached for study enrollment during drop-off and registration at the beginning of each of three camp sessions. Camper drop-off occurs at Boston College High School in Boston, MA and directly to Camp Wing in Duxbury, MA. CARES Study enrollment was done at The Boston drop-off location. Approximately 75% of campers are brought to camp via the Boston drop off, making it the better source for Study Participants. A table was set up with a sign reading ‘Asthma Study’ near the tables where families checked in their children for the camp session. Parents were approached by the study staff member and asked if their child had asthma and if so, were they willing to have their child participate in a study investigating whether asthma symptoms improved at summer camp. Parents were informed that the study was optional as well as confidential. Written informed consent was obtained from the parents and verbal informed consent was obtained from the children. Children were given an ice-pop as an incentive. 65 parents/children were approached. 53 were enrolled (82%); two participants withdrew during the initial assessment because of time. All 51 Participants
who enrolled completed the study through the full two weeks of camp. 96% of Participants completed the initial survey and 100% of those individuals completed the follow-up.

**Data Collection**

Parents completed a demographics questionnaire where they indicated the Participant’s race, age, and living situation (apartment or home, public housing or rental, and number of occupants and bedrooms). This information was used to determine if a Participant’s living situation could be considered overcrowded. The U.S. Department of Housing and Urban Development defines overcrowded living conditions as 2.0 or more People Per Bedroom (PPB)(Blake, Kellerson, & Simic, 2007). Parents also selected particular exposures that existed in the home (pets, carpeting, pests, water damage, smokers, and chemical cleaners). Participants whose parents indicated that a certain exposure was present in the home were considered ‘positive’ for that exposure; many Participants had ‘multiple exposures’ meaning they had 2 or more exposures present in the home (for full questionnaire see Appendix A). Campers were interviewed the same day they arrived at camp, and again the day before they left (on days 0 and 14 respectively). Campers were asked to rate their asthma symptoms according to the ACT™ for their respective age group (see Appendix B). Campers’ answers were recorded by a study staff member. The ACT™ given to campers under the age of 12 required an adult to answer three of the questions about the participant’s symptoms. Parents answered these questions during enrollment along with the demographics questions. At the end of the study, the campers’ cabin counselors were asked to complete
this part of the questionnaire (Figure 5). All data was collected in person on paper forms that were locked in a file cabinet for the duration of the study.

**Data Analysis**

Data were analyzed using Microsoft Excel Data Analysis Tools to perform T-tests and mean determinations. P values less than 0.05 were considered statistically significant.
Figure 5: Data Collection Flow Chart. Order of data collected for CARES study.
RESULTS

Participants in the study ranged in age from 7 to 13 years old with a mean age of 10.7 years. 59% of Participants were male while 41% were female. African Americans comprised 76% of the surveyed campers, Hispanics made up 12% of the Participants, and White or Biracial individuals made up 10%. One participant declined to self-identify race. 65% of surveyed campers’ zip codes corresponded with urban neighborhoods. 26 Participants took the Childhood ACT™, while 25 were old enough to complete the Standard ACT™ (Table 1).

Table 1: CARES Study Participant Demographics

<table>
<thead>
<tr>
<th>Demographic</th>
<th>N(Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>30 (59%)</td>
</tr>
<tr>
<td>Female</td>
<td>21 (41%)</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>3 (6%)</td>
</tr>
<tr>
<td>8</td>
<td>8 (16%)</td>
</tr>
<tr>
<td>9</td>
<td>6 (12%)</td>
</tr>
<tr>
<td>10</td>
<td>3 (6%)</td>
</tr>
<tr>
<td>11</td>
<td>8 (16%)</td>
</tr>
<tr>
<td>12</td>
<td>10 (20%)</td>
</tr>
<tr>
<td>13</td>
<td>13 (25%)</td>
</tr>
<tr>
<td>Mean Age</td>
<td>10.7</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>39 (76%)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>6 (12%)</td>
</tr>
<tr>
<td>Biracial</td>
<td>3 (6%)</td>
</tr>
<tr>
<td>White</td>
<td>2 (4%)</td>
</tr>
<tr>
<td>Not Reported</td>
<td>1 (2%)</td>
</tr>
<tr>
<td>Urban Survey Used</td>
<td></td>
</tr>
<tr>
<td>Childhood ACT™</td>
<td>26 (51%)</td>
</tr>
<tr>
<td>Standard ACT™</td>
<td>25 (49%)</td>
</tr>
</tbody>
</table>
Participants were surveyed about their current medications. 94% had been prescribed a rescue inhaler (e.g. ProAir HFA or XOPENEX HFA) by their doctor (data not shown). Flovent was the most common controller inhaler medication (39%, data not shown). 8% of Participants carried an Epipen with them (data not shown).

Table 2: Mean Pre-Camp and Post-Camp ACT scores for Junior and Senior Participants

<table>
<thead>
<tr>
<th>Survey Group</th>
<th>Mean Pre-Camp ACT™ Score</th>
<th>Mean Post-Camp ACT™ Score</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior</td>
<td>22.96</td>
<td>25.23</td>
<td>0.009</td>
</tr>
<tr>
<td>Senior</td>
<td>20.52</td>
<td>22.44</td>
<td>0.006</td>
</tr>
</tbody>
</table>

Participants who completed the Childhood ACT™ (ages 4-11) were assigned the group name ‘Junior’ while those who completed the Standard ACT™ (ages 12 and up) were designated ‘Senior’. The Juniors began camp with better controlled asthma, having a Mean Pre-Camp ACT™ score of 22.96 compared to the Senior’s 20.52 (controlled Asthma is considered a score >19 (“Asthma Control Test (ACT),” n.d.). The Juniors also saw a greater improvement of ACT™ score while at camp, 2.27 compared to 1.92 (Table 2). Both Juniors and Seniors experienced improvement in their mean ACT™ scores while at camp (p=.009 and p=.006 respectively). While it was clear both groups saw improvement in asthma control after two weeks at camp, connecting this improvement to any pre-camp exposure or classification proved difficult.

On the demographics form completed at enrollment, parents answered questions regarding exposures the camper experienced in the home. Parents were asked to indicate
if any of the following were present in the Participant’s primary residence: pets, a smoker, cleaning chemicals, carpeting, pests such as mice or cockroaches, and water damage. Groups of Participants who had experienced a particular variable (pets in the home, smoker in the home etc.) were compared against those who had not. T tests were run comparing the before and after ACT™ scores of each group (exposure positive and negative seniors, and exposure positive and negative Juniors) to determine if there was a statically significant difference between the scores (Table 3). Too few Participants were identified as being exposed to water damage (n=3, data not shown) and pests (n=2, data not shown) to run T tests for statistical significance.

**Multiple Exposures**

Both Juniors and Seniors who experienced multiple exposures in the home showed no significant improvement of ACT™ scores as a group (p=.079 and p=.063 respectively), while those who had single exposure or none at all did have a significant improvement (p=.024 and p=.046 respectively) (Table 3).

**Overcrowding**

Overcrowding scores were calculated using information provided on the demographics form. Of the 25 seniors, only 8 were classified as living in an overcrowded home. Those individuals showed an improvement in their ACT™ scores (p=.003), while those who did not meet the criteria for overcrowding did not (p=.132). There was only one Junior in the overcrowded category and so statistical analysis was not performed (Table 3).
Table 3: Exposure Group ACT™ Scores

<table>
<thead>
<tr>
<th>Exposure Category</th>
<th>Junior N</th>
<th>Junior Mean Pre-Act Score</th>
<th>Junior Mean Post-Act Score</th>
<th>Junior P Value</th>
<th>Senior N</th>
<th>Senior Mean Pre-Act Score</th>
<th>Senior Mean Post-Act Score</th>
<th>Senior P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Exposures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junior</td>
<td>9</td>
<td>23.44</td>
<td>25.89</td>
<td>0.024</td>
<td>17</td>
<td>22.71</td>
<td>24.88</td>
<td>0.079</td>
</tr>
<tr>
<td>Senior</td>
<td>18</td>
<td>20.61</td>
<td>22.28</td>
<td>0.046</td>
<td>7</td>
<td>20.29</td>
<td>22.86</td>
<td>0.063</td>
</tr>
<tr>
<td>Overcrowded Living Condition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junior</td>
<td>25</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Senior</td>
<td>17</td>
<td>20.35</td>
<td>21.71</td>
<td>0.132</td>
<td>8</td>
<td>20.88</td>
<td>24.00</td>
<td>0.003</td>
</tr>
<tr>
<td>Share Home with Pets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junior</td>
<td>15</td>
<td>23.20</td>
<td>25.07</td>
<td>0.076</td>
<td>11</td>
<td>22.64</td>
<td>25.45</td>
<td>0.073</td>
</tr>
<tr>
<td>Senior</td>
<td>15</td>
<td>21.07</td>
<td>22.47</td>
<td>0.046</td>
<td>10</td>
<td>19.70</td>
<td>22.40</td>
<td>0.063</td>
</tr>
<tr>
<td>Share Home with a Smoker</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junior</td>
<td>19</td>
<td>22.84</td>
<td>25.74</td>
<td>0.004</td>
<td>7</td>
<td>23.29</td>
<td>23.86</td>
<td>0.761</td>
</tr>
<tr>
<td>Senior</td>
<td>22</td>
<td>20.45</td>
<td>22.36</td>
<td>0.014</td>
<td>3</td>
<td>21.00</td>
<td>23.00</td>
<td>0.184</td>
</tr>
<tr>
<td>Chemical Cleaners Used in Home</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junior</td>
<td>9</td>
<td>22.67</td>
<td>25.56</td>
<td>0.107</td>
<td>17</td>
<td>23.12</td>
<td>25.06</td>
<td>0.053</td>
</tr>
<tr>
<td>Senior</td>
<td>15</td>
<td>20.47</td>
<td>22.67</td>
<td>0.032</td>
<td>10</td>
<td>20.60</td>
<td>22.10</td>
<td>0.101</td>
</tr>
<tr>
<td>Carpeting in the Home</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junior</td>
<td>15</td>
<td>23.53</td>
<td>25.00</td>
<td>0.153</td>
<td>11</td>
<td>22.18</td>
<td>25.55</td>
<td>0.033</td>
</tr>
<tr>
<td>Senior</td>
<td>17</td>
<td>20.71</td>
<td>22.29</td>
<td>0.060</td>
<td>8</td>
<td>20.13</td>
<td>22.75</td>
<td>0.049</td>
</tr>
</tbody>
</table>
**Pets in the Home**

Having pets living in the home with the Participant did not appear to have a significant effect on the ACT™ scores of the Juniors (no pets p = .076; pets p = .073). Seniors that did not share their home with a pet (15 individuals) saw an improvement in their ACT™ scores (p = .046) compared to the Seniors that did have a pet at home (p = .063) (Table 3).

**Smoker in the Home**

Most of the Participants lived in a smoke-free home (80% Data not shown). Both Juniors and Seniors that lived in smoke-free homes showed improved ACT™ scores (p = .004 and p = .014). Those Campers that lived with a smoker in the home did not see significant improvement of their ACT™ scores (p = .761 and p = .184) (Table 3).

**Chemicals in the Home**

Chemical use in the home was the most common exposure overall (53% exposed; Data not shown). Seniors that were not exposed to chemical cleaners in the home were the only group that saw statistically significant improvement in their ACT™ scores (p = .032). Juniors saw no difference in ACT™ score regardless of chemical status in the home and Seniors with chemical use in the home did not see any change in ACT™ score while at camp (Table 3).
Table 4: Exposure Group Mean ACT™ Comparisons

<table>
<thead>
<tr>
<th>Variable</th>
<th>Negative Exposure</th>
<th>Positive Exposure</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Exposures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junior</td>
<td>2.44</td>
<td>2.18</td>
<td>0.856</td>
</tr>
<tr>
<td>Senior</td>
<td>1.67</td>
<td>2.57</td>
<td>0.522</td>
</tr>
<tr>
<td>Overcrowded Living Condition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junior</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Senior</td>
<td>1.35</td>
<td>3.13</td>
<td>0.121</td>
</tr>
<tr>
<td>Share Home with Pets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junior</td>
<td>1.87</td>
<td>2.82</td>
<td>0.585</td>
</tr>
<tr>
<td>Senior</td>
<td>1.40</td>
<td>2.70</td>
<td>0.377</td>
</tr>
<tr>
<td>Share Home with a Smoker</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junior</td>
<td>2.90</td>
<td>0.57</td>
<td>0.275</td>
</tr>
<tr>
<td>Senior</td>
<td>1.91</td>
<td>2.00</td>
<td>0.945</td>
</tr>
<tr>
<td>Chemical Cleaners Used in Home</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junior</td>
<td>2.89</td>
<td>1.94</td>
<td>0.615</td>
</tr>
<tr>
<td>Senior</td>
<td>2.20</td>
<td>1.50</td>
<td>0.576</td>
</tr>
<tr>
<td>Carpeting in the Home</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Junior</td>
<td>1.47</td>
<td>3.36</td>
<td>0.270</td>
</tr>
<tr>
<td>Senior</td>
<td>1.59</td>
<td>2.63</td>
<td>0.456</td>
</tr>
</tbody>
</table>
Carpeting in the Home

Carpeting in the home was associated with improved ACT™ scores in both Juniors and Seniors (p=.033 and p=.049). Those who did not have carpeting in the home did not have a statistically significant different post-camp ACT™ score from their pre-camp score (Table 3).

Mean Differences of Exposure Groups

T tests were also conducted comparing the differences between before and after ACT™ scores of positive and negative exposure groups (Table 4). For example, the mean difference between Pre- and Post-camp ACT™ scores for Seniors that lived in overcrowded homes was 3.13. On average, a Senior camper whose home would be classified as overcrowded, saw an increase in ACT™ score of 3.13. Seniors that did not live in an overcrowded home saw a mean difference of 1.35. On average, their ACT™ scores increased by 1.35 while at camp. T tests were run using the individual differences in ACT™ scores to determine if the difference of ACT™ score seen by the exposed group was statistically different from the unexposed group’s. None of these comparisons showed statistical significance (Table 4).
DISCUSSION

This pilot study attempted to determine if two weeks at summer camp out of the urban environment improved the asthmatic symptoms of urban children. Using a very limited number of campers, we tried to correlate specific demographics and exposures to increased ACT™ scores in Subjects. Our sample population consisted of 65% urban residents. Crossroads for Kids specifically seeks to work with urban, socially at-risk youth, a mission that aligned with the aims of this study. It was unsurprising that the majority of our Participants were male (59%, Table 1). The Asthma and Allergy Foundation of America has established that asthma is more common in male children than female (“Asthma and Allergy Foundation of America - Information About Asthma, Allergies, Food Allergies and More!,” n.d.). Our large number of minority Participants is also to be expected due both the socioeconomic status of the surveyed population, and asthma’s higher prevalence amongst racial minorities (Butz, Kub, Bellin, & Frick, n.d.; Gergen, 2005; Schwartz & Pepper, 2009; Togias et al., 2010) (Table 1). The Camp Wing site hosts campers from ages 6 to 14, ensuring any enrolled Participants would be old enough to complete one of the ACT™ surveys.

While both groups of Participants started camp with clinically controlled asthma (“Asthma Control Test (ACT),” n.d.), the Juniors’ asthma was slightly better controlled than the Seniors’. Juniors had a mean pre-camp ACT™ score of 22.96 out of a possible 27 (85%) while Seniors started camp with a mean ACT™ score of 20.52 out of a possible 25 (82%) (Table 2). Older children are more likely to manage their own medications at home, while parents are in charge of medications for younger children.
The increase in ACT™ score seen in both groups can also partially be attributed to the regimented dispensing of medications. Nursing staff conduct four medication passes daily, with additional administration of medications for campers who take off-time medicines (e.g. a p.m. ADHD medication). Medication logs are maintained and campers are tracked carefully to ensure they are receiving their medication on time, and using proper technique with inhalers. The American Lung Association identifies proper medication timing and use as an important part of Asthma management (“Understand Your Medication,” n.d.). More data comparisons are needed to draw any conclusion about the nature of the ACT™ score increase in the study.

Multiple Exposures in the Home

The first set of data comparisons that were made involved comparing groups of Participants defined by exposure status and see if each group saw a statistical difference in their ACT™ scores between the start and end of the study. When we looked at groups defined by the number of measured exposures in the home, individuals that had only a single or no exposure at all saw a difference in their ACT™ scores. Those that had multiple exposures in the home did not see an improvement in their ACT™ scores. It is possible that parents were averse to checking off multiple exposures on the intake paperwork. While three of the exposures asked about do not have a social stigma attached to them (carpeting, pets in the home, and chemical cleaners use in the home), the other three (smoker in the home, pests, and water damage in the home) could carry some amount of embarrassment. It is possible that parents underreported multiple exposures in the home. Parents could have recognized that the listed housing conditions could be
harmful for a child with asthma and admitting that their child lives with those exposures could be embarrassing for a parent.

**Overcrowding**

Overcrowded living conditions are described by the US Department of Housing and Urban Development as 2 or more persons per bedroom (PPB). Upon comparing the Senior Participants that lived in overcrowded housing to their uncrowded counterparts, those who lived in overcrowded homes saw a significant improvement in their ACT™ scores. This comparison was not run with the Juniors because only one individual was classified as living in overcrowded conditions, making a comparison statistically insignificant. Overcrowding can lead to increased respiratory illnesses, as well as increased endotoxin levels in the home which can exacerbate asthma (Ownby et al., 2013). It can also act as a marker for lower socioeconomic status, which is also associated with asthma. While at camp, Participants did live in single room cabins with up to 12 other individuals. While this certainly meets the criteria for overcrowding, the cabins are open air and the appropriate bathroom to person ratio is maintained as established by the Massachusetts State Health Department. It was clear that individuals in this study that living in overcrowded housing saw an improvement in their ACT™ scores, however a larger study would be required to definitively make a connection between the two.

**Pets in the Home**

The role that living with pets, typically dogs and cats, plays in asthma onset and
exacerbation is contested in the literature (Medjo et al., 2013b; Uddenfeldt, Janson, Lampa, & Rask-Andersen, 2013). Pet ownership was common amongst study Participants, with 21 of the 51 Campers having pets at home. The only group that saw improvement in their ACT™ scores were Seniors who did not have pets in the home. Because of the location and nature of the cabins Participants lived it at camp, it is possible that animal fur and dander were present in the cabins during the study. This would obviously cloud the data and make distinctions more difficult to make between home exposure and study exposure. While it is possible that pets may play a role in Asthma development and persistence, the data collected in this study was unable to side conclusively with one side of the argument or the other.

**Smoker in the Home**

Probably one of the most important factors that were investigated in this study was the relationship between smokers in the home and ACT™ score improvement upon removal from the environment with a smoker. Unlike the possible contamination issue with animals at camp, smoking is not permitted anywhere on Camp Wing property. Only non-smoking staff are hired and there is a zero-tolerance policy in place for violations involving tobacco use. 7 Junior Participants and 3 Senior Participants were self-identified by parents as living with smokers in the house. These Juniors and Seniors did not see an improvement in ACT™ score as a group. Those in the negative exposure category did see a statistically significant increase in their ACT™ scores at the end of 2 weeks at camp. We believe, as mentioned previously that there is a possibility of underreporting of smokers in the home. Smoking carries a social stigma, and parents knew this study was
investigating asthma in children. There could be some pressure felt by parents to withhold their smoking status from study investigators. Recent figures from the CDC put 14.4% of Boston adults as smokers (“CDC - Community Profile - Boston, MA - Communities Putting Prevention to Work,” n.d.). 19% of our Participants lived with a smoker, however only 65% of our Participants were classified as urban. It should also be noted that several parents disclosed during enrollment that they did not select the box for smoking in the home because they only smoke outside. Again, the data does not necessarily support the literature, but self-selection bias must also be taken into account.

**Chemical Cleaners in the Home**

Chemical cleaner use in the home was the most common exposure found amongst Participants (53%). We believe that parental reporting of chemical cleaner use to be accurate, as keeping a clean house is not seen as shameful or embarrassing. Several parents also wrote under the box checked for chemical cleaner use, ‘clean home’ or ‘house kept clean and neat’. Harsh chemical cleaning supplies and air fresheners have been established to cause asthmatic symptoms and irritate air passages (Nazaroff & Weschler, 2004). The American Lung Association cautions against using such cleaners in the homes of Asthmatics or other respiratory illnesses (“Cleaning Supplies and Household Chemicals,” n.d.). Camp Wing primarily uses ‘green’ industrial cleaners in the bathrooms and showers at camp. Bathrooms are not cleaned while campers are using them and open-air structure of the buildings allows for any fumes to disperse quickly. Senior Participants in the study who did not use chemical cleaners in the home, saw an increase in their ACT™ scores while at camp. None of the other groups saw statistically significant
improvement, although all group’s ACT™ scores did increase.

**Carpeting in the Home**

Finally, Participants were categorized by whether or not they had carpeting in the home. Carpeting is believed to gather allergens such as dust mites, pet dander, and pollen (Wu & Takaro, 2007). The Asthma and Allergy Foundation of America recommends cleaning carpets with a HEPA filter vacuum or replacing them with hardwood floor (“Asthma and Allergy Foundation of America - Information About Asthma, Allergies, Food Allergies and More!,” n.d.). All floors in buildings at Camp Wing are either timber, tile, or synthetic solid surface. Both Junior and Senior Participants that had carpeting in their home saw increases in ACT™ scores that were significant. The negative exposure groups also had increases in ACT™ scores, but they were not significant. Carpeting is a catch-all exposure, while it could be a primary contributor to asthma symptoms, it could (like overcrowding) be a marker for lower socioeconomic status that is the real indicator of asthma exacerbation. Older homes and apartments are more likely to have carpeting, and older buildings are more often found to have structural problems, water damage, mold, pests, and asbestos (Holt et al., 2013; Northridge et al., 2010; Papadimitriou, Riza, Pililitsis, Chrousos, & Linos, 2011; Williams, Sternthal, & Wright, 2009). Participants were not surveyed about the age of the home that they lived in, it would have been an interesting correlation to establish. However, it is unlikely that many Parents would know this information as the majority of Camp Wing’s population rents their home.

While we were able to see some significant increases in ACT™ scores within
exposure groups, there were no statistical differences between positive and negative exposure groups for the same variable. This lack of comparative significance in the data points to a lack of statistical power in this pilot study.

**Limitations**

The biggest limitation of this study was small sample size. 51 participants was too small of a number to establish any real statistically significant trends. The study did capture a majority of eligible Participants and was able to maintain 100% of Participants from start to finish.

Requiring that Participants have physician-diagnosed asthma also limits the number of enrolled Participants. Rather than requiring a diagnosis for participation, we would have probably been able to enroll more individuals if we had instead relied on physiological definitions of asthma such as Peak Flow readings or Spirometry testing. Unfortunately the collection of those measurements was beyond the scope of this pilot study.

A previously undiscussed limitation stems from the familiarity of the Research Investigator and the Participants. The majority of the campers knew the Investigator as a member of Camp Wing staff as were aware that the project was part of ‘school work’. It is possible campers tried to ‘help’ by indicating their asthma had improved more than it had objectively. This study also relies on getting the majority of its data from children. Surveys were answered on the most emotional days of the camp session, right after the Campers arrive when they may be nervous or homesick, and right before they go home, when they are sad to leave new friends but excited to return home. Choosing a more
objective metric for asthma improvement such as peak flow measurements might provide more standardized data.

It is also possible that the duration of the study, 2 weeks, is not long enough to see a significant effect related to the exposures experienced by Participants at home. A future variable that could be investigated is length of stay at camp, comparing campers who spend 2, 4 and 6 weeks at camp.

Having to use two different surveys to collect data divided our Sample Population and greatly decreased the statistical power of the study. While both surveys were Asthma Control Tests, the questions and score totals for each were different, making pooling the data difficult. The surveys also do not include information about social variables experienced by the Participants. Studies have highlighted the importance of this parameter when investigating asthma in urban and minority pediatric populations.

In this pilot study no significant association between environmental changes and asthma control could be made. There was improvement of asthma symptoms in different exposure groups, but they were not statistically significant. General improvement of asthma symptoms was significant but no correlation to a specific exposure or demographic group was possible.

Future studies would be improved by increasing the number of participants, possibly recruiting through other camps that serve primarily urban populations. Having an individual unfamiliar to the Participants collect the data could also help diminish well-intentioned ringers.
APPENDIX A

Parent CARES Demographics Questionnaire and Parental ACT™ Questions for Participants 4-11 years old

Has your child been diagnosed with Asthma by a doctor? ☐YES ☐NO

During the last 2 weeks, how many days did your child have any daytime asthma symptoms?

☐ Not at all ☐ 1-2 days ☐ 3-5 days
☐ 6-9 days ☐ 10-13 days ☐ Everyday

During the last 2 weeks, how many days did your child wheeze during the day because of asthma?

☐ Not at all ☐ 1-2 days ☐ 3-5 days
☐ 6-9 days ☐ 10-13 days ☐ Everyday

During the last 2 weeks, how many days did your child wake up during the night because of asthma?

☐ Not at all ☐ 1-2 days ☐ 3-5 days
☐ 6-9 days ☐ 10-13 days ☐ Everyday

Which of the following best describes your child’s race? You may choose more than one.

☐ Asian ☐ Black or African American
☐ Somali ☐ White or Caucasian
☐ American Indian or Native American ☐ Cape Verdean
☐ Haitian ☐ Jamaican or West Indian
☐ Other ______________

What is your child’s zip code? __ __ __ __
What type of housing does your child live in?

☐ An apartment
☐ A house/townhouse/condo
☐ Residential treatment
☐ Government housing
☐ Mobile home/trailer
☐ Shelter/transitional living situation
☐ Hotel/motel
☐ Subsidized housing

How many bedrooms are in your child’s home? ___ ___

How many people live in your child’s home? ___ ___

Which of the following describe your child’s home? Select all that apply.

☐ Share home with pets
☐ Smoking(s) in home
☐ Carpeting in home
☐ Chemical cleaners containing bleach of ammonia, air fresheners
☐ Evidence of mice or cockroaches
☐ Evidence of leaks or water damage

Does your child take any of the following medications? Select all that apply.

☐ Albuterol (MDI) inhaler
☐ Xopenex (MDI) inhaler or solution
☐ Pulmicort respules
☐ QVAR
☐ Advair MDI inhaler
☐ Singulair
☐ Dulera
☐ Albuterol solution for nebulizer
☐ Flovent
☐ Pulmicort flexhaler
☐ Advair Discus
☐ Symbicort
☐ Alvesco
APPENDIX B

Parent CARES Demographics Questionnaire for Participants 12+ years old

Has your child been diagnosed with Asthma by a doctor? ☐YES ☐NO

Which of the following best describes your child’s race? You may choose more than one.

☐ Asian          ☐ Black or African American
☐ Somali        ☐ White or Caucasian
☐ American Indian or Native American  ☐ Cape Verdean
☐ Haitian       ☐ Jamaican or West Indian
☐ Other __________

What is your child’s zip code? __ __ __ __

What type of housing does your child live in?

☐ An apartment    ☐ Mobile home/trailer
☐ A house/townhouse/condo ☐ Shelter/transitional living situation
☐ Residential treatment ☐ Hotel/motel
☐ Government housing ☐ Subsidized housing

How many bedrooms are in your child’s home? __ __

How many people live in your child’s home? __ __

Which of the following describe your child’s home? Select all that apply.

☐ Share home with pets ☐ Carpentry in home
☐ Smoker(s) in home ☐ Evidence of mice or cockroaches
☐ Chemical cleaners containing damage bleach of ammonia, airfreshers ☐ Evidence of leaks or water

Does your child take any of the following medications? Select all that apply.

☐ Albuterol (MDI) inhaler  ☐ Albuterol solution for nebulizer
☐ Xopenex (MDI) inhaler or solution  ☐ Flovent
☐ Pulmicort respules  ☐ Pulmicort flexhaler
☐ QVAR  ☐ Advair Discus
☐ Advair MDI inhaler  ☐ Symbicort
☐ Singulair  ☐ Alvesco
☐ Dulera
APPENDIX C

Childhood Asthma Control Test™ Used by Participants ages 4–11 years old

1. How is your asthma today?
   - 0: Very bad
   - 1: Bad
   - 2: Good
   - 3: Very good

2. How much of a problem is your asthma when you run, exercise or play sports?
   - 0: It's a big problem, I can't do what I want to do.
   - 1: It's a problem and I don't like it.
   - 2: It's a little problem but it's okay.
   - 3: It's not a problem.

3. Do you cough because of your asthma?
   - 0: Yes, all of the time.
   - 1: Yes, most of the time.
   - 2: Yes, some of the time.
   - 3: No, none of the time.

4. Do you wake up during the night because of your asthma?
   - 0: Yes, all of the time.
   - 1: Yes, most of the time.
   - 2: Yes, some of the time.
   - 3: No, none of the time.

Score:
Not at all 1-3 days/mo 4-10 days/mo 11-18 days/mo 19-24 days/mo Everyday

Total:

19 or less
May be a sign that your child's asthma is not controlled as well as it could be. No matter what the score, bring this test to your doctor to talk about your child's results.
### APPENDIX D

**Asthma Control Test™ used for Participants aged 12+ years old**

1. **In the past 4 weeks**, how much of the time did your asthma keep you from getting as much done at work, school or at home?

<table>
<thead>
<tr>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>


2. **During the past 4 weeks**, how often have you had shortness of breath?

<table>
<thead>
<tr>
<th>More than once a day</th>
<th>Once a day</th>
<th>3 to 6 times a week</th>
<th>Once or twice a week</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

3. **During the past 4 weeks**, how often did your asthma symptoms (wheezing, coughing, shortness of breath, chest tightness, or pain) wake you up at night or earlier than usual in the morning?

<table>
<thead>
<tr>
<th>4 or more nights a week</th>
<th>2 or 3 nights a week</th>
<th>Once a week</th>
<th>Once or twice</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

4. **During the past 4 weeks**, how often have you used your rescue inhaler or nebulizer medication (such as albuterol)?

<table>
<thead>
<tr>
<th>3 or more times per day</th>
<th>1 or 2 times per day</th>
<th>2 or 3 times per week</th>
<th>Once a week or less</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
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</table>

5. **How would you rate your asthma control during the past 4 weeks?**

<table>
<thead>
<tr>
<th>Not controlled at all</th>
<th>Poorly controlled</th>
<th>Somewhat controlled</th>
<th>Well controlled</th>
<th>Completely controlled</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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</table>

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The American Lung Association supports the Asthma Control Test and wants everyone 12 years of age and older with asthma to take it.

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*Asthma Control Test™ is a trademark of QualityMetric Incorporated.*
# LIST OF JOURNAL ABBREVIATIONS

<table>
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<th>Full Name</th>
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<td>Annals of Allergy, Asthma and Immunology</td>
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<tr>
<td>Atmos Environ</td>
<td>Atmospheric Environment</td>
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<tr>
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<td>CHEST Journal</td>
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<td>Ups J Med Sci</td>
<td>Upsala Journal of Medical Sciences</td>
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Upsala Journal of Medical Sciences, 118(2), 111–121.


CURRICULUM VITAE

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July 2009 – June 2012

Conducted Protocols to investigate the role of qnr genes in antimicrobial resistance. Maintained laboratory facilities, developed protocols, presented at lab meetings and acted as laboratory Safety Officer.

Medically Relevant Experience:

Dr. William Goldberg MD PC, Medical Assistant
June 2013 – Present

Responsible for performing patient EKGs, Spirometry, INRs, administering vaccines and injections. Maintain electronic medical record and conduct patient triage over the phone.

Crossroads for Kids, Camp Wing Healthcare Coordinator
June - August 2012 and 2013

Responsible for medication distribution to campers as well as maintenance of health records for 500 campers and staff. Provided care at daily sick call and accompanied campers to medical appointments and ER visits.