RESEARCH REPORT

Risk factors for asthma prevalence and chronic respiratory illnesses among residents of different neighbourhoods in Buffalo, New York

Jamson S Lwebuga-Mukasa, Tonny J Oyana, Paulette Wydro

Study objective: The aim of this study is to identify risk factors for asthma prevalence and chronic respiratory illnesses in Buffalo’s neighbourhoods after previous studies reported increased levels of asthma among residents of Buffalo’s west side.

Main results: A multivariate logistic regression model shows that the risk of persons with asthma and chronic respiratory illnesses is significantly (p < 0.05) high among children and young adults living in Buffalo’s west side, newer housing units, and of Latino ethnicity. In a separate analysis of the nine risk factors, it was observed that location, gender, age, and race were significant risk factors even after adjusting for age of housing, pets, moulds, animal trigger, and smoking.

Conclusions: These findings confirm the hypothesis that a considerable risk of asthma and chronic respiratory illnesses exists particularly among Buffalo’s west side residents. Further evaluation of these risk factors is warranted to determine the severity of asthma and the reasons for such a significant disease burden.
an eight month period starting from 1 January 2002 to the end of August 2002, primarily in the mornings and evenings on weekdays and on weekends after 1 pm. This study was approved by the University at Buffalo Human Investigation Committee in accordance with national and institutional guidelines for the protection of human subjects. All participants signed a statement of informed consent.

The survey was conducted using 17 trained community residents (35 were recruited but a rigorous selection procedure left 17) who had previously completed a 2.5 hour training session given by the Centre for Asthma and Environmental Exposure (CAEE) staff. Additional training in quality control measures and error handling procedures was provided to team leaders of each group. The surveyors had no prior knowledge of asthma prevalence among the households surveyed.

In the field, a sample selection was determined through a four stage process. The first stage entailed establishing the actual size and geographical distribution of households in the study area using current postal data. A spreadsheet of households was created in MS Excel (Microsoft, Seattle, WA). We then randomly (using a random integer between 1 and 60) selected the first household. We prepared a short list for the surveyors showing every fourth household organised by block starting from the 36th household. The surveyors were then asked to administer a questionnaire to every fourth household or to the nearest households whenever they found unoccupied houses, or if a respondent in the household...

### Table 1 List of variables (risk factors) used in multivariate analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Association</th>
<th>Variable</th>
<th>Association</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastside</td>
<td>+</td>
<td>Other pets</td>
<td></td>
</tr>
<tr>
<td>Westside</td>
<td>+</td>
<td>Moulds</td>
<td></td>
</tr>
<tr>
<td>South Buffalo</td>
<td>–</td>
<td>Cockroaches</td>
<td></td>
</tr>
<tr>
<td>Near west</td>
<td>–</td>
<td>Smoke</td>
<td></td>
</tr>
<tr>
<td>Downtown</td>
<td>+</td>
<td>Education-high school</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>–</td>
<td>Age 1–5 years</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>+</td>
<td>Age 6–17 years</td>
<td></td>
</tr>
<tr>
<td>Age of housing (dwellings) 1–24 years</td>
<td>+</td>
<td>Age 18–34 years</td>
<td>+</td>
</tr>
<tr>
<td>Age of housing (dwellings) 24–54 years</td>
<td>+</td>
<td>Age 35–64 years</td>
<td>+</td>
</tr>
<tr>
<td>Age of housing (dwellings) 55–99 years</td>
<td>+</td>
<td>Age ≥65 years</td>
<td>+</td>
</tr>
<tr>
<td>Renter (hiring)</td>
<td>+</td>
<td>African American</td>
<td></td>
</tr>
<tr>
<td>Owner (housing)</td>
<td>+</td>
<td>White</td>
<td></td>
</tr>
<tr>
<td>Cats</td>
<td>+</td>
<td>Latino</td>
<td></td>
</tr>
<tr>
<td>Dogs</td>
<td>+</td>
<td>Other race</td>
<td></td>
</tr>
<tr>
<td>Birds</td>
<td>+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Risk factors that are positively (+) associated and negatively (−) associated with asthma and chronic respiratory illnesses at a significance level of p<0.05.
refused to participate in the study. The second stage entailed the distribution of 8 to 10 questionnaires per day, approaching households at different times of the day, especially early in the mornings and evenings. Upon arrival at the home, the surveyors introduced themselves, sought consent, and requested for the head of the household to conduct the survey.

The third stage entailed the evaluation of completed questionnaires by the survey team in consultation with the authors. Completed questionnaires were then submitted for entry into the computers. Three research assistants, trained and supervised by the authors, entered the data in Microsoft Excel worksheets. The final stage entailed calling a randomised sample of 200 households who had completed the questionnaires to validate some of their responses. Overall, the survey teams reported about a 2% to 5% refusal rate on particular days, that older people were more willing to participate than younger people, and that more households participated during the spring and summer seasons than winters. The survey of the community provided a good response rate of 82% of the targeted households.

Persons with asthma or chronic illnesses were identified among the individuals with respiratory problems based on questionnaire responses. The criterion for asthma diagnosis was based on the head of household’s report of having been told by a healthcare provider that a person in their household had diagnosed asthma. Chronic respiratory illnesses data based on the analysis of persons with breathing problems in the preceding 12 months.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Asthma 95%CI</th>
<th>Chronic 95%CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>18.5 (106/573) 15 to 22</td>
<td>14.4 (82/568) 12 to 18</td>
</tr>
<tr>
<td>Female</td>
<td>31.4 (332/1057) 29 to 34</td>
<td>16.6 (175/1054) 14 to 19</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>20.4 (161/790) 18 to 24</td>
<td>12.2 (96/786) 10 to 15</td>
</tr>
<tr>
<td>White</td>
<td>23.9 (122/509) 20 to 28</td>
<td>18.4 (94/510) 15 to 22</td>
</tr>
<tr>
<td>Latino</td>
<td>50.1 (122/239) 45 to 58</td>
<td>17.9 (42/234) 13 to 23</td>
</tr>
<tr>
<td>Other race</td>
<td>30.2 (29/96) 21 to 40</td>
<td>22.9 (22/96) 15 to 33</td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastside</td>
<td>18.5 (80/433) 15 to 23</td>
<td>10.7 (48/445) 8 to 14</td>
</tr>
<tr>
<td>Westside</td>
<td>24 (157/654) 21 to 27</td>
<td>19.4 (151/777) 17 to 22</td>
</tr>
<tr>
<td>South Buffalo</td>
<td>40.5 (62/153) 33 to 49</td>
<td>11.2 (12/107) 6 to 19</td>
</tr>
<tr>
<td>Near West</td>
<td>46.1 (66/143) 38 to 55</td>
<td>15.2 (14/92) 9 to 24</td>
</tr>
<tr>
<td>Downtown</td>
<td>28.7 (75/261) 23 to 35</td>
<td>14.7 (32/218) 10 to 20</td>
</tr>
</tbody>
</table>

Data shown as percentages with numbers in parentheses. Prevalence shown for each independent variable. Asthma data based on the head of household’s report of having been told by a healthcare provider that a person in their household had diagnosed asthma. Chronic respiratory illnesses data based on the analysis of persons with breathing problems in the preceding 12 months.

Figure 2 Spatial distribution of persons with asthma in relation to major roadways and potential exposure sites. Clustering of persons with asthma is evident in Buffalo’s west side especially in zip codes 14201, 14207, and 14213 and along the major roadways and potential exposure sites. Fair distribution is evident in the east and south. Persons with asthma are sparsely distributed in the downtown and middle/near west locations.
Figure 1 presents the spatial distribution of surveyed households according to geographical regions in relation to major roadways and potential exposure sites. A sample (n = 1277) was available for multivariate analysis after coding variables of interest into dichotomous variables (yes, no). The sample size is reduced because of the coding process and missing values in some variables. Responses (yes, no) about persons with asthma and chronic respiratory illnesses had originally been compiled from a three part questionnaire used for the survey.

Multivariate analysis was conducted to assess potential relations between three mutually exclusive dependent variables and nine risk factors. Recent evidence reviewed in Oyana28 about risk factors for asthma and chronic respiratory illnesses provided a rationale for defining these variables. Three mutually exclusive dependent variables (persons with asthma; persons with chronic respiratory illnesses; and a combination of persons with asthma or chronic respiratory illnesses) were used to evaluate risk factors for asthma and chronic illnesses. Nine risk factors (location, gender, age, household triggers, pets, smoking status, ethnicity/race, age of housing units, and educational status) yielded 32 subcategories (later referred to as variables/factors) from our study database as shown in table 1. The two categories of risk factors were analysed separately using a multivariate logistic regression model in three phases. The first phase entailed a preliminary assessment conducted to eliminate non-significant variables (p > 0.05) from the general model, as well as to investigate potential confounders (race, gender, pets, education, and smoking) and interaction effects (age of housing × location, race × smoking, and age × smoking). The second phase entailed using a reduced model and the final phase of analysis produced our best model. A backward elimination strategy was preferred in all three phases of modelling. Residual analysis was conducted to evaluate our best model for test of lack of fit.

RESULTS
Multivariate logistic regression analysis of 32 factors found that only 20% (that is, three to six factors) of them were significantly associated with increased risk for asthma or chronic respiratory illnesses. Based on the general model used for analysis, persons with asthma comprised of 26.3% while the rest were non-asthma households. There were some observed interactions during the preliminary assessment phase and consequent models thereafter. Overall, the risk of persons with asthma and chronic respiratory illnesses is significantly (p < 0.05) high among children (6 to 17 years) and young adults (18 to 34 years) living in Buffalo’s west side, or newer housing units, and of Latino ethnicity. A negative association was found among the male population in all three multivariate analyses conducted.

Table 2 presents the general distribution of asthma and chronic respiratory illnesses by selected variables. Most of the illnesses were observed among the female participants. Respondents reporting more than 36% of these illnesses resided in Buffalo’s west side. Minority communities (African Americans and Latinos) are the most susceptible with more than 50% of self reported asthma and chronic respiratory illnesses.

Figure 2 gives the spatial distribution of persons with asthma in relation to major roadways and potential exposure sites. Clustering of persons with asthma is evident in Buffalo’s west side especially in zip codes 14201, 14207, and 14213 and along the major roadways and potential exposure sites. Fair distribution is evident in the east and south of the study area. Persons with asthma are sparsely distributed in the downtown and middle/near west locations.
There was a strong association among children ranging from 6 to 17 years and young adults 18 to 34 years, age of the dwellings (less than 24 years), Latino ethnicity, and location of the dwelling on Buffalo’s west side are significantly (p<0.05) associated with increased risk of asthma and chronic respiratory illnesses, Buffalo, New York.

**DISCUSSION**

The main findings of the study are: children aged 6 to 17 years and young adults 18 to 34 years, age of the dwellings (less than 24 years), Latino ethnicity, and location of the dwelling on Buffalo’s west side are significantly (p<0.05) associated with increased risk of asthma and chronic respiratory illnesses. There was a modest association among newer housing units while a negative statistical association was found among the male population.

In a separate analysis of the nine risk factors, we observed that location, gender, age of housing, animal triggers, age, and race were identified as important risk factors for asthma. These results are consistent with our specific analysis of the 32 variables described earlier. However, the only main difference between the analyses of 9 and 32 variables is the statistical significance of animal triggers in the former. Also, further investigation of interaction effects using nine risk factors indicated that: (1) there was a statistically significant interaction between age of housing and location; (2) there was some interaction between race and smoking, but the intercept was weak; and (3) there was no interaction between age and smoking. While the results in (1) and (2) may require additional analysis, we found that location, gender, age, and race were significant risk factors even after adjusting for age of housing, pets, moulds, animal trigger, and smoking.

**Key points**

- A multivariate logistic regression model shows that the risk of persons with asthma and chronic respiratory illnesses is significantly (p<0.05) high among children and young adults living in Buffalo’s west side, newer housing units, and of Latino ethnicity;
- Children aged 6 to 17 years and young adults 18 to 34 years are significantly (p<0.05) associated with increased risk of asthma and chronic respiratory illnesses;
- Location, gender, age, and race were significant risk factors even after adjusting for age of housing, pets, moulds, animal trigger, and smoking.

**Policy implications**

- There is persuasive evidence supported by previous and current studies that residents living in close proximity to the US-Canada border crossing point have a major disease burden and attention should be focused on regulatory monitoring of air quality;
- This study provides much needed guidance to manage risk among people with asthma living near the US-Canada border crossing point;
- Incorporate health effects into trans-border transportation planning.

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**Table 3** Significant odd ratios (OR) of risk factors that were associated with asthma or chronic respiratory illnesses, Buffalo, New York

<table>
<thead>
<tr>
<th>Variables</th>
<th>OR = $e^{\theta}$</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asthma</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Westside</td>
<td>2.176</td>
<td>1.477 to 3.205</td>
</tr>
<tr>
<td>Male</td>
<td>0.533</td>
<td>0.355 to 0.799</td>
</tr>
<tr>
<td>Age (6–17 years)</td>
<td>1.501</td>
<td>1.042 to 2.163</td>
</tr>
<tr>
<td>Age (18–34 years)</td>
<td>3.333</td>
<td>2.193 to 5.056</td>
</tr>
<tr>
<td>Latino</td>
<td>2.741</td>
<td>1.159 to 6.484</td>
</tr>
<tr>
<td><strong>Chronic respiratory illnesses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Westside</td>
<td>1.685</td>
<td>1.246 to 2.280</td>
</tr>
<tr>
<td>Male</td>
<td>0.676</td>
<td>0.488 to 0.937</td>
</tr>
<tr>
<td>Age (6–17 years)</td>
<td>2.297</td>
<td>1.491 to 3.537</td>
</tr>
<tr>
<td><strong>Asthma or chronic respiratory illnesses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Westside</td>
<td>2.290</td>
<td>1.570 to 3.339</td>
</tr>
<tr>
<td>Male</td>
<td>0.548</td>
<td>0.422 to 0.711</td>
</tr>
<tr>
<td>Age (6–17 years)</td>
<td>1.469</td>
<td>1.036 to 2.083</td>
</tr>
<tr>
<td>Age (18–34 years)</td>
<td>3.217</td>
<td>2.151 to 4.811</td>
</tr>
<tr>
<td><strong>Chronic respiratory illnesses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Westside</td>
<td>1.728</td>
<td>1.186 to 2.517</td>
</tr>
<tr>
<td>Male</td>
<td>0.533</td>
<td>0.355 to 0.799</td>
</tr>
<tr>
<td>Age (6–17 years)</td>
<td>1.942</td>
<td>1.334 to 2.828</td>
</tr>
</tbody>
</table>

Likelihood ratio $\chi^2$ test: *$\chi^2$=459.764, p=0.000, and $\chi^2$=629.528; analysis of risk factors is based on a multivariate logistic regression model (p<0.000); sample size (n=1277); asthma data based on the head of household’s report of having been told by a healthcare provider that a person in their household had diagnosed asthma; chronic respiratory illnesses data based on the analysis of persons with breathing problems in the preceding 12 months.

Figure 3 gives the spatial distribution of persons with asthma or chronic respiratory illnesses in relation to major roadways and potential exposure sites. A similar spatial pattern of distribution of persons with asthma or chronic respiratory illnesses was observed as described for figure 2. The maps show that Buffalo’s west side has a higher spatial concentration of persons with asthma and chronic respiratory illnesses compared with the other geographical regions (east, middle/near west, downtown, and the south).

Table 3 shows significant odd ratios (OR) of risk factors that were associated with asthma or chronic respiratory illnesses. Factors that were strongly associated with an increased risk for asthma among persons with asthma were residence in Buffalo’s west side (p<0.000), age (that is, children of 6 to 17 years and young adults of 18 to 34 years (p<0.000)), and Latino ethnicity (p<0.004). Newer housing units were modestly associated with an increased risk for asthma (p<0.029) while there was a negative association among the male population.

Living in Buffalo’s west side was strongly associated with an increased risk for chronic respiratory illnesses (p<0.001). There was a strong association among children ranging from 6 to 17 years (p<0.000). We found a negative association among the male population.

Residents living in Buffalo’s west side (p<0.000), being of Latino ethnicity (p<0.001), and children of 6 to 17 years (p<0.000) and adults of 18 to 34 years (p<0.004) were strongly associated with an increased risk for asthma or chronic respiratory illnesses. There was a modest association among newer housing units while a negative statistical association was found among the male population.
respiratory illnesses. These findings do confirm our hypoth-
hesis that a considerable risk of asthma and chronic respi-
atory illnesses exists particularly among certain groups 
living in specified locations of the study area. Findings of this 
study are also consistent with that of previous studies.4 12 This 
study confirms that asthma and chronic respiratory illnesses 
remain a major health problem among Buffalo’s west side 
residents living in close vicinity to the Peace Bridge Complex 
(PBC) and major roadways feeding it. The hardest hit 
residents are located downwind of the busiest US-Canada 
border crossing point, which harbours a major trade corridor 
for the (NAFTA partners serving the USA, Canada, and 
Mexico).

The main findings are not only useful to understand the 
characteristics of persons with asthma, but also in identifying 
risk factors for asthma and chronic respiratory illnesses in the 
study area. We will briefly examine the significance of these 
findings in detail below.

Residing on Buffalo’s west side yields an increased risk for 
having asthma or a chronic respiratory disease, and this 
finding lends additional evidence suggesting that there may 
be a strong association between increased truck traffic from 
the PBC and the exacerbation of asthma and chronic 
respiratory illnesses in this community. This finding also 
suggests an increased risk of asthma or a breathing problem 
in persons residing in close proximity to the PBC and major 
roadways feeding it. The statistical significance, however, 
implies that there is an important health problem affecting 
the people residing on Buffalo’s west side, and the problem is 
not improving; in actuality, it may be getting worse 
throughout the years with the asthma and bronchitis 
prevalence on the rise.13 It is noteworthy however that, to 
date, no direct relation between inhaled diesel exhaust fumes 
and the development of asthma or other respiratory diseases 
have been reported;2 additional studies are warranted to 
examine this issue further.

The age of the dwelling (newer housings) showed a 
statistically significant correlation with the presence of 
asthma or a respiratory disease among people residing on 
Buffalo’s west side because of its potential contribution to 
increased morbidity and induction of asthma and chronic 
respiratory illnesses. It is possible that newer houses could 
be tightly constructed to preserve heat during winter seasons 
and might have a reduced air exchange system. Additionally, 
poor ventilation systems in newer housing units may increase 
amount of dust particles, dust mites, and fumes from indoor 
cooking with gas stoves, which may act as a trigger in 
asthmatic persons. However, cooking with gas stoves is 
widely spread in all Buffalo communities.

People with Latino ethnicity were found to have an 
increased prevalence of asthma and this finding is consistent 
with current literature30–36 and previous studies done in the 
area.3 7 12 As Latino residents have the highest asthma rates 
and happen to live on Buffalo’s west side this could be a 
confounder. Despite Latino ethnicity being a confounder, the 
link between selected respiratory system mortality and air 
quality problems in Buffalo’s west side can be traced back to 
1960s when this area was predominately populated by white 
people of European origin and African Americans.21 Latinos 
are recent entrants who have migrated to this area mostly 
within the past decade. This finding might not fully explain 
why there is an increased risk for asthma and chronic respiratory illnesses which further lends support to our 
earlier explanation on current exacerbations and the genesis 
of asthma or chronic respiratory illnesses being a result of 
increased levels of inhaled diesel exhaust fumes.

We found a negative statistical association among the male 
population. This finding may be explained by our earlier 
findings,7 12 which showed that females were more suscep-
tible to asthma than males. The data also suggest that 
children and young adults have a higher respiratory disease 
burden than any other age groups. This particular finding is 
in agreement with some of the published work discussed 
earlier4 4 and current literature on risk factors for asthma 
prevalence and chronic respiratory illnesses.20 23 However, 
there were some study limitations that should be high-
lighted—for example, obesity—which were not evaluated 
in data collection; direct inspections of homes were not done; 
and underreporting of certain conditions could not be 
verified. This study does not, however, have any evidence to 
suggest that residents of any given community would be more 
likely to under-report some conditions than their peers 
in other neighbourhoods. There was also a demographic bias; for example, the reported race composition in comparison 
with the census data was different, and the dominance of 
older respondents was particularly skewed in the 30 to 65 
year age group, which has implications for the findings of the 
study. This over-representation of certain groups is a 
potential bias. However, prevalence estimates were corrected 
to account for the selection bias. It is possible that the 2% to 
5% households that did not participate in the survey might 
be different, but we have no obvious reason to believe that 
their asthma prevalence was any different from the other surveyed 
households.

In conclusion, the findings of this study have two 
important implications: (1) the three to six risk factors 
identified by this study under the general umbrella of 
susceptibility factors, including genetic susceptibility, health 
status, residence and exposure history, and also lifestyle and 
activity might have some role in the induction and exacer-
bation of asthma; (2) there is an urgent need to characterise 
sources of environmental pollutants and exposures in 
Buffalo’s west side, including outdoor and indoor sources. 
The characterisation process, if done in spatial and temporal 
terms, might provide further insights about potential rela-
tions between risk factors and environmental pollutants. 
While the major findings in this study have contributed to 
our understanding of how risk factors might influence 
asthma and chronic illnesses, further evaluation, including 
the need to correlate findings to air quality assessments, 
especially traffic related pollution, is warranted to definitively 
link asthma and environmental factors.

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Conflicts of interest: none declared.

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