Household Fuels for Cooking and Allergies of Preschool Children in Tianjin, China: a Cross-Sectional Study

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Abstract

Gas, coal and biomass fuels are the dominant energy fuels for cooking in China. Exposure to the smoke released from gas, coal and biomass fuels contributes to respiratory diseases in childhood. To identify the association between asthma and allergy and cooking fuels at homes in China, an epidemiological questionnaire study on the home environment and children’s health was launched in Tianjin in 2013. Data for 7,865 children and homes are included in the study. The prevalence rate of diagnosed asthma, diagnosed pneumonia, diagnosed eczema, and diagnosed rhinitis among children was 4.5%, 27.9%, 38.6% and 19.6% respectively. Coal fuels used for daily cooking did have a significantly increased likelihood of asthma-related symptoms, doctor-diagnosed pneumonia and rhinitis ever. Children in families that used gas fuel for daily cooking had more pneumonia. Biomass/wood fuel was associated with a reduced risk for rhinitis.

Keywords: Biomass fuel; Gas fuel; Children’s allergies;

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1. Introduction

Asthma and allergies are becoming increasingly prevalent among children in China. A national survey of 438,000 children from 0 to 14 years old in 43 cities in year 2000 indicated that the prevalence rate of physician diagnosed asthma was 1.97%, which has a 64% increase over those in year 1990 [1, 2]. The prevalence rate of diagnosed asthma among children aged 0-14 at Tianjin increased by 1.82 times between 1996 and 2000 [3]. People spend 90% of their time indoors. In previous studies, indoor environment was found to have substantial influence on human’s health [4, 5]. The association between indoor environment and asthma needs to be investigated.

Fuels used for daily cooking are important pollution sources in the indoor environment. Gas, coal and biomass fuels are the dominant energy fuels for daily cooking for nearly one third of the world's population. During combustion of fuels, a multitude of pollutants associated with high levels of indoor air pollution (IAP) are released which include suspended particulate matter (SPM), carbon monoxide, formaldehyde, nitrogen dioxide and polycyclic aromatic hydrocarbons (PAH). The evidence is strong that exposure to those pollutants can lead to increased risk of diseases including respiratory infections (e.g., pneumonia, tuberculosis and chronic obstructive pulmonary disease (COPD), lung cancer, and asthma), low birth weight, cataracts, and cardiovascular events [6, 7, 8, 9].

However, there are few studies focused on the relationship between children’s allergic diseases and fuels used for daily cooking in China. To identify the association between asthma and allergy and cooking fuels in homes in China, an epidemiological study was launched at Tianjin in 2013.

2. Methods

A cross-sectional study was performed among preschool children at Tianjin in 2013. Data were collected on fuels used for daily cooking and children’s health outcomes. Health outcomes mainly focused on symptoms related to atopic eczema, asthma, rhinitis as well as earlier allergies in the family. Cooking fuels used were categorized into four types: coal, biomass/wood, gas and electricity. SPSS Statistics 19.0 was used for data analyses. Adjusted odds ratios (aOR) with 95% confidence intervals (95% CI) were calculated in logistic regression models to analyze the associations between cooking fuels and children’s asthma. Adjustments were made for family allergic history, gender, age, social-economic status and survey locations. For all the analyses, a p-value of <0.05 was considered significant.

3. Results

With a response rate of 78% we have data on 7,865 children, their homes, and families. 63.1% of the investigated homes used gas fuel for cooking, followed by 13%, electricity, biomass 4.3%, and coal 3.3%. Among them, 83.7% homes used gas fuel for daily cooking in Tianjin city while 26.1% families used gas fuel in rural or country areas. The proportions of household fuels for daily cooking in different areas are shown in Table 1. The prevalence of children’s diagnosed asthma, pneumonia, eczema, and rhinitis was 4.5%, 27.9%, 38.6% and 19.6% respectively.

Table 1. The proportions of household fuels for daily cooking in different areas

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>All houses n (%)</th>
<th>City n (%)</th>
<th>Suburban n (%)</th>
<th>Rural or country area n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel used for cooking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coal</td>
<td>248(3.3)</td>
<td>86(2.3)</td>
<td>48(3.6)</td>
<td>94(7.6)</td>
</tr>
<tr>
<td>Biomass/wood</td>
<td>397(5.4)</td>
<td>18(0.5)</td>
<td>33(2.5)</td>
<td>332(26.7)</td>
</tr>
<tr>
<td>Gas</td>
<td>4680(63.1)</td>
<td>3099(83.7)</td>
<td>1009(76.1)</td>
<td>325(26.1)</td>
</tr>
<tr>
<td>Electricity</td>
<td>964(13.0)</td>
<td>187(5.0)</td>
<td>236(17.8)</td>
<td>493(39.6)</td>
</tr>
</tbody>
</table>

The associations between fuels used for daily cooking and children's allergies are shown in Table 2. Children in families that used coal fuel for daily cooking did have a significantly increased likelihood of asthma, and asthma-related symptoms (doctor-diagnosed asthma, aOR=2.3, 95% CI: 1.2-4.5; dry cough in the last 12 months, aOR=1.8, 95% CI: 1.1-2.8). Using coal for cooking was also found to be associated with doctor-diagnosed pneumonia, rhinitis ever and doctor-diagnosed eczema. Biomass/wood fuels used for daily cooking was also found to be associated with
dry cough in the last 12 month (aOR=1.5, 95% CI: 1.0-2.4) and eczema ever (aOR=1.4, 95% CI: 1.0-1.8), but it was a protective factor for rhinitis in the last 12 months (aOR=0.6, 95% CI: 0.4-0.9). Gas fuel used for daily cooking was also a risk factor for several symptoms: doctor-diagnosed pneumonia and doctor-diagnosed eczema. The adjusted odds ratios are shown in the Table 2.

### Table 2. Associations between fuels used for cooking and children's allergies

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Coal aOR,95%CI</th>
<th>Biomass/wood aOR,95%CI</th>
<th>Gas aOR,95%CI</th>
<th>Electricity aOR,95%CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry cough in the last 12 months</td>
<td>1.8 (1.1-2.8)</td>
<td>1.5(1.0-2.4)</td>
<td>1.2(0.9-1.6)</td>
<td>1.0</td>
</tr>
<tr>
<td>Doctor-diagnosed Asthma</td>
<td>2.3(1.2-4.5)</td>
<td>0.9(0.3-2.2)</td>
<td>0.7(0.4-1.2)</td>
<td>1.0</td>
</tr>
<tr>
<td>Doctor-diagnosed Pneumonia</td>
<td>1.5(1.0-2.1)</td>
<td>1.0(0.7-1.5)</td>
<td>1.4(1.1-1.8)</td>
<td>1.0</td>
</tr>
<tr>
<td>Rhinitis ever</td>
<td>1.3(0.9-1.8)</td>
<td>0.8(0.6-1.1)</td>
<td>1.0(0.9-1.3)</td>
<td>1.0</td>
</tr>
<tr>
<td>Rhinitis in the last 12 months</td>
<td>1.3(0.9-1.8)</td>
<td>0.6(0.4-0.9)</td>
<td>1.0(0.8-1.3)</td>
<td>1.0</td>
</tr>
<tr>
<td>Doctor-diagnosed Rhinitis</td>
<td>1.1(0.6-2.0)</td>
<td>1.0(0.5-2.0)</td>
<td>0.9(0.6-1.3)</td>
<td>1.0</td>
</tr>
<tr>
<td>Eczema ever</td>
<td>1.0(0.7-1.4)</td>
<td>1.4(1.0-1.8)</td>
<td>1.1(0.9-1.3)</td>
<td>1.0</td>
</tr>
<tr>
<td>Eczema in the last 12 months</td>
<td>1.1(0.7-1.8)</td>
<td>1.1(0.7-1.7)</td>
<td>0.8(0.6-1.0)</td>
<td>1.0</td>
</tr>
<tr>
<td>Doctor-diagnosed Eczema</td>
<td>1.1(1.0-1.5)</td>
<td>1.2(0.9-1.7)</td>
<td>1.2(1.0-1.5)</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Odds ratios were adjusted for gender, age, socio-economic status, family allergy history and survey location(city, suburban and rural).

### 4. Discussion

This study has shown that children living in homes with coal or biomass/wood fuels used for daily cooking do have a significantly increased likelihood of asthma-related symptoms. This is consistent with what has been found in other studies. Household fuel-use (HFU) patterns are strongly associated with multiple effects, including air quality, human health, and regional climate change. The levels of SO₂, NO₂, and suspended particulate matter indoors were significantly greater in houses that used coal, wood, kerosene and cow dung cake. And more asthma, rhinitis, and upper respiratory tract infections were diagnosed for children residing in those homes. Due to the combustion of fuels, a multitude of pollutants associated with high levels of indoor air pollution (IAP) are released which include suspended particulate matter (SPM), carbon monoxide, formaldehyde, nitrogen dioxide, polycyclic aromatic hydrocarbons (PAH), etc. [10]. Xu reported that wheezing and asthma were associated with using coal for cooking [11].

Biomass or wood fuels used for cooking was associated with dry cough, but not with asthma in this study. But biomass smoke was found to be associated with children and adults’ asthma in previous studies [10, 12]. A case-control study conducted among children aged 1 month to 5 years in Kuala Lumpur identified kerosene or wood stove as a main cause of asthma [12]. One study carried out in rural China also found positive association between wheezing, asthma and exposure to wood or hey smoke [11].

The major strength of this study is the large sample size and the detailed questions on life habits and health outcomes. There are limitations with the present study. All the information was reported by parents. There may exist recall bias on children’s health outcomes. In the next step, health outcomes will be validated by medical test and PM concentration in homes will be measured.

### 5. Conclusions

Coal, biomass/wood and gas fuels used for cooking in homes may have negative effects on allergies and pneumonia among children in China.
Acknowledgements

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References