

Assessment of Asthma Triggers in Four Schools of the Ravenswood City School District

Human Biology 117A/B

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INTRODUCTION

We are addressing the issue of asthma in children of East Palo Alto. Our community is defined as the school-age children in Ravenswood City School District in East Palo Alto and Menlo Park. We have assessed four schools: James Flood Magnet School (K to 8th), Cesar Chavez Elementary (4th to 8th), Green Oaks Academy (K to 3rd), and Ravenswood Child Development Center (Pre to K). Our community partner is Laurie Bauer, RN, MSPH, and Dorothy Vura-Weis, MD, MPH. The current project aims to assess the school environment for the presence of allergens that have been found to exacerbate asthma symptoms and to help schools reduce the concentration of allergens in the schools by formulating recommendations.

There were six main research questions:

1. What are possible triggers for asthma in the primary school environment?
2. How are the triggers being addressed?
3. Which triggers are most prevalent?
4. Which triggers are the most hazardous?
5. Which are easiest to fix?
6. What resources and actions are necessary to address these risk factors?

Why Asthma is a Problem?

Unmanaged asthma results in missed school days, increased hospitalizations, and even death. Asthma is the most common reason for missed school days in the United States. Each year in the U.S. there are 14 million missed school days due to asthma. Among those under 15, asthma is the third leading cause of hospitalization. Among those under 18, it is estimated that the annual cost of treating asthma is \$3.2 billion. Also it is concerning that asthma prevalence has been increasing. Asthma prevalence among children rose from 3.6% in 1980 to 6.2% in 1996. In addition, there has been a dramatic rise in childhood deaths resulting from asthma. In 1979, there were 93 reported deaths in children from asthma. In 1996, this number increased to 266 (CDC, 2005). Currently, asthma rates in California among children are around 9%, which is the same in

San Mateo County. In 2001, nearly 136,000 California students aged 12-17 missed one or more days of school per month. As a result, schools lost \$40.8 million (Vura-Weis, 2005).

There has been increasing attention on asthma in EPA. One out of six people in East Palo Alto have asthma (Mitchell, 2005). A recent study conducted by Laurie Bauer in the Ravenswood School District found that the prevalence of asthma among school children is between 8.5% and 13% (Vura-Weis, 2005). The EPA community has deemed asthma to be such a concern that they have created the East Palo Alto asthma task force, which is a coalition of representatives from the school district, health centers, local government, and health agencies and organizations.

Asthma: An Introduction

Asthma is a chronic condition affecting the lungs. When irritated, the hyper-responsive airways of those with asthma narrow or become obstructed. It then becomes difficult to breathe. Chest tightness, shortness of breathing, wheezing, and coughing are some symptoms that are caused by the narrowing or obstruction of airways. The narrowing or obstruction of the airway results from bronchoconstriction, airway inflammation, and increased mucus production. Bronchoconstriction refers to the tightening of the muscles around the airways. Airway inflammation refers to swelling, redness, and narrowing of the airways in the lungs. Triggers such as strong fumes, inhaled irritants, cold air, dust, emotional upsets, smoke, and exercise cause bronchoconstriction. Airway inflammation occurs as a result of inducers or causes. Those with a family history of allergies or asthma are at increased risk of developing asthma. A diagnosis of asthma is made after a detailed history, physical examination, consideration of differential diagnoses, and trial use of asthma medications (Canadian Lung Association, 2005). Sometimes chest x-ray, blood

tests and sputum studies, allergy prick skin testing, spirometry, challenge tests are also used to diagnose asthma.

Asthma is not evenly distributed across the population. African Americans are more likely to have asthma, more likely to be hospitalized for asthma, and more likely to die from asthma than whites. African Americans are four times more likely to be hospitalized for asthma compared to whites, and are twice as likely to die of asthma. In addition, higher rates of asthma are found in urban and low-income population (Solomon 2003).

Impact of Unmanaged Asthma

Unmanaged asthma results in missed school days, increased hospitalizations, and even death. Asthma is the most common reason for missed school days in the United States. Each year, in the U.S. there are 14 million missed school days due to asthma. Among those under age 15, asthma is the third leading cause of hospitalization. Among those under 18, it is estimated that the annual cost of treating asthma is \$3.2 billion. Also it is concerning that asthma prevalence has been increasing. Asthma prevalence among children rose from 3.6% in 1980 to 6.2% in 1996 (CDC, 2005). In addition, there has been a dramatic rise in childhood deaths resulting from asthma. In 1979, there were 93 reported deaths from asthma in children. In 1996, this number increased to 266.¹ Currently, asthma rates in California among children are around 9%, which is the same in San Mateo County. In 2001, nearly 136,000 California students aged 12-17 missed one or more days of school per month. As a result, schools lost \$40.8 million (Vura-Weis, 2005).

There has been increasing attention on asthma in East Palo Alto (EPA). One out of six people in EPA have asthma (Mitchell, 2003). A recent study conducted in the Ravenswood School District

found that the prevalence of asthma among school children in the district is between 8.5% and 13% (Vura-Weis, 2005). The EPA community has deemed asthma to be of such concern that they have created the East Palo Alto asthma task force, which is a coalition of representatives from the school district, health centers, local government, and health agencies and organizations (Epidemiological Bulletin, 2003).

A cure for asthma has not yet been found, but minimizing contact with asthma triggers can control asthma (CDC, 2005). Research has been focused on two settings for asthma triggers: at home and at school. In this project we will be focusing solely on the school environment.

Schools and Asthma

Some studies have found a prevalence of asthma triggers in the schools, indicating that an assessment of schools may be appropriate. Tortolero et al. (2002) assessed the physical environment of libraries and 5-7 classrooms in each of the 60 elementary schools in Texas in 1997. Three hundred eighty-five rooms were assessed. Conditions that would encourage mold growth were found in 76.7% of schools. Mold and mildew was seen on or around 95% of the schools. Approximately 40% of the schools' halls and main entrances smelled of mold. In the classrooms, dust was seen in 78.4% of the heating and ventilation systems (HVAC). Art-supply irritants were spotted in 93% of the rooms. Cleaning supply irritants were spotted in 65% of the rooms. In addition, 80% of the rooms had dust on the furniture. On occasion (12.5%), mold was observed on the floor, walls, tiles, or ceilings. In addition, dust samples were collected for 80 rooms. Researchers detected dust mite allergen levels to be over the proposed action level in 20% of the rooms. Cockroach allergen levels were above the recommended level for 10% of the

classrooms. Mold spores counts were over the recommended level in over 50% of the classrooms. It was also noted that there was poor ventilation in the classrooms. Almost 90% of the classrooms had high levels of CO₂. Rust and mold were detected in some HVAC systems. While Tortolero et al.'s study was done in Texas, and the current study is to be done in California, the investigators' work demonstrates that schools can have moderate to high levels of certain asthma triggers (Tortolero, 2002).

Smedje et al. (2001) found an association between the presence of specific asthma triggers in the schools and asthma incidence. Smedje et al. surveyed 1,347 students in 39 public schools in Sweden. Questionnaires were mailed to students in 1993. In 1997, the same questionnaire was mailed again to those who completed the survey in 1993. The survey asked students about their lower respiratory symptoms, allergies, smoking habits, the family, and the domestic environment, and whether they have been diagnosed with asthma. The investigators found that children in schools with more settled dust and cat allergen in the dust had a greater incidence of asthma diagnosis than children in schools with less settled dust and less cat allergen in the dust. Greater concentrations of formaldehyde and total molds in the classroom area were also associated with increased asthma diagnosis in children without a history of childhood eczema and allergy to pollens and pet dander (Smedje, 2001).

Asthma Triggers and Asthma Symptoms

Murray and Ferguson (1983) found that asthma symptoms declined after asthma triggers were removed. Murray and Ferguson's study focused on the home environment. The investigators sought to determine if asthma symptoms in children with house dust mite allergies and asthma

would improve after one month of reducing the level of allergen present in the bedroom. There were two groups in the study. One group of 10 children received the treatment, while the other group did not. For the treatment group, the investigators encased box springs, mattresses, and pillows in allergen-impermeable covers. Every two weeks, blankets and mattress pads were also washed in hot water. In addition, carpet and upholstered furniture were removed from the bedroom. Compared to the control group, children in the treatment group had significantly reduced asthma symptom days and days requiring asthma medicine. Also, compared to the control group, airway hyper-responsiveness significantly declined (Murray and Ferguson, 1983). These are hopeful findings because they suggest that if triggers are identified, removing them--especially from the home environment--may significantly reduce asthma symptoms. These findings may be applicable to the school environment.

Interplay of Genes and the Environment

For many decades, there has been an ongoing debate about the effects of “nature versus nurture” on an individual’s life. This debate examines the relative impact of an individual’s genetic code versus environmental factors on the development and progression of a disease. Until recently, asthma has solely been considered a genetically linked disorder. Very few studies had shown the environmental effects on the onset of asthma, and therefore the chance of developing asthma was based primarily one’s genetic predisposition rather than on environmental triggers. An abundance of research points to an association between high rates of asthma and the presence of the following environmental factors: animal skin, hair, and feathers; cockroaches; cold and infections; dust and house mites; molds; pollen; smoke (tobacco and non-tobacco byproducts); strong odors and sprays; occupational dust and

vapors (from plastic, wood, and metals); air pollution; weather; and exercise (Asthma and Genetics 2005).

In order to fully comprehend the complex interplay between genetics and the environment in relation to the development of asthma, it is critical to delve into how each variable is found to function independently. Current ongoing studies point at a large impact of genes on the development of asthma. A study conducted in Arizona identified a strong correlation between genetics and the prevalence of asthma in its study population (Table I). Three hundred forty-four families participated in this study. As is clear in the results from this study, the probability of presenting with asthma is highly dependant upon the frequency of a genetic trait in the parents' genetic codes.

Table 1. Prevalence of asthma in parents versus offspring

| Presence of Asthma in Parents | Percentage of Offspring with Asthma |
|--------------------------------------|--|
| Neither parent has asthma | 6% |
| One parent has asthma | 20% |
| Both parents have asthma | 60% |

Twin studies have proven to be particularly useful in determining the role the environment plays in causing asthma. While fraternal twins do not have an identical genetic code, identical twins do. Observing the prevalence of asthma in these two populations allows for a well-defined understanding of the interplay between genes and the environment on the onset

of asthma. A 1995 twin study conducted by Sarafino and Goldfeder displays the roles genes and environmental factors concurrently play. This studied population consisted of 94 pairs of twins, 39 of which were identical and 55 were fraternal. All 94 pairs of twins had at least one individual presenting asthma. As seen in Table II, it was found that an identical twin whose sibling had asthma was more likely to be predisposed to the disease than in the case of a fraternal twin. At the same time, it is clear that genes are not the only factor playing a role. In 41% of the cases, only one identical twin developed asthma. If asthma was only a genetic disorder, identical twins who are born with the same genetic codes should theoretically have the same chances of developing asthma. Furthermore, if asthma were only an environmentally linked disorder, identical twins and fraternal twins would have the same likelihood of developing asthma since they are exposed to the same environmental conditions. In reality however, identical twins have more than double the probability of presenting with the respiratory disorder. From this evidence, it can therefore be understood that an individual may genetically inherit a tendency or predisposition to asthma, but developing the disorder may also require the participation of environmental triggers.

Table 2. Prevalence of asthma between identical twin pairs and fraternal twin pairs

| Type of Twin Pairs | Number of Pairs Examined in Study | Percentage of Pairs Where Both Twins had Asthma |
|---------------------------|--|--|
| Identical | 39 | 59% (23 of 39 pairs) |
| Fraternal | 55 | 24% (13 of 55 pairs) |

Genes and the environment may further influence asthma in a number of different ways. Atopy is the genetic predisposition to allergic reactions and asthma. Mark Ridley (2000) reports that researchers have linked specific genes on various different chromosomes, including 2, 5, 6, 12, and 13 with asthma susceptibility. Chromosomes 11, 14, and 16 may also contain asthma related genes. Ridley cautions, however, that different racial/ethnic groups may have different genes that are connected with asthma. Also, genes cannot entirely explain why some people develop asthma while others do not.

Gina Solomon (2003) reported that studies have found dramatic increases in the prevalence and severity of asthma. Since 1980, the number of people with asthma in the U.S. has increased by 42%. Asthma prevalence in children has experienced a 58% rise from 1980 to 1993. From 1980 to 1993, asthma deaths increased by 78%. Solomon contends that these increasing rates are not due to genetic changes since genetic changes occur over a longer time span. Furthermore, people without atopy or family histories of allergies or allergic disease are making up a larger portion of those with asthma.

Solomon reports that new investigations suggest that asthma can be caused by environmental factors. Pet dander, dust mites, secondhand smoke, cockroach feces, fungal contamination, viral infections, pollen, nitrogen oxides, particulate matter, and diesel exhaust are some of the environmental factors that have been associated with asthma. In children, prenatal and postnatal exposure to secondhand smoke appears to influence the development of asthma and increase the severity of asthma. In adults, asthma attacks increase in severity and frequency with exposure to secondhand smoke.

The immune system may be an important consideration in uncovering the reasons for the increases in asthma prevalence. It has been found that babies who are formula fed are more likely to develop asthma and allergies than babies who were breastfed. Breast milk contains immune-modulators that may make infants less prone to infectious disease and allergy. Also, it has been discovered that the ratio of type 1 T-helper cells to type 2 T-helper cells appears to influence the development of asthma symptoms. People with a predominant Th1-type are less likely to develop asthma symptoms compared to those with a predominant Th2-type.

Environmental factors during infancy and childhood may alter this ratio. Graham Rook and John Stanford contend that the increase in asthma may be mainly attributable to cleanliness. The two researchers argued that to have the correct balance of T-cells, the body must be exposed to small doses of germs throughout childhood. However, in modern affluent societies, antibacterial products are everywhere and the tapeworm that was once commonly infected humans is no longer a familiar threat (Ridley 2000).

Particularly relevant for Flood School are the studies that have found associations between heavy truck traffic and asthma. Pekkanen et al. (1997) found that the distance between children's schools and major roads is associated with asthma. As the distance of the schools to truck traffic shortens, the severity of the children's asthmatic symptoms increases. Flood school has the highest rate of asthma in the district, and only a tall wall separates the school from the 101 freeway.

Returning to Solomon's study, she concludes by stating that environmental factors and genes are both important contributors to explaining asthma, and there may be in fact interaction effects.

Environmental exposures that occur prenatally and during infancy may affect one's chances of developing asthma later in life. In addition, environmental factors have been linked to the cause or exacerbation of asthma.

Peat (1996) reviews the current literature on environmental factors of asthma. The investigator states that environmental factors are most likely the cause of the increase in the prevalence of asthma in affluent countries. It is estimated that 80-90% of people with asthma are sensitized to one or more common allergens. Peat concludes that house dust mites are the most important documented risk factor for asthmatic symptoms. Studies have found that severity of asthma is influenced by house dust mite exposures. In these studies, peak flow variability, risk of admission to hospital, and medication requirements were measures of asthma severity. Peat et al. (1996) found that when levels of *Dermatophagoides pteronyssinus* antigen 1 (Der p 1), one of the major allergens of the house dust mite, doubles, the risk of children having current asthma doubles as well. In the United Kingdom, researchers found that for every twofold increase of Der p1 levels, there is a one fold increase in airway hyper-responsiveness (AHR). There are certain factors that influence the level of dust mites. These factors include air exchange rate, indoor humidity, outdoor humidity, the amount of furnishings, and the frequency with which furnishings are washed. The investigator stressed the importance of reducing the level of dust mites in the bed as children are in very close proximity to the allergens for a substantial amount of time. Similarly, it is important for toys, curtains, and soft furnishings to be frequently washed. From the literature, it is gathered that both environmental, genetic, and the interplay of the two influence the development and exacerbation of asthma.