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On growth and development: Housing environment impacts on children's development and its relevance in interior design solutions

Karyn McKey-Paz

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On Growth and Development:
Housing Environment Impacts on Children’s Development and Its Relevance in Interior Design Solutions
by
Karyn McKey-Paz
Thesis
Submitted to the College of Technology
Eastern Michigan University
In partial fulfillment of the requirements
for the degree of

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in
Interior Design

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Abstract

The role of housing quality and housing location in children’s development are of great importance, as these issues may affect their outcomes later in life. Housing and neighborhood conditions include but are not limited to housing costs, residential layout, and neighborhood surroundings. These characteristics could determine whether or not the physical condition of the house is healthy and safe, and if the neighborhood in which the house is located is free from danger, all of which have an effect on their development.

This research paper goes into a detailed examination of how the characteristics of children’s home and neighborhood conditions and environments affect their physical health, social-emotional well-being, and cognitive development with an emphasis on those children who live in low-income housing and communities. From there, it offers strategies and solutions that interior designers and even parents can use while designing environments for children. It also discusses programs wherein parents can become involved in order to help make their communities a safe and stimulating area for their children to grow up in.
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<th>Acronym</th>
<th>Definition</th>
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<tr>
<td>ASHRAE</td>
<td>American Society of Heating, Refrigeration, and Air-Conditioning Engineers</td>
</tr>
<tr>
<td>AAFA</td>
<td>Asthma and Allergy Foundation of America</td>
</tr>
<tr>
<td>ADHD</td>
<td>Attention Deficit Hyperactivity Disorder</td>
</tr>
<tr>
<td>BC</td>
<td>Black Carbon</td>
</tr>
<tr>
<td>CO</td>
<td>Carbon Monoxide</td>
</tr>
<tr>
<td>CRI</td>
<td>Carpet and Rug Institute</td>
</tr>
<tr>
<td>CDC</td>
<td>Center for Disease Control and Prevention</td>
</tr>
<tr>
<td>CAA</td>
<td>Clean Air Act</td>
</tr>
<tr>
<td>dB</td>
<td>Decibel</td>
</tr>
<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
</tr>
<tr>
<td>ETS</td>
<td>Environmental Tobacco Smoke</td>
</tr>
<tr>
<td>HFFI</td>
<td>Healthy Food Financing Initiative</td>
</tr>
<tr>
<td>HHI</td>
<td>Healthy Homes Initiative</td>
</tr>
<tr>
<td>HVAC</td>
<td>Heating, Ventilating, and Air-Conditioning</td>
</tr>
<tr>
<td>HEPA</td>
<td>High-Efficiency Particulate Air</td>
</tr>
<tr>
<td>IAQ</td>
<td>Indoor Air Quality</td>
</tr>
<tr>
<td>IEQ</td>
<td>Indoor Environmental Quality</td>
</tr>
<tr>
<td>IPM</td>
<td>Integrated Pest Management</td>
</tr>
<tr>
<td>LEED</td>
<td>Leadership in Energy and Environmental Design</td>
</tr>
<tr>
<td>MDF</td>
<td>Medium Density Fiberboard</td>
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<tr>
<td>Abbreviation</td>
<td>Description</td>
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<td>-------------------------------------------------------</td>
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<tr>
<td>MERV</td>
<td>Minimum Efficiency Reporting Value</td>
</tr>
<tr>
<td>MDHA</td>
<td>Minnesota Department of Health and Asthma Program</td>
</tr>
<tr>
<td>NAS</td>
<td>National Academy of Sciences</td>
</tr>
<tr>
<td>NCHS</td>
<td>National Center for Health Statistics</td>
</tr>
<tr>
<td>NCHH</td>
<td>National Center for Healthy Housing</td>
</tr>
<tr>
<td>NRPA</td>
<td>National Recreation and Parks Association</td>
</tr>
<tr>
<td>PHS</td>
<td>Pediatric Home Service</td>
</tr>
<tr>
<td>PFC</td>
<td>Perflourated Compounds</td>
</tr>
<tr>
<td>PFC</td>
<td>Phenol Formaldehyde</td>
</tr>
<tr>
<td>PBDE</td>
<td>Polybromated Diphenlys Ethers</td>
</tr>
<tr>
<td>PCB</td>
<td>Polychlorinated Biphenyl</td>
</tr>
<tr>
<td>PVC</td>
<td>Polyvinyl Chloride</td>
</tr>
<tr>
<td>RETA</td>
<td>Reduced Environmental Triggers of Asthma</td>
</tr>
<tr>
<td>SAD</td>
<td>Seasonal Affective Disorder</td>
</tr>
<tr>
<td>HUD</td>
<td>U.S. Department of Housing and Urban Development</td>
</tr>
<tr>
<td>UFB</td>
<td>Ultrafine Particulates</td>
</tr>
<tr>
<td>VOC</td>
<td>Volatile Organic Compound</td>
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<td>WHO</td>
<td>World Health Organization</td>
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Introduction

The criterion for a healthy human social environment for children is well known and discussed in many books and magazines for parents. These types of references often preach that children need love and attention from parents or guardians in order to attain healthy psychological, social, and bodily development, even the development of the brain and nerves. In fact, without the love of an adult, children’s brain development can be up to 30 percent less than those who grow up enveloped in it (Day, 2007). What about the physical environment? This also affects brain development. According to Day (2007), the brain learns from environmental experiences how it “needs” to develop. The physical environment also has an influence on other physical developmental factors, as well as cognitive development and socio-emotional development.

It is clear that children’s well-being and development don’t depend only on their interactions with their parents or guardians. What can be more essential to a child’s environment than his or her own home: The place where they eat, sleep, and play every day? The conditions of the home in which they live can affect every child’s development, regardless of where the home is. (Vandivere et al., 2006).

However, children who come from poor or low-income families tend to fare worse in growth and development than those who do not (Vandivere et al., 2006). These families are more likely to experience problematic housing circumstances, such as the physical quality of the home, due to their financial limitations.

This paper explores various ways children’s home environments can affect three primary areas of their well-being, which include physical development, socio-emotional development, and cognitive development. Factors of housing that can affect children’s
development and well-being, both positive and negative, include physical quality of the home, housing costs, and neighborhood characteristics.

Each of the three areas of development—physical, socio-emotional, and cognitive—are equally important, as success in these areas is necessary to say that a child is “faring well” (Vandivere et al., 2006).

The physical development of a child provides him or her with the abilities he or she needs to explore and interact with the world (Brotherson, 2006). This is crucial for the first five years of their lives as they are beginning to explore what’s around them. In order to develop and maintain these abilities, a child should be free of disease and illness, safe from accidents and injuries, and have adequate sleep, nutrition, and exercise.

The socio-emotional or well-being development of a child gives him or her the capacity to experience, regulate, and express emotions, form close and secure relationships, explore the environment, and learn (mich.gov, 2003).

Cognitive development is the construction of thought processes, including remembering, problem-solving, and decision-making. The cognitive development of a child provides him or her with the ability to learn and solve problems, make good decisions, and acquire essential literacy, mathematical, and technological skills (Vandivere et al., 2006). Further exploration into these forms of development will be discussed in the following chapters.

Research shows that the physical environment does in fact influence children’s development, yet there is limited research and concern for the impact of residential environments on children’s development.
Chapter One:

Housing in Relation to Children’s Physical Development

A child’s physical health depends on the characteristics of the home in which he or she lives. In fact, housing and health go hand in hand as they are two of our basic needs for individual and collective identity, privacy, social progress, and survival (Vandivere et al., 2006; Baeder and Jacobs, 2009). It is a fact that improved housing means improved health, and has been accepted for well over a century, with improved sanitation in the form of indoor plumbing, separation of housing from industrial emissions through zoning, and improvements in housing durability. These improvements all demonstrated health gains by eliminating or controlling cholera, typhoid, tuberculosis, injuries, and other diseases and conditions (Baeder and Jacobs, 2009). These gains were among the first efforts to regulate housing quality. However, according to the National Center for Healthy Housing (NCHH), today, housing and health are both in a state of crisis, particularly those families with limited means.

Figure 1.1 shows a brief overview of housing factors that affect children’s physical health. Chronic afflictions such as asthma, cancer, lead poisoning, accidents, injuries, and mental health disorders, and the link between housing and health have been gaining attention and receiving further investigation (Baeder and Jacobs, 2009), as these adversities have been costing the United States $54.9 billion annually (Breysse et al., 2004). Factors that can lead to such diseases include structural conditions relating to building quality and maintenance, safety hazards, functional systems such as ventilation, smoke alarms, heating/cooling and plumbing, or environmental toxins including lead, asbestos, and neurotoxins.
Indoor air quality is affected by outdoor pollution naturally, but in recent years, scientists have been concerned about indoor air pollution that is attributable to interior materials and substances (Winchip, 2007). Research shows that some interior environments have a greater level of pollution than the outdoor environment. Because children spend 80 to 90 percent of their time indoors (U.S. Environmental Protection Agency, 2002), the possible origins of the many long-term health risks they face can be traced to indoor environments, particularly the home environment, which represents an important source of fetal and early childhood exposures to biologic and chemical agents, as well as a strategic opportunity for intervention (Krieger and Higgins, 2002).
Figure 1.1 Housing Factors that Affect Children’s Physical Health
1.1 Indoor Biologic Pollutants

Biologic pollutants are living organisms that can travel through the air and promote poor indoor air quality. Pollutants related to housing structure include allergens from cockroaches, rodents, dust mites, fungi, and mold. These agents are all favorable to an environment with excess moisture possible from structural and plumbing deficiencies. Other biologic pollutants include respiratory irritants such as environmental tobacco smoke (ETS), cleaning agents, fungal cell wall components, and volatile organic compounds (VOC’s). The national academy of sciences (NAS; 2000) analyzed the current knowledge of the association between exposure to these biologic pollutants in the home and the development and exacerbation of asthma.

Other diseases and symptoms caused by these indoor exposures include allergies, infection, hypersensitivity, pneumonitis, inhalation fevers, mucosal irritation, central nervous system effects, psychological effects (including depression), dermatitis, and even some forms of cancer (Baeder and Jacobs, 2009; Wu and Takaro, 2007).

1.2 Indoor Chemical Pollutants

Chemicals that “off-gas,” or release toxic agents, are among the top contributors to indoor air pollution. The most significant neurotoxins found in residential settings are lead, household pesticides, cigarette smoke, carbon monoxide, nitrogen dioxide, asbestos, formaldehyde, VOC’s, and radon (Baeder and Jacobs, 2009; Breyesse et al., 2004; Winchip, 2007) and have been associated with developmental disorders, asthma and other respiratory illnesses, and cancer (U.S. Environmental Protection Agency, 2010; American Cancer Society, 2011). Exposure to high levels of substances like carbon
monoxide has been associated with fatalities (Baeder and Jacobs, 2009). Structural deficiencies, gas stoves, and introduction of source materials that off-gas are all housing factors that can increase the presence of chemical agents in or around a dwelling (Baeder and Jacobs, 2009).

1.3 Lead

Lead is a natural occurring, highly toxic metal found in the Earth’s crust. Because of human activities such as mining, manufacturing, and burning fossil fuels, lead can be found pretty much everywhere. Since lead is abundant and inexpensive, it was used in a variety of household products and materials for many years.

Lead has been recognized as a poison for thousands of years, from as early as ancient Greek times, but the profound impact that chronic exposure to even low levels of lead can have on developing children wasn’t recognized in the United States until the 1970s (Godwin, 2009; Sharfstein and Sandel, 1998).

Lead damages many parts of the human body, and sudden poisoning can cause constipation, fatigue, anemia, nerve damage, and altered brain function, which can lead to coma, seizures, and even death (Godwin, 2009; Sharfstein and Sandel, 1998), although childhood deaths from lead poisoning are extremely rare today. Long-term exposure to lead can harm the blood, brain, kidneys, and reproductive organs. The main concern in children is the long-term effects of lead on the developing brain. Children under the age of six are especially vulnerable as their brains and central nervous systems are still developing, and lead can interfere with this process (Vandivere et al., 2006). According to the Center for Disease Control and Prevention (CDC), about 250,000 children in the
United States ages one to five years have blood lead levels greater than 10mg of lead per deciliter of blood. Children who are at a high risk for lead poisoning include those in poor families, living in inexpensive housing or in rented or older homes (Kim et al., 2002).

1.4 Construction/Building Deficiencies

Injuries are by far the leading cause of death for children in the United States after the first year of life (Nagaraja et al., 2005). In 2003, one third of all injury-related deaths resulted from residential injuries (National Safety Council, 2003). For infants, children, and young adults 0-19 years old, at least fifty-five percent of unintentional deaths (excluding motor vehicle accidents) occur in the home (Nagaraja et al., 2005). The majority of unintentional residential injuries, however, do not result in death. For every residential injury death, there are about 650 non-fatal injuries (Home Safety Council, 2011).

Structural flaws in housing are crucial causes of fatal and non-fatal injuries and envelope factors related to construction, design, installation, and lack of maintenance efforts.

Faulty construction or neglected maintenance is the primary cause of structural hazards in homes (Cummins, 2001). Faulty construction leads to building defects that increase the likelihood of structural hazards and fires, which in turn increase the risk of falls, burns, scalds, poisoning, drowning, and other injuries (Cummins, 2001; Baeder and Jacobs, 2009). Children of low-income families are more likely to be exposed to
structural dangers in the home, particularly because they live in low-income rental properties that often endure neglect and poor maintenance.

1.5 Neighborhood and Health

Living in extreme-poverty neighborhoods can have a detrimental effect on health outcomes such as mortality and children’s physical behaviors, due to the conditions they endure. Such conditions include lack of access to quality medical care, high-crime rates, and access to drugs. Neighborhoods with high poverty rates also have strong implications for employment prospects for parents, children’s educational outcome, safety, and access to supermarkets, healthy restaurants, and parks (Vandivere et al., 2006; Baeder and Jacobs, 2009). Limited employment prospects and a lack of neighborhood resources can have cascading effects into major issues of concern, such as homelessness and rising rates of obesity in U.S. children. Children who experience housing and instability or homelessness have a twenty-five percent greater risk of poor health in adulthood and experience in mortality (Baeder and Jacobs, 2009).

1.6 Housing Location and Outdoor Air Pollution

Air pollution is typically due to a variety of different pollutants coming from factories, power plants, transportation, and wildfires. Although many air pollutants occur naturally, such as volcanic eruptions, forest fires, and dust storms, the majority of air pollutants are caused by humans. The major categories of air pollution produced by humans are air toxics, carbon oxides, hydrocarbons, nitrogen oxides, ozone particulate
matter, and sulfur oxides (Winchip, 2007). In general, these contaminants can cause a variety of health problems such as eye irritation, chronic bronchitis, heart disease, asthma, and respiratory infections. Some contaminants can even cause cancer, birth defects, and death (Winchip, 2007). Studies demonstrate that children are more susceptible to air pollution than adults, partly because they spend more time outdoors, and they are still in developmental stages (Hill and Keating, 2002). Children may be exposed to various mixtures of these contaminants depending on their proximities to the sources.

1.7 Non-Auditory Effects of Noise

People often associate sound with noise, or vice versa; however, there are distinct differences between the two. Sound is defined as a mechanic vibration propagated by elastic media, which alters the pressure, displaces the particles, and can be recognized by a person or an instrument (World Health Organization, 2009). Noise, on the other hand, is an unwanted or objectionable sound. Usually, acoustic signals that produce a pleasurable sense, like rainfall or music, are recognized as “sound,” and unpleasant sounds as “noise,” such as noise from nearby vehicular traffic. Sound and noise can be an environmental stressor and often differentiates between individuals. For instance, one person’s music is another person’s noise (World Health Organization, 2009).

Noise is measured in units known as decibels (dB). Noise levels can range anywhere from 1 dB, such as light breathing, to 70 dB, like highway traffic, to 150 dB, such as a jet engine. Most people know that exposure to loud noise over a long period of
time could result in hearing loss (about 85 dB or higher), but non-auditory effects of chronic noise exposure, particularly in children, often gets little attention.

Noise from transportation is an increasingly prominent feature of the urban environment (Clark and Stansfeld, 2007). Research has demonstrated that transportation noise can have a moderate effect on physical health such as hypertension and cardiovascular disease. One way noise may affect health is through annoyance. Noise causes annoyance responses in both children and adults, and annoyance may cause stress-responses and subsequent illnesses such as respiratory symptoms, migraine, and bronchitis (Brugge et al., 2007; Niemann and Maschke, 2004, Baeder and Jacobs, 2004). Evans and Lepore (1993) examined the empirical evidence on the non-auditory effects of noise on children and organized it into three areas of functioning: physiological, emotional/motivation, and cognitive. The emotional/motivation and cognitive effects of noise will be discussed in another chapter.

**Physiological Effects of Noise**

Very little research has been done on noise and its effects on the physical development of children. Noise has been implicated in the development or exacerbation of a variety of health problems, ranging from hypertension to elevated blood pressure. In their examination, Evans and Lepore found that several previous studies did uncover possible links between chronic noise exposure and elevated blood pressure.

Although the studies were done on children at school, the same outcomes can affect children who live in a home near one or all of these noise sources.

In their examination, Evans and Lepore concluded that:
“Residing or attending school near a major noise source is associated with elevated blood pressure. More research is clearly called for, especially tracking children before, during, and after exposure to noisy environments. . .” (Evans, 1993)
Chapter Two:

Housing in Relation to Children’s Social-Emotional/Cognitive Development

Some of the same features of housing that affect children’s physical health also affect their social-emotional and cognitive development, as seen in Figure 2.1. These two topics will be discussed together because many housing effects go hand in hand.

Social-emotional development in children is a combination of social development and emotional development. It refers to a child’s capability for self-confidence, trust, and empathy, and the ability to develop competencies in language usage. A child’s social-emotional health is affected by a range of different factors including biology, relationships, and environment. Biology involves the temperament of a young child and other genetic influences. Relationships formed with primary caregivers, family members, and others, influence a child’s social-emotional development. Environmental toxins, abuse, poverty, and community violence are all environmental factors that affect children’s social-emotional development (Waltz, n.d).

Cognition refers to the scientific term for “process of thought.” How we attain knowledge, how we store knowledge, and how we modify knowledge, are all processes that concern cognitive psychologists (Pick, n.d.). Jean Piaget (1896-1980), a developmental psychologist known for his epistemological studies with children, described children as active and motivated learners who construct an increasingly complex understanding of the world around them through numerous interactions with their physical and social environments (McDivitt and Ormond, 2006). Piaget’s theory is based on a series of stages, whereby each stage develops the child’s abilities further and
further, eventually reaching the adult-like mind. Table 2.1 describes each stage of Piaget’s theory.

Table 2.1

*Piaget’s Four Stages of Cognitive Development*

<table>
<thead>
<tr>
<th>Age (Yr)</th>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>Sensorimotor</td>
<td>The infant progresses from reflexive, instinctual action at birth to the beginning of symbolic thought. The infant constructs an understanding of the world by coordinating sensory experiences with physical actions.</td>
</tr>
<tr>
<td>2 to 7</td>
<td>Preoperational</td>
<td>The child begins to represent the world with words and images, which reflect increased symbolic thinking and go beyond the connection of sensory information and physical action.</td>
</tr>
<tr>
<td>7 to 11</td>
<td>Concrete Operational</td>
<td>The child can think logically about concrete events and classify objects into different sets.</td>
</tr>
<tr>
<td>11 to 15</td>
<td>Formal Operational</td>
<td>The adolescent reasons abstractly and logically. Thought is more idealistic.</td>
</tr>
</tbody>
</table>

Table adapted from: Santrock, Child Development, BE.

However, Piaget’s theory drew a lot of criticism from other developmental psychologists for several reasons, including his failure to contribute cultural influences on cognitive development. Russian psychologist Lev Vygotsky (1896-1934) believed that the development of human beings is far too complex to be defined by such stages as Piaget’s. Instead, he believed that cognitive development occurs as a result of social interactions; in other words, children’s cognitive development is affected by their knowledge of their social community stimulated by adults passing along the meanings
that their culture assigns to objects and events and by helping children with challenging
tasks (McDivitt and Ormond, 2006).

Regardless of whose theory is more accurate, because child development is a
rather difficult area to study, one can be certain that the cognitive process starts as early
as infancy and continues throughout childhood and adolescence (Pick, n.d).

A child’s housing environment is crucial to their cognitive development and
social-emotional development. It needs to provide a motivational, engaging, safe and
clean place for children to explore and understand their surroundings. Physical qualities
of housing that affect these two areas of development include structural quality, hazards,
privacy, and children’s resources.
Figure 2.1 Housing in Relation to Children’s Social-Emotional And Cognitive Development
2.1 Neurotoxins and Behavior Problems

We are living in a land of chemicals. In fact, in the last half-century, more than 85,000 industrial chemicals have been registered in the United States, with many of them finding their way into our environment and even our bodies (Orzech, 2007).

A neurotoxin is any compound coming from an exogenous source, such as the environment that affects the neurological development. Research is ongoing concerning the association between neurotoxins and behavioral problems and learning disabilities. Because they are small and still developing, children are the most vulnerable to the harmful effects these toxic chemicals pose. They also can be affected before birth if the mother is exposed to excessive levels of toxins. The neurotoxins in the housing environment will impact children’s cognitive development, which often leads to behavioral problems including Autism and Attention Deficit/Hyperactivity Disorder and ends up being a social cost to society and the healthcare system.

- **Autism**

  Autism is a developmental disorder that impairs non-verbal and verbal communication and reciprocal social interactions. A recent study by researchers at the University of California Medical Investigation of Neurodevelopmental Disorders has linked increasing rates of autism with fetal and infant exposure to pesticides and household chemicals.

- **Attention Deficit/Hyperactivity Disorder (ADHD)**

  ADHD is one of the most common neurodevelopmental disorders in childhood, affecting 5.4 million school-age children (CDC, 2003), and data suggest that the prevalence is increasing at an alarming rate. It is usually diagnosed in childhood and lasts
into adulthood (CDC, 2010). Children with ADHD have trouble paying attention, get easily distracted from schoolwork or play, may forget things, and may be overly active. Though it is unclear what mechanisms lead to the development of ADHD, environmental and genetic factors have been linked to this disease (Hoffman et al., 2010).

Certain toxins in the environment are known or suspected to cause a variety of developmental disorders, including autism and attention deficit disorder, which affect three to eight percent of four million children born each year in the United States (Landrigan and Garg, 2002). Though most of the toxicants, such as methyl-mercury, and certain pesticides are found scarcely in several water sources and some of our food, some toxins such as lead, polychlorinated biphenyls, perflourated compounds, and polybrominated diphenyls ethers are found in common household materials and products.

2.2 Obesity/Overweight

As troubling as obesity is on a child’s physical health, it also has a profound effect on his or her social and emotional well-being. Obesity during childhood and adolescence can cause psychological and social problems and may predispose young people to obesity and its health consequences as adults (Dietz, 1998). The most widespread consequences of childhood obesity are psychosocial since obese children become targets of early and systematic discrimination (Dietz, 1998). Research shows that children as young as six years old often associate obesity with negative characteristics, such as laziness and sloppiness, and develop negative attitudes about their overweight peers, often excluding them from play (Dietz, 1998).
Although younger children who are overweight do not have a negative self-image or low self-esteem, when they become adolescents they may develop these issues from the psychological stress of social stigma which, in turn, can hinder academic and social functioning that will likely persist into adulthood (Center for Disease Control and Prevention, 2010; Dietz, 1998). Other social-emotional issues related to childhood obesity include depression, low self-concept and bullying, social struggles with peers, risk of eating disorders, and emotional eating (Begley, 2008).

2.3 Housing/Neighborhood Quality and Location

Housing quality and type and the neighborhoods in which housing are located have also been investigated in relation to children’s social-emotional development (Kopko, nd). For instance, families living in high-rise apartments or condos have fewer relationships with neighbors than those who live in single-family residences, resulting in less social support for parents and restricted play opportunities for children (Evans, 2006; 2003).

In many high-rise buildings, particularly for low-income families, not enough resources are allocated to spaces that allow the development and maintenance of social networks (Evans, 2003). Lobbies, lounges, and other small-group spaces are non-existent or located too far from residences or are in public areas that produce insufficient residential control and feelings of ownership (Evans, 2003).

Neighborhood characteristics such as quality of municipal services, retail services, recreational opportunities including natural settings, street traffic, accessibility of transportation, and the quality of educational and health facilities have a significant
influence on children’s social-emotional development. Evans’s (2006) research findings support the beneficial effects on children’s exposure to natural settings. Natural settings are favored by children and allow them to practice gross motor abilities as well as engage in social interactions (Evans, 2006). They also lessen the detrimental effects of children’s exposure to chronic stress (Evans, 2006).

2.4 Noise

Many people associate noise and its affects as causing damage to the ear canal; however, noise has non-auditory effects as discussed in Chapter One. As mentioned previously, Evans and Lepore (1993) examined the empirical evidence on the non-auditory effects of noise on children and organized it into three areas of functioning: physiological, emotional/motivation, and cognitive. The physiological effects were discussed in Chapter One.

Most research on non-auditory effects of noise on children has focused on the cognitive area of a child’s development. Evans and Lepore have subdivided the areas of cognitive development into three subtopics: 1) Attention and Perception; 2) Memory; and 3) Intellectual Achievement.

**Attention and Perception.** Attention deficits may occur in children who are exposed to chronic noise (Evans and Lepore, 1993). Studies on the cognitive effects on children exposed to noise reveal deficits in standardized measures of sustained attention and possible decrements in visual attention. Evans and Lepore found that teachers reported that children in noisy schools tend to have more difficulty concentrating than children from quieter schools (Crook and Langdon, 1974; Ko, 1979; Kryter, 1985; Kyzar, 1977).
This can also be correlated with children in noisy homes who are trying to study or do homework. According to Hefts (1979) study, children from noisy homes took longer to locate target pictorial stimuli within an array of pictures than children from quieter homes did (Evans and Lepore, 1993).

Children living within these conditions develop cognitive strategies to deal with the distracting influence of noise and learn how to ignore or tune out auditory stimuli. Although children from residential areas who are exposed to chronic noise appear to be more resistant to acute auditory distractors, since they are able to ignore them, they still may suffer from deficits in auditory discrimination. Auditory discrimination refers to the brain’s ability to organize and make sense of language sounds.

**Memory.** There appears to be little or no effects of noise on simple memory. This holds true for both chronic and acute exposure to noise. However, if the memory task requires special attention, there can be some negative effects of noise because if the child has to pay particular attention because of the difficulty of the task, noise may interfere with the memory task.

**Intellectual achievement.** Numerous studies have revealed links between noise exposure and reading deficits among elementary-age school children. “It is important to note the onset that unlike chronic effects of noise on cognition, studies of reading and achievement confound chronic and acute noise exposure since they all have relied upon archival records of achievement tests” (Evans and Lepore, 1993). Evans and Lepore reviewed several studies on acute noise exposure on the intellectual achievement that found few negative effects; therefore, [due to later studies on the effects of chronic noise exposure], it is safe to say that community noise and achievement findings are probably
caused by chronic exposure and not acute exposure (Evans and Lepore, 1993). In their findings, Evans and Lepore stated that the noise exposure impacts in the homes of infants and toddlers and revealed evidence that noise can indeed interfere with normal cognitive development. Another study revealed that the same home noise levels can affect reading abilities in elementary-aged school children.

2.5 The Importance of Play

The importance of play isn’t usually accepted as a necessity to life because it is most commonly referred to as the “opposite of work” and “doesn’t involve learning” (Klein et al., 2004). But play is vital to optimal child development and has been recognized by United Nations High Commission for Human Rights as a right of every child and specifically states in Article 7, paragraph 3 that:

The child shall have full opportunity for play and recreation which should be directed to the same purposes as education; society and the public authorities shall endeavor to promote the enjoyment of this right; (UN General Assembly, 1959).  

While this birthright is given to every child born in this world, it is often challenged by forces such as neighborhood violence and limited resources available to children living in poverty (Ginsburg, 2007).

Childhood play is crucial for social-emotional and cognitive development, and without this essential mechanism for development, children may grow into anxious, socially unstable adults.
An article published by Scientific American Mind (2009) addressed the future of children who do not play as young kids. Psychiatrist Stewart Brown, who interviewed the infamous Charles Whitman, who in 1966 went on a shooting rampage at the University of Texas Austin, killing fourteen people and injuring dozens others, interviewed twenty-six other convicted Texas murderers and found that they all had two things in common: they came from abusive families and they never played as kids. Not all children who are deprived from playing as a child will grow up to be a murderer, but there is a reason for concern with this matter as many children are growing up without play opportunities because their housing environments lack adequate space and safe atmospheres.

2.6 Overcrowding

Residential crowding has long been identified as an important housing problem. Most studies in the United States define overcrowding as more than one person per room (excluding bathrooms), meaning that a maximum of five people could live in a home with only two bedrooms, a kitchen, a living room, and a dining room without it being overcrowded (Brennan, 2011). However, with no additional space for children to play, have alone time, and to study and do their homework, crowding can have detrimental effects. Chapter three further explains the effects overcrowding can have on child development.
Chapter Three:
Research Design and Methodology

For this analytical descriptive study, data on the effects the home environment has on children’s development were collected from books, journals, and online sources. The data were then analyzed and organized into categories of child development. Figure 3.1 shows a detailed diagram of the key housing factors that affect all areas of a child’s development.

Figure 3.1 Research and Methodology
3.1 Physical Development and Housing

The national academy of sciences defines asthma as:

A chronic disease of the airways characterized by an inflammatory response involving many cell types. Both genetic and environmental factors appear to play important roles in the initiation and continuation of the inflammation. Although the inflammatory response may vary from one patient to another, the symptoms are often episodic and usually include wheezing, breathlessness, chest tightness, and coughing. Symptoms may occur anytime of the day but are more commonly seen at night. These symptoms are associated with widespread airflow obstruction that is at least partially reversible with pharmacologic agents or time (NAS, 2000, p. 23).

**Asthma.** Asthma is the most common long-term disease among children (Center for Disease Control and Prevention, 2009). It occurs in approximately 7.1 million children in the United States (National Center for Health Statistics (NCHS), 2009). Evidence indicates that children exposed to indoor air contaminates in the first years of their lives have a higher probability of developing asthma (Wu et al., 2007). Although asthma often resolves itself as the child grows up, the disease is known to reoccur in adulthood. Half of all children with asthma will have abnormal lung function later in life.

The NAS (2000) evaluated strength of the scientific evidence concerning the possible associations between biologic agents and the prevalence and severity of asthma. Although some agents have little evidence regarding the exacerbation of asthma, each agent should be mentioned as they might pose slight risks.
3.2 Indoor Biologic Exposures

Biological air pollutants are found in almost every home. Sources include human occupants who bring viruses or bacteria from outside of the home, arthropods that shed allergens and indoor surfaces near water where fungi and bacteria can grow. Each following section begins with providing general information of an agent associated with biologic exposures and a summary of factors that influence exposure.

**House dust mites.** Dust mites can be found primarily in mattresses, pillows, bedding, carpeting, and upholstered furniture. They are very small in size, about 250 to 300 microns in length, and are not visible to the naked eye (Lyon, 2000). Since they absorb water from air, they require a relative humidity of 50% to survive. A recent national survey found that over 80% of U.S. households have detectable levels of house dust mite allergens in the bedroom (Arbes Jr. et al., 2003) (Baeder and Jacobs, 2009).

The NAS found sufficient evidence of a causal relationship between dust mite allergen exposure and the development of asthma in children. There is evidence that decreasing exposure can help control allergy symptoms of a patient. Dust control is a recommendation for reducing dust mites in the home. To do this, one must reduce the concentration of dust borne allergens in the living environment by controlling allergen production and the dust which to transports it (Lyon, 2000).

**Fungi/mold.** Out of 1,000,000 species of fungi, people are routinely exposed to 200 different variations (NAS, 2000). Fungi have many disease agents including allergens, toxins, irritants, and sometimes infectious diseases. Fungal growth occurs in the presence of moisture and originates in indoor environments from two sources, including infiltrating from outdoors, and colonization on the interior of the home (NAS,
Building materials such as wallboard and insulation materials, carpets, and furniture, are all active fungal sources when they contain moisture. They can also grow in poorly maintained water-based appliances such as humidifiers and vaporizers, through which the fungi would be released into the air. Many studies suggest that exposure to fungi plays a role in asthma, and the fraction of current asthma cases attributable to fungi exposure in housing is estimated to be 21% (Mudarri and Fisk 2007; Baeder and Jacobs, 2009). Although there is insufficient evidence to determine if there is an association between fungal exposure and the development of asthma, exposure to fungi is associated with the exacerbation of asthma-related symptoms in sensitized individuals (NAS, 2000; Baeder and Jacobs, 2009).

The Environmental Protection Agency (EPA) (2009) recommends controlling moisture sources in the home by fixing plumbing leaks as soon as possible and safely cleaning and/or removing contaminated items immediately.

**Cockroach.** The cockroach is a major source of indoor allergens. The cockroach allergen is believed to derive from feces, saliva, and the bodies of the insect (Asthma and Allergy Foundation of America (AAFA), 2005). Studies reveal that 78% to 98% of urban homes have cockroaches, with each home having 900 to 330,000 of these pests (AAFA, 2005). Heavy infestations may create piles of allergens in carpets, beds, and around appliances and furniture, and are often hard to get rid of. Humidity in the home is an important factor of infestations, although cockroaches can live in any environment from tropical areas to the coldest places on earth (NAS, 2000; AAFA, 2005). The AAFA suggests calling pest control experts to rid the home of infestations.
Rodents. Rodent allergen exposure has been linked to allergies and asthma (NAS, 2000). Allergens from rodents are primarily found in urine, which becomes dried up and airborne on dust particles for a long period of time (NAS, 2000; Baeder and Jacobs, 2009). Many inner-city children are exposed to rodent allergens since they are common in low-income, inner-city apartments.

Research shows that controlling environmental asthma triggers such as allergens and air pollutants can drastically reduce childhood asthma. For example, The Minnesota Department of Health and Asthma Program (MDHA) partnered up with Pediatric Home Service (PHS) to conduct a demonstration project called Reducing Environmental Triggers of Asthma (RETA), in homes of children with asthma. The study addressed environmental factors in the home using inexpensive and rather simple interventions with the most common interventions being High-Efficiency Particulate Air (HEPA) cleaners, pillow and mattress dust encasements, and HEPA vacuum cleaners. Several outcomes demonstrated significant outcomes overtime with reported declines in unscheduled office and hospital visits, a decline in missed school days, and improvements in daytime symptoms and functional limitations (MDH, 2007).

Educating parents and even landlords about indoor biological pollutants should be the first step in combatting asthma and other diseases influenced by the indoor air. Checklists regarding common agents, along with preventative measures and simple interventions could be a tool that is given to parents upon move-in time by landlords, real estate agents, and even designers.
3.3 Indoor Chemical Exposures

Chemicals are emitted by a wide array of products used indoors; from building materials and furnishings to household products and equipment. According to the EPA, concentrations of many VOC’s are up to 10% higher indoors than outdoors (EPA, 2011). General information describes specific agents in this section followed by factors that influence chemical exposure.

**Lead.** Chapter one explained lead and its detrimental effects on children’s health. Housing conditions are the most frequent cause of childhood lead poisoning (Sharfstein, M.D. and Sandel, M.D., 1998). A wide range of studies have consistently demonstrated the primary source of lead poisoning in children in the United States is exposure to leaded paint (Godwin, 2009). Leaded paint was commonly used in the United States for the first part of the last century and was not banned from residential use until 1978. Unless the lead-containing paint has been removed or alleviated by a contractor who specializes in the removal of lead hazards, it is likely to persist in the home. Over 40% of homes built between 1940 and 1959, and over 65% of homes in the United States built prior to 1940 still contain hazards due to leaded paint (Godwin, 2009). Lead from paint gets incorporated into household dust and is both inhaled and ingested by small children who are prone to putting items in their mouths as they explore their surroundings.

The second most common source of lead exposure in the United States is lead-contaminated soil. Although the EPA have taken measures to eliminate lead from gasoline in the United States by the middle 1980’s (Sharfstein, M.D. and Sandel, M.D., 1998), the old lead emitted by motor vehicles and deposited in the soil decades ago still
remain (Godwin, 2009). This soil can be tracked in the homes by people and pets and become integrated with household dust.

The Lead Contamination Act of 1988 authorized the CDC to initiate a program with efforts to eliminate childhood lead poisoning in the United States (CDC, 2009). This became known as the CDC Childhood Lead Poisoning Prevention Program, and attained primary responsibility to develop programs to prevent childhood lead poisoning, educate medical providers about childhood lead poisoning, provide funding to state and local health departments to determine the extent of childhood lead poisoning, and support research to determine the effectiveness of prevention efforts.

Since its initiation, the CDC Childhood Lead Poisoning Prevention Program has:

- Funded nearly 60 childhood lead poisoning prevention programs to develop, implement, and evaluate lead poisoning prevention activities;
- Provided technical assistance to support the development of state and local lead screening plans;
- Fostered agreements between state and local health departments and state Medicaid agencies to link surveillance and Medicaid data;
- Provided training to public health professionals through CDC’s Lead Poisoning Prevention Training Center;
- Supported the formation of collaborative relationships between CDC’s funded partners and other lead poisoning prevention organizations and agencies (e.g., community-based, nonprofit, and housing groups);
- Developed the Childhood Blood Lead Surveillance System through which 46 states currently report data to CDC;
- Expanded public health laboratory capacity in states to analyze blood and environmental samples and to ensure quality, timely, and accurate analysis of results; and
- Published targeted screening and case management guidelines which provide health departments and health care providers with standards to identify and manage children with elevated blood lead levels.

*Note:* Adapted from “CDC’s Childhood Lead Prevention Program”.

Lead poisoning in children continues to be a health threat, despite efforts made by the CDC and other agencies to eliminate childhood lead poisoning as a public health problem by the year 2010. Partly because of the removal of lead in many consumer products, the average blood lead levels in children has dramatically declined, though lead still persists in the environment and is still present in many older homes and the surrounding soils. It is important that the owners of these homes are well educated about lead and its effects on children. Potential lead hazards should be the number one priority of the landlord, and complete renovation by an experienced professional of a lead contaminated house is a must before any child is subjected to living in the environment.

**Volatile Organic Compounds (VOC’s).** Volatile Organic Compounds (VOC’s) are emitted gases from certain solids or liquids (Environmental Protection Agency, 2010). Common household items that can release VOC’s include paint, varnish, cleaning supplies, pesticides, building materials and furnishings, as well as products containing particle board and plywood, and air fresheners. Common VOC’s that pollute indoor air include:

- Toluene- found in paints, paint thinners, lacquers, and adhesives.
Styrene- found in rubber, plastic, insulation, fiberglass, pipes, automobile parts, food containers, and carpet backing.

- Xylene- found naturally in fuel, but it’s also used as a cleaning agent.

- Benzene- known as a human carcinogen, it can be found in lubricants, dyes, detergents, drugs, and pesticides.

- Formaldehyde- also a human carcinogen, it is used in the production of fertilizer, paper, and plywood, and used in numerous interior products.

The ability of organic chemicals to cause health effects varies greatly from those that are highly toxic, to those with no known health effect (EPA, 2010). Like other pollutants, the degree and nature of the health effect will depend on many factors including level of exposure and length of time exposed. Some people have experienced immediate symptoms soon after exposure to some organic compounds. These symptoms include, eye and respiratory tract irritation, headaches, dizziness, visual disorders, and memory impairment. According to the EPA (2010), many organic compounds are known to cause cancer in animals; some are suspected of causing, or are known to cause, cancer in humans.

**Carbon Monoxide (CO).** Carbon monoxide is a colorless and odorless non-irritating gas that is produced through the incomplete combustion of hydrocarbons, and can kill people unintentionally (CDC, 2008; Miller et al., 1995). This gas is an environmental hazard, and unintentional CO poisonings have occurred in multiple settings including residencies, motor vehicles, and workplaces. Seventy-two percent of non-fatal CO exposures occur in the home (CDC, 2006). Major sources of CO in the home include tobacco smoke, malfunctioning or inadequately vented gas appliances, oil
or wood burning appliances, and unvented appliances that are designed for outdoor use such as gasoline-powered electricity generators (Baeder and Jacobs, 2009). Chronic and acute exposures can result in serious health effects, and survivors of this type of poisoning may have long-term neurological effects like memory deficits, impaired judgment, poor concentration, and other adverse health effects.

**Pesticides.** A pesticide is a chemical used to prevent, destroy, or repel pests like insects, mice, and other animals (EPA, 2011). While pesticides have benefits for society and can be powerful weapons for controlling these pests, they are inherently toxic and can severely harm a child’s health (EPA, 2007). Traditionally, pesticide exposure has been evaluated in relation to its use in agriculture or other occupations, however, there is growing evidence that prove residential pesticide exposure is of considerable magnitude and may be higher in urban areas than in rural areas (Berkowitz et al., 2003). Exposures to pesticides occur through diet, dermal absorption, and through inhalation of airborne pesticides either as an aerosol or adsorbed on dust particles (Baeder and Jacobs, 2009), and can remain in a home for years after the use of these agents have stopped. Children are susceptible to pesticides because they have fewer natural defenses as their bodies are still growing. This in turn can cause the development of serious health effects if they are overexposed to pesticides (EPA, 2007). The EPA has categorized two types of exposure to pesticides; acute exposure and long-term exposure. Acute exposure refers to an intense exposure over a short period of time; for example, a child playing in a room during a spraying. Acute exposure to pesticides could cause short-term effects such as headaches, dizziness, weakness, and nausea. Long-term exposure refers to exposure over a long period of time. This can cause more serious health effects such as learning disabilities,
behavioral and neurological changes, organ damage, various forms of cancer including leukemia and brain tumors, and asthma symptoms (EPA, 2007; Children’s Environmental Health Network, 2010). Educating parents is the best way to help prevent pesticide poisonings. The EPA has developed an effective way to reduce children’s exposure to pesticides known as Integrated Pest Management (IPM), a method of pest management that focuses on eliminating the causes of pest infestations.

Owners and renters should know, and take seriously, the potentially harmful health effects indoor chemical pollutants. Like the biological agents, information should be provided to future residents of homes that may contain these hazards.

3.4 Injuries

Parents often associated their homes with being the place to escape the dangers of the outside world, but unintentional injuries are the leading cause of death among children under the age of 14 and 45% of these deaths occur in or around the home. These injuries and deaths are caused primarily by falls, and drowning, fire, and burns. Each section describes common injuries that occur around the home.

**Falls.** Falls are the leading cause of non-fatal injuries for children ages 0 to 19 (CDC, 2009). Falls on or from stairs, falls on the same level from slipping, tripping, or stumbling, falls from the use of baby walkers, and falls from or out of building windows are the most commonly reported causes of falls in the home (Home Safety Council, 2010). Window falls occur more frequently in large urban areas, low-income neighborhoods, and in overcrowded housing. Children living in apartment buildings have the highest number of window fall incidents – five times more than children living in
residences (Safe Kids USA, 2009). Lack of safety devices such as grab bars, safety gates, and window guards, structural defects such as uneven floors and unsteady stairs, and insufficient lighting in crucial areas are residential hazards associated with falls among children.

If homeowners and landlords adopted these safety measures, the number of injuries and deaths would drop drastically.

**Drowning.** The Home Safety Council (2004) defines drowning as death resulting from suffocation within 24 hours after submersion in water. [Besides motor vehicle accidents\(^1\)], drowning is the leading cause of death among children ages 1 to 14 years (CDC, 2007). One-third of unintentional home drownings occur in bathtubs, 45% occur in home swimming pools, and 18% of unintentional home drownings are unspecified (Home Safety Council, 2004). For infants (under age 1), more than half of drownings occur in bathtubs, and 12% occur in buckets. More than half of drownings among children ages 1 to 4 are pool related. Children ages 5 to 14 most often drown in open water sites [near the home] (Home Safety Council, 2004, 2011). Preventative measures can be taken to reduce drownings such as 4-sided protective fencing around swimming pools, bathtub-design initiatives to prevent drownings, and home- and community-based education programs for drowning preventions (Baeder and Jacobs, 2009).

**Fire.** An average of 116,000 children are injured from fire and burn related incidents each year, and about 488 children die every year (Safe Kids, USA, 2009), making it the 3\(^{rd}\) leading cause of death among children ages 1 to 14 (CDC, 2009). Most fatalities are due to smoke and toxic gas inhalation rather than burns (Hall, 2001).

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\(^1\) In 2009, the Center for Disease Control and Prevention reported that motor vehicle accidents were the leading cause of unintentional injury death in children in the United States whom are under 14 years of age.
Primary residential hazards associated with fire-related injuries and deaths are lack of functional smoke alarms, non-existing fire extinguishers, and no arc fault circuit interrupters (AFCI’s) (Baeder and Jacobs, 2009). Electrical fires in the U.S claim about 480 children’s lives each year and injure 2,300. Many of these fires are caused by the misuse and poor maintenance of electrical appliances, incorrectly installed wiring, and overloaded circuits and extension cords (Baeder and Jacobs, 2009).

Installing residential smoke alarms and sprinkler systems can reduce the risk of death by 82% and reduce the risk of injury by 46% (CDC, 2009; Safe Kids USA, 2009). While these reduce the risk of injury and death, their effectiveness depends on the presence of safe egress (fire escapes, window access, fire rated stairways) from the home in the event of a fire.

**Burns/scalds.** Tap water temperatures and home heating are two ways that burn injuries can be associated with housing conditions. Hot water heater temperature settings have been associated with increased incidence and severity of burns (Sharfstein and Sandel, 1998). Scald burns commonly occur from contact with hot foods and liquids and most frequently with hot tap water. Hot tap water accounts for nearly 1 in 4 of all scald burns among children and is associated with more deaths and hospitalizations than any other hot liquid burns (Safe Kids USA, 2007). Most scald related deaths occur in children under four years old, and this age group has the highest risk for burn-related injuries, primarily because they are actively exploring their environment and have yet to develop cognitive skills that would help them to recognize the dangers of hot liquids and objects. Burns from hot tap water are generally more severe than other scalds, and most frequently occur in the bathtub or shower. Primary residential deficiencies associated
with scalds include lack of anti-scald devices for shower heads and faucets, and water-heater thermostats that are set above 120 degrees (Baeder and Jacobs, 2009). Children living in apartments are susceptible to hot water burns because their parents or caregivers have no way of knowing their hot water heater settings, and often have no access to their hot water heaters.

Many communities have established local ordinances or building codes that require the installation of anti-scald plumbing devices in all new construction. Though the laws have been effective in reducing the number of burn and scald injuries and deaths associated with hot tap water, it doesn’t help children living in older homes and apartments with negligent landlords and unsuspecting parents.

Reports of home heating burns are extremely common either from wood stoves, kerosene heaters, floor furnaces, or most commonly, exposed home radiators (Sharfstein and Sandel, 1998). Burns from these types of appliances can cause serious life-long injury and even death.

In 1993, an estimated 1881 children living in the United States visited emergency rooms for the treatment of burns related to home radiators (CDC, 2001). A study conducted by the CDC in an inner-city housing development located in Chicago, Illinois between 1991 and 1994 revealed that the majority of radiator burns were caused by uncovered radiators. These radiators reached temperatures up to and between 180 to 230 degrees Fahrenheit. Building codes in Chicago require that radiators be covered in public places like schools, churches, and daycare facilities, but there is no requirement for covered radiators public or private housing. This puts thousands of children at severe risk of burns and repeated burns.
3.5 Neighborhood Surroundings and Health Outcomes

The neighborhood environment in which a child grows up can affect all aspects of their health; physical, social-emotional, and cognitive. The availability of neighborhood amenities like playgrounds, libraries, parks, sidewalks, and community centers provide children with opportunities to be active and involved within their communities, however poor conditions such as run-down housing, vandalism, and outdoor air pollution may have an opposing impact on a child’s overall well-being.

**Obesity/overweightness.** The physical environment of a home and a community can either discourage or support opportunities for play, an essential component of child development, and for physical activity, an important strategy in the resolution of the obesity epidemic (Ginsburg, 2007).

Childhood obesity has reached epidemic levels in developed countries (Dehgan et al., 2005), tripling the rates nationally since the late 1970’s (Los Angeles County Department of Public Health, 2007). Today, 25% of children in the U.S. are overweight and 11% are obese (Dehgan et al., 2005; Center for Disease Control and Prevention, 2010). The health implications of obesity in childhood are overwhelming. Insulin resistance, type 2 diabetes, hypertension, obstructive sleep apnea, poor self-esteem, and a lower health-related quality of life are among the comorbidities seen more commonly in affected children and youth than in their unaffected counterparts (LeBlanc and Gomez, 2006). In addition, up to 80% of obese youth continue this trend into their adult years.

Although overweight and obesity in children are reputed to be the outcomes of consuming more calories than they use, an increase of fat intake, as well as excessive sugar intake and increased portion size, a steady decline in physical activity also
contributes to this epidemic. Physical activity declines when children lack adequate opportunity to play and/or exercise (Cummins, 2001).

Neighborhood characteristics such as limited access to essential resources and unsafe environments contribute to the nation’s obesity epidemic. The physical ecology of a neighborhood is defined by its urban structure, such as its built environment, land use mix, open space, and street network (Loukaitou-Sideris, 2005). Since physical activity takes place in a spatial context, such as walking, cycling, and playing, the urban structure characteristics will either promote or prohibit physical activity (Loukaitou-Sideris, 2005). Studies show that changes in health behaviors are unlikely to occur without improvements or modifications in the built environment. For instance, environments with high vehicular traffic will discourage walking and the use of nearby sidewalks (Loukaitou-Sideris, 2005).

Neighborhoods provide environmental opportunities or constraints for physical activity. Some neighborhoods, most often in the suburbs, provide wide sidewalks, biking paths, parks and playgrounds, and public swimming pools, while other neighborhoods, most likely in the inner-city, have dangerous streets, cracked sidewalks, and high traffic volumes. Neighborhoods resembling the latter have physical disorders such as graffiti, litter, and abandoned buildings, and social disorders like crime, loitering, and drug use (Loukaitou-Sideris, 2005). Living in disadvantaged neighborhoods generates stress and fear in parents, in turn, hindering outdoor play and activity. Letting children play nearby is not an option as most of these neighborhoods are made up of small apartments with no open outdoor space, and houses with no backyards for children to play.
A recent study in Los Angeles County, California showed that children living in low-income neighborhoods were nine times more likely to be overweight than those living in well-off neighborhoods, since they have reduced access to supermarkets and fresh produce, as well as little to no access to safe parks or playgrounds, recreation centers, and walking paths (Los Angeles County Department of Public Health, 2007).

Though there is no simple solution to combating childhood obesity, there are strategies that can be taken to help with the fight. For instance, in some states and communities, special incentives are provided to existing supermarkets and farmers markets to establish their businesses in low-income communities.

**Housing location and outdoor air pollution.** About 11% of U.S. households are located within 100 meters of a major highway (Bruegg et al., 2007). Research indicates that there are elevated levels of ultrafine particulates, black carbon, nitrogen oxide, and carbon monoxide that downwind from highways and people living within 200 meters of highways are exposed to these pollutants more than those who live at a greater distance from the highway (Brugge et al., 2007). Studies have shown that children who live near highways have an elevated risk for the development of asthma and reduced lung function (Brugge et al., 2007).

Power plants are another major source of the most common pollutants that put children’s health at risk. Pollutants that power plants release in the air include; particulate matter, ozone, sulfur dioxide gas, sulfate particulate matter, nitrogen oxides, mercury, and a mass of other air toxins. These toxins are associated with asthma attacks, respiratory disease, and heart disease. Particulate matter is, possibly, the most pervasive and harmful pollutant from power plants, plaguing American children (Hill and Keating,
Particulate matter is a mixture of solid particles and liquid droplets found in the air (EPA, 2011). While power plants directly emit particulate matter as soot, the sulfur dioxide gas from power plants is a major source of particulate matter as it becomes transformed into tiny acidic sulfate particles in the atmosphere (Hill and Keating, 2002). Power plants emit more tons of particulate matter forming sulfur dioxide than any other pollution source, making power plants responsible for most of the particulate matter found in many parts of the U.S. (Hill and Keating, 2002). In 2005, they comprised two-thirds of all sulfur dioxide emissions.

<table>
<thead>
<tr>
<th>Electricity Generation</th>
<th>Fossil Fuel Combustion</th>
<th>Industrial Processes</th>
<th>Transportation</th>
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<td>75%</td>
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*Table 3.1 Sulfur Dioxide Emissions 2005*

In 2007, power plants contributed to 67% of sulfur dioxide, 23% of nitrogen oxides, and 40% of man-made carbon dioxide in the United States (EPA, 2007). Over 35 million children live within 30 miles of a power plant, a distance in which children may be reasonably affected. In 2000, over 250,000 children lived within 1 mile of a power plant and 20% of those children were living in poverty (Hill and Keating, 2002). Living in poverty makes children more susceptible to the effects of air toxins because of limited access to health care and substandard housing conditions.
The Clean Air Act (CAA) of 1970, which was amended in 1990, identifies the standards for air quality and emissions. It was designed to make sure that all Americans have air that is safe to breathe. Aspects of the CAA include clean-up programs that address smog, particulates, carbon monoxide, and hazardous air pollutants (Winchip, 2007). However, the CAA has a loophole that allows old and dirty power plants to escape modern standards. Once the loophole is closed, and smokestack emissions controls are used across the board, emissions of sulfur and nitrogen oxides, that form particulate matter, would decrease by 90% or more (Hill and Keating, 2002).

3.6 Social-Emotional /Cognitive Developments and Housing

Children’s housing environments are critical to their outcomes of social-emotional and cognitive development. Chemicals, housing layout, and structural quality all pose hazards in the household and can deter these areas of their development by causing an array of behavioral problems as well as adverse impacts on their cognition.

**Lead poisoning and social-emotional development.** Lead is a potent toxin very commonly associated with a host of neurobehavioral problems in children, such as hyperactivity, attention deficit, impulsivity and other behavioral problems and learning disabilities (Evans, 2003, 2006; Jacobs and Wendel, n.d.). Such disorders often persist throughout adulthood (Bellinger et al., 2001). Several studies have been conducted exploring the connection between lead and these neurobehavioral problems, all of which are symptoms prevalent in childhood ADHD, but none of the studies claim that lead actually causes or triggers the onset of ADHD.
**Lead Poisoning and Cognitive Development.** There is a growing amount of evidence showing a connection between lead exposure and cognitive development. Because they are at a stage of rapid brain development, children are especially vulnerable to the harmful effects of lead. Numerous studies reveal the adverse impacts of lead exposure on child cognition, such as test scores, memory and learning abilities, and fine motor skills. Low-level lead exposure, at or below 10µg per deciliters are associated impaired cognitive function, enough to lower IQ scores, and new evidence suggests that childhood lead exposure may have an irreversible effect on IQ during the adult years.

**Polychlorinated biphenyls (PCB’s).** PCB’s are a man-made group of organic chemicals. They are mixtures of up to 209 chlorinated compounds that do not occur naturally. PCB’s can be oily liquids or waxy solids that are colorless to light yellow, and have no smell or taste. Before 1977, they were used as insulation, coolants and lubricants, glues, sealants, inks, fire retardants and in many kinds of electrical equipment. All PCB imports and exports were banned in the United States in 1979, because of evidence of causing harmful health effects, however, they are still an environmental issue today and they can still be found in older buildings and homes that may still have electrical equipment manufactured before the ban. They are most commonly found in older fluorescent light bulbs, older television sets, and old refrigerators. When these devices get hot during operation, small amounts of PCB’s may leak into the air and raise the level of PCBs in indoor air. Exposure to PCB’s has been linked to ADHD and other behavioral problems, poor reading comprehension, low IQ’s, and memory problems.

**Perflourated compounds (PFC’s) or polyflouroalkyl chemicals.** PFC’s are man-made compounds based on the element fluoride. They are absorbed through ingestion and
to a lesser extent, inhalation. PFC’s have been used since the 1950’s in countless products with little government testing. PFC’s are used on some carpets, furniture, and draperies to make them stain resistant. Researchers found increased odds of ADHD in children with higher PFC serum levels.

**Polybrominated diphenlys ethers (PBDE’s).** PBDE’s are a man-made bromine-based compound used as flame retardants in consumer products made of plastics and foams, primarily for electronics, wire insulation, back coatings for draperies and upholstery, and insulation in the home (healthychild.org). They have been used since the 1970’s, and until recently brominated compounds were considered safe.

Actual products that contain PBDE’s are; computers, television sets, cellphones, electronics, polyurethane foam mattresses, cushions, carpet, upholstered furniture, and draperies, and the list could go on and on. Though European companies started phasing out the use of PBDE’s production, the United States has no federal regulations restricting the use of PBDE’s despite the health risks they pose.

PBDE’s pose health risks for all humans, for example, links to cancer, effects on the liver and immune system and reproduction system, however, children’s exposure to PBDE’s are much higher than adults. Research indicates that young children receive up to 300 times greater exposure to PBDE’s than adults, primarily through breast milk ingestion, and inadvertent dust exposure, the dominate exposure pathway (Acala et al., 2010; Factsheet, 2007). Studies in mice indicate exposure to PBDE’s during brain development has lasting effects on learning, memory, and behavior. Children of low-income families face dissimilarly high exposures due to the presence of older, deteriorated, or poorly manufactured furniture and draperies treated with PBDE’s.
Though some manufacturers and companies like Dell, Sony, Hewitt-Packard, and IKEA have phased out the use of PBDE’s, and opted for safer alternative fire retardants, many companies continue use them.

The central nervous system is a vulnerable to toxins especially during early developmental stages. Once damage to the nervous system occurs, it is likely irreversible. Educating parents and landlords about the harmful effects of these toxins is crucial.

**Overcrowding.** Studies reveal that residential crowding has negative effects on the social-emotional development in children. These negative outcomes include elevated psychological distress and behavioral problems (Evans et al., 1999). According to Evans et al., (1999), children ages 10 to 12 years old are likely to withdraw in overcrowded situations. This type of behavior may be means of coping with an over-stimulated environment.

Overcrowding also influences parental behaviors, which in-turn affect their child’s social-emotional well-being. Studies show that parents in crowded homes are less responsive to young children, with evidence of unresponsiveness beginning before the child reaches one year of age (Evans, 2006).

In addition to unresponsiveness, overcrowding also puts tension on parent-child relationships. Parents in overcrowded homes are likely to engage in punitive parenting

This affects the levels of distress in children 10 to 12 years old. Strained relationships between parent and child negatively influence social and emotional measures in children (Evans, 1998).

Overcrowding also affects children’s development in regards to educational attainment. They tend to have lower math and reading scores, complete fewer years of

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2 Punitive Parenting is a way of parenting that uses punishment as a means to teach.
education, and are less likely to graduate from high school than their peers who do not live in overcrowded conditions. There are several reasons children living in crowded homes have reduced educational achievement. Overcrowding may increase noise and chaos that interfere with children’s studies and cognitive development. The other problem could be that they have a lack of space to sit down and study and do their homework.

**Light.** Sunlight is the most important source of light and energy for living organisms. Most people spend part of each day under the influence of sunlight, however as communities become more urbanized, people are spending less time in the natural sunlight and more time in artificial lighting. Most research focuses on schools and how the quality of natural light can significantly influence children in the classroom. But what about the natural lighting in their homes? There is little to no research on children living in homes without adequate natural lighting.

Levels of lighting, particularly the amount of daylight exposure can impact psychological well-being. Brightness brings joy, and levity, while dark and gloom brings depression and sadness. Seasonal Affective Disorder (SAD) is a form of depression that is associated with the amount of exposure to daylight, and can begin as early as the teen years.
Chapter Four

Strategies Interior Design Can Provide

Interior design influences our world in many different ways; how we live, how we navigate various buildings, and how we react to different environments.

Sections 3.1 and 3.2 in chapter three explored the many attributes that affect the indoor air quality (IAQ) of a home, as well as safety concerns, adequate play space, and crowding issues. This section gives a brief analysis of sustainability in regards to indoor environmental quality (IEQ). It also explores solutions for improving IAQ through material and product selection, creating safe spaces for children to play, reducing exterior noise, as well as solutions for overcrowding.

A child’s physical, social-emotional, and cognitive health depends on the environment in which he or she lives. Exposure to toxic substances such as lead, affects all areas of their development. Younger children are more prone to lead and its effects because they are often crawling on the floor, putting objects in their mouths, and are exposed to lead through dust, soil, and in some cases, chipping paint.

Increases in asthma among children prove that there is a link between their physical environment and their health. As stated before, indoor air quality factors associated with asthma are: mold, dust mites, insects, rodents, and smoke, all of which can be avoided. The interior design of a home is crucial as it relates to each product and material that resides within the home, therefore, interior designers must be knowledgeable about products and materials they specify that can potential cause health problems and know which products are safe for children.
4.1 Sustainability

The EPA defines sustainability as being based on one principle and that is:

   Everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment. Sustainability creates and maintains the conditions under which humans and nature can exist in productive harmony that permits fulfilling the social, economic and other requirements of present and future generations.

*Note:* Adapted from: “Environmental Protection Agency, 2011”

   Sustainability is important in making sure we have and will continue to have water, materials, and resources to protect the environment, as well as human health (EPA, 2011). Sustainability can be practiced through a variety of ways, including green building. Green building is the practice of creating structures and using processes that are environmentally responsible and resource efficient throughout a building’s life-cycle from design, construction, operation, maintenance, renovation, and demolition (Green Building Education Services, 2009). Green buildings are structures that are specifically designed to reduce the overall negative impact of the built environment on the natural environment, and human health. Ways to reduce the negative impacts of building environments to human health is by improving the IEQ, as well as better educating the public on alternative interior materials and products that do not pose a threat to theirs and their children’s health.

4.2. Indoor Environmental Quality and Indoor Air Quality

   Indoor Environmental Quality (IEQ) refers to the quality of the air and environment inside buildings that can affect the health, comfort, and performance of the
buildings occupants, through pollutant concentration and conditions (Green Building Education Services, 2009). Studies show that concentrations of indoor air pollutants far exceed those that are outdoor (EPA, 2010). Other building variables that affect the indoor environment include: perception of space, temperature, humidity, lighting, acoustics, and air quality (GBES, 2009; Winchip, 2007). The indoor Air quality (IAQ) can be complicated. For one, the earth’s atmosphere naturally consists of smoke particles from natural forest fires, mold spores from soil and some plants, plant pollen, air-borne pathogens transmitted through the air, dust, and variations of carbon dioxide and oxygen levels, all of which can gain access to indoor spaces. Therefore, having a “pure” earth atmosphere is virtually impossible.

Several techniques have been acquired into universal guidelines to be incorporated into building codes. Some that use simple formulas to calculate how much fresh air per hour a person’s house needs in order to maintain a healthy indoor environment. However, there are “trade-offs” that have to be made. For instance, if a family lives in an area heavily populated with factories and automobile traffic, calculations would have to be made so that the “fresh air” exchange is not harming the occupants; however the polluted indoor air, from gas stoves, off-gassing materials, etc., will not have a chance to escape as often, causing potential health problems for the occupants. To alleviate such obstacles, standards require that outdoor air quality is studied thoroughly before design decisions are made. Such analyses are commonly done on commercial buildings, but seldom done on residential homes.

The most common standard followed to ensure adequate air ventilation is the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE)
Standard 62.1, which prescribes minimum ventilation rates and indoor air quality for indoor areas that have human occupants, to reduce the potential adverse health effects of those occupants. The standard also specifies that the ventilation systems be designed to prevent the introduction of contaminants, and reduce the growth potential for microorganisms. ASHRAE defines acceptable indoor quality as:

“Air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction”.

*Note:* Adapted from: “ASHRAE Standard 62.1, 2010”

There are many sources of indoor air pollution in any home, new or old. Sources include building materials, furnishings, combustion sources such as oil, gas, and kerosene products, carpeting, and certain types of wood used for furniture and cabinetry, and household cleaning products, and dampness. Inadequate ventilation can increase indoor pollutant levels by not bringing in enough outdoor air to dilute emissions from indoor sources, and by not carrying indoor pollutants outside of the home (EPA, 2011). Since many lower-income or inner-city homes, are older and probably not maintained properly by homeowners or landlords, poor indoor air quality is a major problem. The primary reasons for poor IAQ in residential homes are:

- Energy conservation measures, which include well-insulated and tighter sealed homes.
- Poor design and or construction
- Increase use of synthetic building materials, furnishings, and finishes.
- Poor maintenance of the home.
The structural constituents of a home (including apartment buildings), products, and materials affect the IAQ of the interior. Section 3.1 briefly described household contaminants and their effects on children’s development. Several household contaminants derive from products and materials. The most common contaminants include formaldehyde, VOC’s, carbon monoxide, and lead. VOC’s are an important concern for interior designers because they exist in thousands of interior materials and products. To protect children’s health, and to reduce the quantity of indoor air contaminants, products and materials should not contain any of these contaminants, or they should have low-emitting features. Table 4.1 shows household products and materials that contain these toxins.

Table 4.1
Products and Materials That Contain Chemicals

<table>
<thead>
<tr>
<th>Furnishings and Finishes</th>
<th>Contaminants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle Board</td>
<td>Formaldehyde</td>
</tr>
<tr>
<td>Plywood</td>
<td>Formaldehyde</td>
</tr>
<tr>
<td>Paint</td>
<td>Lead³, VOCs</td>
</tr>
<tr>
<td>Pressed-wood</td>
<td>Formaldehyde</td>
</tr>
<tr>
<td>Carpet</td>
<td>Formaldehyde, VOCs, PBDE’s, PFC’s</td>
</tr>
<tr>
<td>Upholstery</td>
<td>PFC’s, PBDE’s</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Household Products</td>
<td></td>
</tr>
<tr>
<td>Cleaners and Disinfectants</td>
<td>Benzene</td>
</tr>
<tr>
<td>Solvents (i.e. paint strippers)</td>
<td>Benzene, Toluene</td>
</tr>
<tr>
<td>Aerosol sprays</td>
<td>Methylene chloride</td>
</tr>
</tbody>
</table>

³ Leaded paint was banned in the United States, but older homes still contain this toxic substance.
The most cost-effective way to reduce indoor air pollution is by controlling the source, by either eliminating the individual sources or by reducing their emissions. Choosing sustainable products and materials are the best solutions for achieving this. Detoxification is one strategy that supports the classification of a sustainable products and materials. The strategy of detoxification includes substituting benign alternatives for problematic chemicals (Heine, 2007).

Thanks to an increased awareness of sustainable products, and the benefits not only to the environment, but to the health of people, many manufacturers are starting to produce products that are good for people and the environment. Appropriate materials and products to enhance IAQ must be thoroughly researched before they are specified as safe alternatives for the indoor environment.

4.3 Finishes and Indoor Air Quality

A close analysis of building materials and interior products is necessary in order to have healthy IAQ. Being that research has confirmed that contaminants from products are being released into the indoor air and can negatively affect human health, it is important that designers and consumers obtain complete information about a product before bringing it into the home. Many common household finishes such as flooring and wall coverings contain toxic substances; however, because of the increased awareness of the potential dangers of these substances, many manufacturers are producing products that are safe for people and the environment.
**Carpet.** For many health reasons, decisions for selecting carpeting should be based on careful research and analysis. There are several IAQ facets related to carpet systems. They include; materials used in the fibers, adhesives, and sealants. Furthermore, depending on the pile, carpet can easily collect and retain dust, dust mites, allergens, bacteria, and microbes, all of which contribute to asthma and allergies. The basic components of the carpet system include the carpet, carpet backing, carpet cushion or padding, and the installation method. There are many important characteristics that are associated with the carpet systems, and the traits that affect sustainable design, however for the purposes of this section, the discussion focuses on the attributes that affect IAQ and children’s development.

Two primary fibers used for carpet are natural and synthetic. Some natural fibers include wool, jute, sisal, and hemp. The major synthetic fibers include nylon, polyester, and polypropylene. Wool is the most common *natural* fiber used for carpet. Although it is rather expensive, it has great characteristics such as its natural resistance to flames, resistance to soil, and wear. Some wool carpeting can have chemical additives to deter moths, but those toxic agents can, and should, be avoided. Nylon, with the two typical types Nylon 6, 6 and Nylon 6, is the most common fiber used for carpet. Its best features include good resistance to stains and soils, excellent resiliency and durability, and low-cost. However, there are concerns regarding the production processes. The production of Nylon 6 involves the use of benzene, a known human carcinogen, and Nylon 6, 6 involves the use of an extremely poisonous substance, hydrogen cyanide gas (Green Seal, 2001).
Carpet backing is another component used in carpeting composed of fabrics and yarns that make up the back of the carpet. The materials should be examined for their content as some may contain polypropylene; however, some carpet manufacturers produce the backing using natural fibers like hemp-cotton, jute, and natural latex rubber (Winchip, 2007). The binders used for backings, are synthetic rubber, polyurethane, polyvinyl chloride (PVC), and ethylene vinyl acetate (EVA), all of which have health drawbacks. PVC contains stabilizers such as lead, and also contains phthalates, that may be released into the indoor environment throughout the life of the carpet (Green Seal, 2001).

Carpet cushioning is another component of the carpet system that can affect the IAQ. A material such as foam, rubber, urethane, or PVC, is adhered to the back side of the carpet to enhance resiliency, and provide additional comfort. Some carpet cushioning has brominated flame-retardants which are detrimental to children’s health. There are natural materials that can be used instead.

Carpet often gets wrongly blamed for emitting high-levels of VOCs and contributing to asthma and allergies. There are no links between carpet and asthma and allergy symptoms. In fact, when properly vacuumed and maintained, carpeting can improve indoor air quality by trapping dust and allergens until they are vacuumed, unlike smooth flooring surfaces which tend to allow dust to re-circulate into the air (Carpet and Rug Institute, n.d.). Additionally, according to the Carpet and Rug Institute (CRI), carpet is the lowest VOC emitter of common flooring selections, and the emissions dissipate very quickly, sometimes in as little as 48 hours. To ensure the lowest emissions, carpet used in homes should carry the Green Label or Green Label Plus logo which signify that
it meets strict standards for VOC emissions. Green Label and Green Label plus testing and certification indicate carpet, carpet backings, cushions, and adhesives that emit low VOCs. The American Lung Association has even approved the Green Label carpet program for its use in their Healthy Homes programs (CRI, n.d.)

**Interior Wood.** There are a variety of wood and wood based materials that are used for interior woodwork applications. Although wood has mostly environmental impacts, there are a few concerns for the health impacts on children.

Pressed wood products are used in a variety of housing applications. Products include particleboard, hardwood plywood, and medium-density fiberboard (MDF). Most of these woods are used to construct subfloors, cabinetry, shelving, laminated flooring, and doors. Pressed-wood products are a dominant source of urea-formaldehyde (UF) and the types of pressed-woods listed above are made with UF resins that are used as binders. Thanks to efforts of the government and the industry, manufacturers have reduced formaldehyde emissions in pressed wood products by 80-90% since the early 1980’s. And in 2010 President Obama signed, into law, the Formaldehyde Standards for Composite Wood Products Act, which establishes limits for formaldehyde emissions from composite (pressed) wood products. To reduce exposure, however, the EPA (2011) recommends the use of exterior-grade products, such as softwood plywood, and flake or oriented strand board which contain phenol-formaldehyde (PF) resins, which generally emit formaldehyde at considerably lower rates than those containing UF resins.
**Wood flooring.** Wood flooring should be specified with care. Since we just learned that processed wood contains formaldehyde, it should be avoided for health reasons. Using solid wood is the best choice for interior wood flooring, not only because of its ability to last up to 100 years, but because it is made from virgin, unprocessed materials. However, labels on this wood should be read carefully to ensure substrates are formaldehyde-free materials, and the adhesives are low- or zero-VOC and water-based (Winchip, 2007). The preferred method for installation is being nailed or screwed to a surface rather than using adhesives.

**Wall coverings- paint.** As previously discussed in Chapter 3, leaded paint was banned in 1978; therefore it is no longer used in paint on the market today. However, it may still exist in homes built prior to 1978, particularly those in low-income communities. It is critical that leaded paint in these homes are eliminated entirely. It is very important to know that any renovation in these homes that requires common activities like sanding, cutting and demolition can create hazardous lead dust and chips by disturbing lead-based paint, which can be harmful to children. The EPA (2011) states:

> “To protect against this risk, on April 22, 2008, EPA issued a rule requiring the use of lead-safe practices and other actions aimed at preventing lead poisoning. Under the rule, beginning April 22, 2010, contractors performing renovation, repair and painting projects that disturb lead-based paint in homes, child-care facilities, and schools built before 1978 must be certified and must follow specific work practices to prevent lead contamination”

*Note: Adapted from: “Environmental Protection Agency, 2011”*

Paints used in the interior of a building can also have a significant impact on the IAQ. The three main types of paints are oil-based, water-based, and natural finishes. Oil- and water- based paints contain VOCs, which are used to enhance application coverage,
to make them dry faster, and to enhance the finish (i.e. flat, glossy) (GVRD, 2001).

Natural finishes have little impact on the IAQ because they contain minimal VOCs. There are many paints on the market that contain little to no VOCs that have the same performance features as traditional paints. However, it is important for homeowners and landlords to understand that there are many paint manufacturers that label their products to be “safe” and “environmentally friendly”, and that may not be the case, as they still may contain VOCs. It is also important to understand that there are no mandatory standards for what constitutes as a “low-odor, and low-VOC paint. There are however, voluntary standards but even some of those may not include the pigment added to the paint at the time of purchase. Green Seal is one of several non-profit organizations that set standards environmentally responsible products. The Green Seal certification for standard GS-11 is based on paints and coating including; wall, anti-corrosive, and reflective coatings, floor paints, primers, and undercoats, and prohibits chemicals like toluene, benzene, and formaldehyde (Green Seal, 1993).

4.4 Furnishings and Indoor Air Quality

**Furniture.** Furniture is also a concern related to indoor air contaminants. Many toxic chemicals and materials are used to construct certain types of furniture and some are potentially dangerous to people due to their toxicity.

**Fabrics.** Fabrics are used for many residential interior applications such as window treatments, furniture upholstery, bed coverings, wall coverings, and more. The manufacturing process can involve the use of heavy metals, such as lead and cadmium, and other chemicals, which is one concern with the use of fabrics in an interior
environment. Another concern is the VOC emissions that some fabrics comprise. The fibers used to produce fabrics are natural, synthetic, and blends with various types. Synthetic fibers are petroleum-based; therefore careful research needs to be done by an interior designer before specifying fabrics made from these types of fibers. Synthetic fibers are known to be more durable, resistant to sunlight, and inexpensive, and so are the most popular. However, some synthetic fibers may contain chemicals that threaten the IAQ and pose health risks. While specifying fabrics, the designer must choose fabrics that are made without using solvents or chemicals. There are a growing amount of textiles being produced that are organic and environmentally safe that does not harm the IAQ.

4.5 Improving Indoor Air Quality

During the early 1970’s, energy measures were put in place thanks to the Energy Crisis; a period in which major industrialized counties, particularly the United States, faced substantial shortages of petroleum. One measure was put in place to minimize outside air to buildings by sealing walls and windows tightly. However, pollutants from building materials, products, and occupant activities were building up inside and were no longer being flushed back to the outside, causing many health problems in people that were sometimes fatal.

The objective to removing poor indoor air is to minimize health risks to humans by reducing exposure to indoor air contaminants. LEED, or Leadership in Energy and Environmental Design, is a suite of rating systems for the design, construction, and operation of a green building. They list two strategies to improve indoor air quality;
avoiding the use of materials consisting of pollutants and VOC’s and; improving ventilation.

**Source Control.** Controlling the source is one of the most effective ways to removing air contaminants. The easiest way to do this is to not allow the source indoors at all. Table 4.2 demonstrates previously mentioned air contaminants, and strategies for residential buildings adapted from LEED to reduce or eliminate them.

*Table 4.2*
Source Control

<table>
<thead>
<tr>
<th>Air Contaminants</th>
<th>Strategies to Reduce or Eliminate Them</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Secondhand smoke</strong></td>
<td>• Smoking should be prohibited indoors</td>
</tr>
<tr>
<td></td>
<td>• Partitioning of rooms</td>
</tr>
<tr>
<td></td>
<td>• Blower door test[^4] must be performed to confirm that air cannot leak between the doors and between adjacent units (apartment buildings).</td>
</tr>
<tr>
<td><strong>Carbon Dioxide</strong></td>
<td>• Monitoring CO2 levels ensures that spaces are receiving enough ventilation.</td>
</tr>
<tr>
<td><strong>Material off-gassing</strong></td>
<td>• Make sure materials used are not affecting the air quality.</td>
</tr>
<tr>
<td></td>
<td>• Purchase products and materials that are acceptable to LEED and meet a 3rd party standard.</td>
</tr>
<tr>
<td><strong>Radon</strong></td>
<td>• Use radon construction techniques to reduce radon infiltrating into</td>
</tr>
</tbody>
</table>

[^4]: A blower door test uses a high powered fan and an air pressure sensing device to measure the airtightness of buildings and to locate trouble spots. **LEED has established an airtightness standard for multifamily dwelling units of 1.25 square inches (8.1 cm²) of leakage area per 100 square feet (9.3 m²) of enclosure area.**
### Chemicals

- Use cleaning products that are "Green".

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**Improving ventilation.** Good indoor air quality comes mechanically, using fans that deliver air through a series of ducts, or naturally, opening doors and windows. Some buildings use both natural and mechanical ventilation and have mixed mode ventilation. The ratio of poor air is reduced by increasing the amount of fresh air entering a home. Ventilation dilutes the level of pollutants in the air. To dilute and remove air contaminants, HVAC, or heating, ventilating, and air-conditioning systems, must bring in adequate amounts of outdoor air.

**Air Filters.** Proper air filtration is essential for good indoor air quality. Air filters are used to reduce the amount of dust, pollen, mold, and bacteria from the air, thus keeping the HVAC system clean. Air filters are rated on the MERV (Minimum Efficiency Reporting Value) system. The higher the MERV rating, the more particles are removed. LEED recommends a filter with a value of at least 8 for residential buildings, though the homeowner or landlord can opt for a higher rated filter. The following chart describes each MERV value in the rating system with emphasis on the home rating value.

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5 Green cleaning products are products that have a lesser or reduced effect on human health and the environment when compared with competing products that serve the same purpose.
**Table 4.3**
MERV Rating System

<table>
<thead>
<tr>
<th>MERV Value Ranges</th>
<th>Typical Particles Trapped by Filter</th>
<th>Typical Applications for the MERV value ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>Pollen, dust mites, standing dust, spray paint dust, carpet fibers</td>
<td>Minimum filtration, used mostly in residential buildings.</td>
</tr>
<tr>
<td>5-8</td>
<td>Mold spores, hair spray, fabric protector</td>
<td>Most commercial applications and better residential buildings.</td>
</tr>
<tr>
<td>9-12</td>
<td>Humidifier dust, lead dust, auto emissions</td>
<td>Superior residential buildings and better commercial buildings.</td>
</tr>
<tr>
<td>13-16</td>
<td>Bacteria, most tobacco smoke, sneeze</td>
<td>Hospital inpatient and general surgery, superior commercial buildings.</td>
</tr>
</tbody>
</table>

*Note:* Table adapted from: The MERV rating system for air filters.

**Indoor Plants.** Common indoor plants may be a valuable implement in the fight against rising levels of indoor air pollution. The National Aeronautics and Space Administration (NASA) found them to be remarkably useful in absorbing potentially harmful gases and cleaning the air inside homes. As stated before, indoor pollutants that affect health are formaldehyde, VOC’s, indoor biologic pollutants, carbon monoxide, nitrogen oxides, radon, and pesticides, and cause a variety of symptoms ranging from allergies, headaches and fatigue through to nervous-system disorders, cancer and death. While it’s a well-known fact that plants convert carbon dioxide into oxygen through photosynthesis, studies conducted by NASA scientists have identified 50 houseplants that also remove the harmful elements from the air.
Dr. B.C. Wolverton, an environmental engineer from Picayune directed the NASA study, along with the assistance from the Associated Landscape Contractors of America (ALCA), and rated these plants for removing chemical vapors, ease of growth, resistance to insect problems, and transpiration\(^6\). Wolverton (1997) expanded the study and assigned plants a rating from 1 to 10, based on a plant’s ability to remove chemical vapors or indoor toxins, resistance to insect infestation, ease of growth, and the rate at which water evaporates from the leaves. The table below shows ten common household plants that significantly remove common pollutants from indoor air.

\textit{Table 4.4}

Common House Plants that can help Purify the Air

<table>
<thead>
<tr>
<th>Top 10 Indoor Plant Species</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Areca Palm (Chrysalidocarpus lutescens)</td>
<td>![Image]</td>
</tr>
<tr>
<td>Lady Palm (Rhapis excelsa)</td>
<td>![Image]</td>
</tr>
<tr>
<td>Bamboo palm (Chamaedorea seifrizii)</td>
<td>![Image]</td>
</tr>
<tr>
<td>Rubber Plant (Ficus robusta)</td>
<td>![Image]</td>
</tr>
</tbody>
</table>

\(^6\) Transpiration is the passage of water through a plant from the roots through the vascular system to the atmosphere.
Dracaena “Janet Craig” (Dracaena deremensis)

Philodendron (Philodendron sp.)

Dwarf Date Palm (Phoenix roebelenii)

Ficus Alii (Ficus macleilandii “Alii”)

Boston Fern (Nephrolepis exaltata “Bostoniensis”)

Peace Lily (Spathiphyllum “Mauna Loa”)

4.6 Interior Design and Safety

Safety is another factor that should be a concern for interior designers. Because unintentional injuries such as fires/burns, drowning, falls, and poisoning, are among the leading causes of death in children, special attention should be paid to the safety needs of children. Safety in the home can be considerably enhanced by the improvement of design.

Falls. Research indicates that a large number of home fall-related deaths and injuries are related to structural or design features of the home. Inappropriate flooring material and paving and poorly designed or constructed stairs, windows and balconies are the most commonly identified structural features of the home that contribute to home fall
injury. Stairs with one or two steps, inappropriate geometry, or non-uniform dimensions, and stairways with no grab bars implicated in a high number of fall-related injuries and deaths.

Most stair related injuries to children occur in infants who fall from stairs while in their baby walkers, or infants who are learning to crawl and explore their surroundings. The use of safety gates and the tops and bottoms of stairs can reduce a child’s chances of falling. In addition, when possible, stairs should be designed with a landing, to “break the fall” which can greatly reduce injury.

Window falls are the most common falls in the home, they most frequently occur in large urban areas, low-income neighborhoods, and in overcrowded housing (Safe Kids USA, 2011). According to Safe Kids USA, children living in apartments have the highest number of window fall incidents. Window guards, designed to open quickly from the inside in case of fire, are proven to save lives. For example, with an education and window guard distribution program in New York City, NY, combined with window guard legislation resulted in a 35% reduction in window fall-related fatalities after just two years (Safe Kids USA, 2011).

**Fire.** Many states have laws requiring the use of smoke alarms in new and existing homes, and in some states, the use of fire sprinklers in new residential homes are required. Since smoke and toxic gases are the main killers in a building fire, smoke detectors are important in every design (Harmon and Kennon, 2005). When a child is injured or dies from a residential fire, a smoke alarm is not working or not present in two-thirds of these occurrences (Safe Kids USA, 2009). Building codes do not always state exactly where to locate smoke detectors, so it is up to the designer to determine the best
placement. Some states require that smoke detectors be placed on each floor of a residential dwelling, and every hallway, and for additional safety, smoke detectors should be placed outside each sleeping area.

**Burns and scalds.** Hot tap water accounts for 1 in 4 scald burns among children, and are associated with more injuries and deaths than any other hot liquid burns (Safe Kids USA, 2007). Tap water burns occurs more often in the bathtub and tends to be more severe since a larger portion of the body is likely to be scalded. Interior designers should suggest or specify anti-scald devices in water faucets and shower heads to prevent such incidents. Hot food and liquid scald burns are also associated with injuries and death, especially in children between the ages of 6 months and 2 years, commonly occur in the kitchen. Stove guards can be installed to prevent children from grabbing hot pots and pans from the stove.

**Drowning.** Although drowning deaths are the results of lack of adult supervision, there are several initiatives that can be taken aid in the prevention. For example, child proof door top locks can be placed on bathroom doors to prevent small children from entering the bathroom and turning on the bathtub faucet. In addition, toilet-locks can be installed to prevent drowning, as there are known cases where toddlers have drowned in toilets (U.S Consumer Product Safety Commission, 2002).
4.7 Play and the Interior Space

Play is an essential to child development because it contributes to the physical, social-emotional and cognitive well-being of children (Ginsburg, 2007). It allows them to use their creativity while developing their imagination and developmental strength. However, play can be limited due to constraints held by the neighborhood, as well as household space and components.
**Obesity.** Chapters two and three discussed the detrimental effects obesity can have on all areas of child development. Play is an essential to physical development because it can increase physical activity, a key strategy in the resolution to the obesity epidemic (Ginsburg, 2007). So it is important to provide places for children relative to their physical needs. Outdoor play is more essential in tackling obesity, because of the amount of space given for children to run around. However, restrictions such as weather and neighborhood safety can prohibit outdoor play. This section will focus on interior strategies that can aid in the epidemic.

Indoor activities such as hide-and-go-seek can promote physical activity within the home with the use of built-in hideaways, niches, and platforms around the home. These types of features can also be used for physical play such as climbing. This may be difficult for families living in rented homes such as high-rise apartments and townhomes therefore landlords should consider similar strategies to support indoor physical activity. Figure 4.2 shows an example of how common household features can be used by children.
Apartment communities could also have supervised indoor play facilities strictly for apartment residents, as well as enclosed outdoor play areas such as courtyards surrounded by the building, so that parents can keep an eye on their children from windows, and/or play spaces surrounded by gardens (i.e. hedges and shrubs). The figures below show examples of how residential communities can provide safe outdoor play areas that are easily accessible to children and helpful for parents to watch their children from indoors.
**Overcrowding.** Chapter two reviewed the effects overcrowding can have on children’s development. Dwellings that are too small and poorly planned contribute to negative social interactions between the family (parents and children) as well as the well-being and development of children (Flade, 1986). Privacy and a sense that they can control what happens are important to children. Research suggest that children have a strong desire to own, control, and occupy space, but territories, such as their own
bedroom, and unclaimed spaces, are often scarce resources for them (Miller, 1986). Children who do not have their own bedroom often seek out spaces like closets, attics, storage areas, and garages that are not under the direct control of adults.

Every home should have spaces allocated for children to read, study, and play on their own without having distractions from other family members.

**Noise.** Noise and its non-auditory effects on a child’s development were discussed in chapter two. Since the majority of noise hazards come from outside sources such as road traffic and nearby airports, it is important that homes have an acoustically controlled environment in relation to exterior noise. Noise can enter the home through walls, doors and windows. These noise entry points can be tightened, insulated, padded, or replaced to help combat exterior noise. Acoustically double-glazed windows can reduce exterior noise by up to 70%. Also available are acoustical door seals that can be installed on most existing doors and can drastically reduce noise from outside. Other alternatives would be to plant trees and shrubs around the building to help absorb outdoor noise. Multi-family homes needs soundproofing materials within the home so when children are playing indoors, it doesn’t bother adjacent residents.
5.1 Summary and Conclusion

The purpose of this research was to find out how a child’s home environment can affect their developmental outcomes. From the findings, there is convincing evidence that a child’s physical environment can directly affect all areas of their development, regardless of where they live. However, children from families with limited means, tend to fare worse than children who live in better quality homes and neighborhoods. Chronic conditions such as asthma, lead poisoning, injuries, and obesity, as well as behavioral problems, intellectual and memory deficiencies, all have links with housing circumstances such as structural conditions, building quality, and neighborhood location.

There are several programs and organizations that address the housing and neighborhood issues and take comprehensive approaches to solving them. One program, developed by the CDC, is the Healthy Homes Initiative (HHI), which is a coordinated, comprehensive, and holistic approach to preventing diseases and injuries that are a result from housing related hazards and deficiencies (Center for Disease Control and Prevention, 2006).

The HHI builds upon the U.S. Department of Housing and Urban Developments (HUD) successful Lead Hazard Control programs to expand its efforts to address a variety of environmental health and safety concerns including: mold, lead, allergens, asthma, carbon monoxide, safety, pesticides, and radon (HUD, n.d.).
They seek to:

- Broaden the scope of single-issue public health programs, such as childhood lead poisoning prevention and asthma programs, to address multiple housing deficiencies that affect health and safety.
- Build capacity and competency among public health, environmental health, and housing professionals, and others who work in the community, to develop and manage comprehensive and effective healthy homes programs.
- Promote, develop, and implement cross-disciplinary activities at the federal, state, tribal, and community levels to address the problem of unhealthy and unsafe housing through surveillance, research, and comprehensive prevention programs.
- Facilitate the collection of local data and monitor progress toward reducing or eliminating housing deficiencies and hazards.
- Develop guidelines to assess, reduce, and eliminate health and safety risks.
- Promote research to determine causal relations between substandard housing and adverse health effects.
- Expand collaborations with the U.S. Department of Housing and Urban Development (HUD), national associations and organizations, academia, community-based organizations, and others, including the American Public Health Association, National Environmental Health Association, and the World Health Organization.
- Identify and implement low-cost, reliable, and practical methods to reduce health and safety risks in substandard housing.

Note: Adapted from CDC’s Healthy Homes Initiative, 2006.
Identifying health, safety, and quality of life issues in the home environment is the primary focus of the HHI, as well as acting systematically to eliminate or mitigate problems.

Another group known as the National Center for Healthy Housing (NCHH) is a non-profit organization that is dedicated to establishing healthy, green, and safe homes for families at all income levels through education, training, and policy efforts. They also unite leaders in the public health, housing, and environmental communities to legislate changes needed to combat inadequate housing policies and practices for families living in substandard housing. Furthermore, the NCHH does research on key aspects of childhood lead poisoning and lead hazard control and reducing exposure to allergens and other residential hazards.

Their research is organized around the following principles:

1. Discover and/or verify the varied links and interactions between housing and health.
2. Discover and/or verify housing interventions that support and/or improve health.
3. Provide the evidence base for new guidelines, regulatory standards, and legislation.
4. Standardize and improve methods of detecting and controlling housing-related health hazards.
5. Present findings in varied formats, including but not limited to peer-reviewed scientific literature, conference presentations, and the popular press.
6. Continue efforts to combat childhood lead poisoning by ensuring policies are practical and scientifically valid.

*Note:* Adapted from NCHH’s research guidelines, 2008
There are several associations that focus on the neighborhood and community to help combat the obesity epidemic as well as educating people about the importance of leading a healthy lifestyle.

PolicyLink, founded in 1999, is a research and action institute that “connects the work of people on the ground to the creation of sustainable communities of opportunity that allow everyone to participate and prosper. Such communities offer access to quality jobs, affordable housing, good schools, transportation, and the benefits of healthy food and physical activity. . .” (PolicyLink, n.d.). They initiated the Healthy Food Financing Initiative (HFFI), which is a “viable, effective, and economically sustainable solution to the problem of limited access to healthy foods, and can reduce health disparities, improve the health of families and children, create jobs, and stimulate local economic development in low-income communities” (PolicyLink, n.d.).

PolicyLink also advocates several practices including taking measures that reduce disparities by investing equitably in parks and open spaces; shifting more funding to projects that benefit dense, urban areas, and low-income communities, and considering options for restoring and reusing existing community assets and facilities, such as school yards, vacant lots, or other land owned by public agencies, as alternatives to new land acquisitions (PolicyLink, n.d.).

Another advocacy association is the National Recreation and Parks Association (NRPA). They are dedicated to the advancement of public parks and recreation opportunities. An ongoing national initiative known as Parks Build Community, demonstrates the transformative value of parks and recreation on the health and vitality of communities across America. Their vision is to select an urban park in need of
revitalization, particularly in a low-income area, and transform the property into a thriving gathering place for youth and adults (NRPA, 2011).

What they do is:

“In partnership with host cities around the U.S., and with the support of numerous public and private agencies, NRPA reconstructs dilapidated facilities and provide new park amenities to areas in need of revitalization — all of which enhance green space, promote health and physical activity, and support social interaction.” *Note:* (NRPA, 2011).

The role of housing quality and housing location in children’s development are of great importance, as these issues may affect their outcomes later in life.

Multiple housing factors such as housing structure, residential layout, and neighborhood surroundings all influence all areas of children’s development including physical health, social-emotional well-being, and cognitive development. Additionally any given housing feature can influence more than one area of development such as the impacts of chemical exposure on their physical development, mental development and their cognitive functioning. These characteristics could determine whether or not the physical condition of the house is healthy and safe, and if the neighborhood in which the house is located is free from danger, all of which have an effect on their development.
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