Primary Care Approaches

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Reducing the Risk of Pesticide Exposure among Children of Agricultural Workers: How Nurse Practitioners Can Address Pesticide Safety in the Primary Care Setting

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Studies have shown that exposure to agricultural pesticides can result in serious acute and chronic health effects in humans. While pesticide exposure may occur in many different settings, agricultural workers and their families are at greatest risk. Children of agricultural workers are at particular risk because of their smaller size, higher metabolic rates, immature body systems, and behavioral and developmental patterns. Health care providers working in rural and agricultural areas are most likely to work with families and children at greatest risk for pesticide exposure. Many health care professionals do not feel adequately prepared to address safety, prevention, and education regarding pesticide exposure. This article reviews current studies on reducing pesticide exposure in children of agricultural workers and outlines a list of recommendations and guidelines for health care professionals working with this population. These guidelines address the particular vulnerabilities and risks of children at all stages of their development and ways in which health care professionals can address these risks with agricultural workers and their families in the primary care setting.

Every year, approximately 1.2 billion pounds of commercial agricultural and residential pesticides are used in the United States, more than double the amount used in the 1960s, accounting for almost 25% of the estimated 5 billion pounds of pesticides used globally per year (Environmental Protection Agency [EPA], 2009). According to a survey by the United States EPA in 2008, 75% of all U.S. households use at least one type of pesticide in or around the home (EPA, 2008a). Additional studies have shown that up to 80% of most pesticide exposure occurs inside the home, not only from residential pesticide use, but also from contaminated soil and dust tracked in from outside that settle on the floors and other surfaces of the home (EPA, 2008a).

While pesticides assist farmers to have better crop yields, help make many types of produce more affordable for consumers, and help control disease-carrying pests, the prevalence of pesticide use is not without consequence. Pesticides are designed to kill living organisms; thus, by their very nature, most pesticides carry risk for harm to humans, animals, and the environment (EPA, 2008c). Research on the long-term effects of chronic pesticide exposure is still underway; meanwhile, current research findings generally include studies done only on the approximately 900 registered individual pesticides and their affects on adult health (Grandjean & Landrigan, 2006). Research is lacking on the potential affect of pesticides used in combination with other pesticides and/or other chemical agents, as they are most commonly used, and on the hazards of exposure to the unborn fetus, infants, and children.

There are over 125,000 reported pesticide exposures in the United States every year, resulting in approximately 30,000 visits to a health care facility (U.S. Department of Health and Human Services, 2000). Although pesticide exposures and related health effects can occur anywhere, regardless of occupation or location, agricultural workers and their families are at particular risk (Quackenbush, Hackley, & Dixon, 2006). There are approximately 780,000 hired agricultural workers in the United States, most of whom work on farms using agricultural pesticides (U.S. Department of Agriculture, National Agriculture Statistics Service, 2008). Studies have shown that essentially 100% of households with one or more family member whose occupation is as an agricultural worker have pesticide residues present in the home (Lambert et al., 2005; Lu, Fenske, Simcox, & Kalman, 2000; Quandt et al., 2003). This results in the pesticide exposure of all adults and children living in these homes.

Health care providers in clinics providing care to migrant and seasonal farmworkers and clinics in agricultural areas are most likely to see families and children at risk for pesticide exposure or individuals who are presenting with acute or chronic conditions resulting from previous exposures to pesticides. The purpose of this article is to review current studies and strategies to reduce pesticide exposure in children of agricultural workers and to develop recommendations for pediatric health care professionals to provide education on pesticide prevention during routine well-child care visits. Recommendations for parents to help minimize their children's risk of pesticide exposure in the home will be identified.

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The *Primary Care Approaches* section focuses on physical and developmental assessment and other topics specific to children and their families. If you are interested in author guidelines and/or assistance, contact Patricia L. Jackson Allen at pat.jacksonallen@yale.edu.

Health Consequences of Pesticide Exposure

Health effects from exposure to pesticides and other toxic agricultural chemicals include acute symptoms, such as nausea, vomiting, salivation, dizziness, headaches, abdominal pain, skin and eye irritation, changes in heart rate, bronchospasm, convulsions, and even coma and death (Alarcon et al., 2005; Alavanja, Hoppin, & Kamel, 2004; Committee on Environmental Health [CEH] & American Academy of Pediatrics [AAP], 2003; Hollinger, 2009; Hoppin et al., 2006; McCauley, Anger et al., 2006). Acute symptoms of pesticide toxicity usually occur within minutes to hours of exposure and may present predominately as cholinergic excess (Hollinger, 2009).

Chronic health effects from long-term exposure may present as headache, dizziness, fatigue, weakness, chest tightness, difficulty breathing, insomnia, confusion, and difficulty concentrating (Alavanja et al., 2005; CEH & AAP, 2003; Dunn, Burns, & Sattler, 2003; Garry, 2004; Gilbert & Collaborative on Health and the Environment's Learning and Developmental Disabilities Initiative, 2007; Grandjean & Landrigan, 2006). Certain types of cancers, including non-Hodgkin's lymphoma, leukemia, multiple myeloma, soft tissue sarcoma, prostate, pancreatic, and lung and ovarian cancers are all linked to pesticide exposure (Alavanja et al., 2004; Alavanja et al., 2005; McCauley, Anger et al., 2006; Walker, Carozza, Cooper, & Elgethun, 2007). The neurotoxic effects of chronic pesticide exposure has been extensively studied and is associated with developmental delays in children, decreased memory function, deficits in cognitive and motor function, and an increased risk for developing Parkinson's disease (Alavanja et al., 2004; Garry, 2004; Gilbert & Collaborative on Health and the Environment's Learning and Developmental Disabilities Initiative, 2007). If health care professionals are unsure about possible signs and symptoms of pesticide exposure, Pediatric Environmental Health Specialty Units (PEHSU) is a resource for advice on diagnosing and managing pesticide exposure and/or toxicity (see Figure 1). The effects of pesticide exposure on human health and clinical manifestations of exposure continue to be researched, improving the knowledge and ability of primary care providers to recognize the signs and symptoms of exposure, when to screen for pesticide exposure, and how to manage both acute and chronic conditions related to pesticide exposure (see Table 1).

Figure 1.
Resources for Health Care Providers

American Academy of Pediatrics: Desk resource, *Pediatric Environmental Health, 3rd Edition.*

American Association of Poison Control Centers: For information on poison prevention and to find the Poison Control Center nearest you, visit http://www.aapcc.org

Centers for Disease Control and Prevention: www.cdc.gov

For information on the prevalence of pesticide use, pesticide safety laws and regulations, and guidelines for reporting pesticide poisonings, search key words: pesticide safety; pesticide safety, laws and regulations; pesticide poisoning, reporting.

Environmental Protection Agency: www.epa.gov
For information on health risks, food safety, worker protection, and funding opportunities for pesticide safety education programs, search key words: pesticide safety; pesticides, grants, and partnerships. For resources designed for children, teachers, and students, search key words: information for kids, pesticides, or visit www.epa.gov/pesticides/kids/

Farm Safety Just 4 Kids: Contact http://www.fs4jk.org for interactive games, coloring, and quizzes about pesticide safety.

Migrant Clinicians Network: Contact http://www.migrantclinician.org for information on migrant health and http://www.migrantclinician.org/toolsource/resource/aunque-cercasano-pesticide-comic-book-pdf.html for educational materials in comic-book style on pesticide safety and recommended practices for pesticide prevention, available in English and Spanish.

The National Pesticide Information Center: For fact sheets and answers to common questions about pesticide safety, visit http://npic.orst.edu

Pediatric Environmental Health Specialty Units (PEHSU): For information on children's environmental health, tutorials and training opportunities for health care professionals, visit www.aoec.org

Table 1.
Commonly Used Agricultural Pesticide Classes in the U.S. and Their Known Human Toxicity

Pesticide	Toxicity
Organophosphates	Irreversible acetylcholinesterase inhibition, nausea, vomiting, hypersecretion, bronchoconstriction, headache, deficits in cognitive function, Parkinson's disease, cancer
N-Methyl Carbamates	Reversible acetylcholinesterase inhibition, nausea, vomiting, hypersecretion, bronchoconstriction, headache, cancer
Pyrethrins	Allergic reactions, anaphylaxis, tremor, ataxia
Pyrethroids	Tremors, ataxia, irritability, enhanced startle response, salivation, seizures
Organochlorines	GABA blockade, lack of coordination, tremors, sensory disturbances, dizziness, seizures
Phenoxyacetic Acid (Dioxins)	Hodgkin's and non-Hodgkin's lymphoma
Estrogenic Compounds (DDT)	Deficits in cognitive function, changes in mood and affect, pancreatic cancer, breast cancer (loosely coorelated)

Sources: Adapted from Alavanja et al., 2004; CEH & AAP, 2003.

Table 2.
Reasons for Children's Increased Vulnerability to Pesticide Exposure

• Higher basal metabolic rate
• Higher respiratory rate
• Higher skin permeability
• Developmental stages (crawling, hand-to-mouth behavior)
• Developing organ systems, especially the central nervous system

Children and Pesticide Exposure

Children are especially vulnerable to the risks of pesticide exposure for several reasons (see Table 2). Children have higher basal metabolic rates than adults. They eat more food and drink more water per body weight than adults, increasing their risk for higher levels of ingestion of toxic chemicals found in contaminated food or water. Children have higher respiratory rates that put them at higher risk for absorption of airborne pesticide particles (Allen, 2007; CEH & AAP, 2003; Dunn et al., 2003; Garry, 2004; Schafer, Reeves, Spitzer, & Kegley, 2004; Sexton et al., 2003; Walker et al., 2007). Children also have more permeable skin, which allows for increased absorption of pesticides through dermal contact (CEH & AAP), and their behavioral and developmental patterns contribute to their increased risk of exposure. Children crawl and play on the floor and have breathing zones closer to the ground, where dust, dirt, and toxins accumulate (Dunn et al., 2003; Pope, Snyder, Mood, & Committee on Enhancing Environmental Health Content in Nursing Practice, Division of Health Promotion and Disease Prevention, Institute of Medicine, 1995). Children often put their hands and other objects in their mouths, increasing the likelihood of even further exposure to and ingestion of higher levels of pesticides (Dunn et al., 2003; Garry, 2004). Many studies suggest that the developing organ systems of children, especially the central nervous system, may be more sensitive to pesticide exposure compared with adults (CEH & AAP, 2003; Dunn et al., 2003; Lambert et al., 2005). These combined factors allow pesticides, as measured through blood serum or urine analysis, to reach much higher levels in children, per kilogram of body weight, than in adults (Garry, 2004).

Pathways of Pesticide Exposure in Children of Agricultural Workers

Children's exposure to pesticides can occur through a multitude of pathways. Children of agricultural workers are exposed to pesticide residues tracked into the home on clothing, shoes, and bodies of their family members after working in the fields (Lambert et al., 2005; Lu et al., 2000; Strong, Thompson, Koepsell, & Meischke, 2008). Once pesticide residues are brought into the home, they can remain there for extended periods, settling on the floors and windowsills, in the carpet, and the surfaces of objects inside the home (Quandt et al., 2004). A study conducted by Lu et al. (2000) showed that children of agricultural workers have pesticide metabolite concentrations in their urine that are five times higher than children living in the same community whose parents are not agricultural workers (Lu et al., 2000). Lu et al. (2000) also found that 16% of children of agricultural workers had detectable pesticide residues on their hands, while none of the children of non-agricultural workers had detectable levels.

Children living near agricultural communities, regardless of parental occupation, can be exposed to pesticides through "drift" of pesticide application, as shown by similar studies comparing hand-wipe samples and urine pesticide metabolites in children living within varying proximity of treated farmland (Lu et al., 2000). Studies show that house dust and soil samples contain greater levels of pesticide residue the closer they are to the pesticide-treated agricultural fields (Lambert et al., 2005; Lu et al., 2000; McCauley et al., 2001). This is especially significant for children of farmworking families because they often live in close proximity to agricultural areas where agricultural "drift" of pesticides can occur. Farmworker housing often lacks adequate circulation, causing many families to leave windows open, allowing pesticide drift to enter the home, settling on window sills, floors, toys, and other surfaces (McCauley, Travers, Lasarey, Muniz, & Nailon, 2006). The behavioral activities of young children put them at increased risk for exposure to these residues as they crawl and play on the floor and put toys and other objects into their mouths, similar to the patterns of behavior that put children at increased risk for toxic lead exposure (Centers for Disease Control and Prevention [CDC], 2005; CEH & AAP, 2003; Quandt et al., 2004).

Adolescents, who often work in agriculture independently or alongside their parents, carry their own set of particular risks for pesticide exposure. Adolescents have often acquired less knowledge than adults regarding the risks of pesticide exposure and safety precautions in the work place (McCauley, Sticker, Bryan, Lasarev, & Scherer, 2002). Studies also show that adolescents often have a different perception of risk than adults, a factor that can affect willingness to abide by recommended safety precautions at work and home (McCauley et al., 2002). Although school exposures are beyond the scope of this article, it is important to note that studies have shown an increase in the prevalence of pesticide-related illnesses at schools through pesticide application on school grounds and through drift exposure from neighboring farms (Alarcon et al., 2005).

Laws and Regulations

In spite of the known health affects of chronic pesticide exposure, current laws and regulations are not comprehensive. Laws are limited to agricultural use of pesticides and focus only on minimizing occupational exposure (EPA, 2008b). The Fair Labor Standards Act, enforced by the Department of Labor, allows employers to hire children for farm labor at a younger age than other employers, starting at age 12 or younger (U.S. Department of Labor, Employment Standards Administration, Wage and Hour Division, 2007). Furthermore, there is no limit to the number of hours a child may work in farm labor (Human Rights Watch, 2000). Adequate housing is considered a basic human right (United Nations General Assembly, 1948); however, most housing facilities for agricultural workers are in substandard condition, are adjacent to fields where pesticides are applied, lack laundry facilities or sufficient space to store work clothes separately, and are overcrowded (Early et al., 2006). Compliance with laws and regulations regarding pesticide safety vary considerably among employers, resulting in many unsafe exposures, incidences of pesticide poisoning, and long-term health consequences (Arcury, Quandt, Cravey, Elmore, & Russell, 2000; Buhler, Langley, Luginbuhl, Jones, & Burnette, 2007; Quackenbush et al., 2006; Shipp, Cooper, Burau, & Bolin, 2005).

Although the EPA and the Occupational Safety and

Table 3.
Training Requirements for Agricultural Workers

• All farmworkers working in areas where pesticides are applied must receive worker safety training.
• Workers must be trained within five days of beginning to work in a pesticide-treated area.
• Training must be repeated every five years.
• Training must be provided in a language understood by the farmworker.
• Training must include the following topics:
➤ Description of where pesticides may be encountered on the job.
➤ Acute and chronic health effects of pesticide exposure.
➤ Pathways of exposure.
➤ Signs and symptoms of pesticide poisoning.
➤ Emergency first aid for pesticide poisoning.
➤ Instructions for obtaining emergency medical care.
➤ Decontamination procedures including emergency eye flushing.
➤ Hazards from pesticide drift.
➤ Hazards from pesticide residue on clothing.
➤ Hazards from taking pesticides or pesticide containers home.
• Requirements of the Worker Protection Standard (WPS) to reduce workers' pesticide exposure risk (clear signage, application and entry restrictions, protection against retaliatory acts).

Sources: Adapted from Arcury et al., 1999; McCauley et al., 2004.

Health Administration (OSHA) require all agricultural workers to receive comprehensive safety training for working with and around pesticides, studies have shown that many do not actually receive adequate or effective training (McCauley, Shapiro, Scherer, & Lasarev, 2004; Quackenbush et al., 2006; Strong et al., 2008). Approximately 80% of farmworkers in the United States are Latino, the vast majority from Mexico (Arcury, Quandt, & Russell, 2002). While pesticide safety training is provided in Spanish, studies indicate that over half of the Spanish-speaking workers speak indigenous languages as a first language (McCauley et al., 2004). Educational and literacy levels, as well as cultural beliefs, may also form barriers to the efficacy of pesticide safety training programs for farmworkers (see Table 3) (Arcury, Marín, Snively, Hernández-Pelletier, & Quandt, 2008; McCauley et al., 2002; McCauley et al., 2004; Quackenbush et al., 2006).

Recommendations for reducing the risk of pesticide exposure in children have been provided by organizations, such as the National Children's Center for Rural and Agricultural Health and Safety (National Ag Safety Database, n.d.) and by individual studies on the effectiveness of recommended safety behaviors (Keifer, 2000; McCauley et al., 2001; McCauley, Travers et al., 2006; National Children's Center for Rural and Agricultural Health and Safety, 2009). Although there is still a need for further research on the effectiveness of these safety behaviors, practices, such as safe storage of residential pesticides, household and personal cleaning habits, showering and changing clothes after working in treated fields and before holding or playing with children, outdoor precautions, and other safety measures, have been linked to a reduction in pesticide exposure in adults and children of agricultural workers (CDC, 2005; CEH & AAP, 2003; Keifer; 2000; McCauley, Travers et al., 2006; National Children's Center for Rural and Agricultural Health and Safety, 2009).

The Health Belief Model and Literature Regarding Pesticide Exposure in American Farmworkers

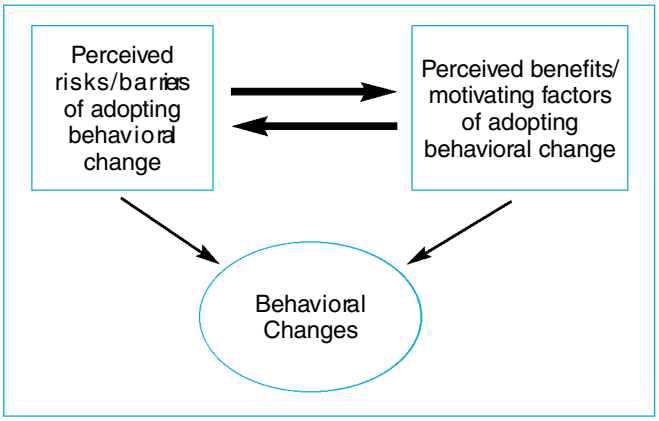
The Health Belief Model focuses on the health beliefs of the individual and the perceived threats or risks for a particular health outcome versus the perceived benefits of taking a certain action or implementing a behavioral change (Encyclopedia of Public Health, 2006; Noar, 2006; Rosenstock, Strecher, & Becker, 1988). This framework was chosen as a means to evaluate the influencing factors associated with the implementation of safety behaviors by farmworkers to minimize their children's risk for exposure. Identifying the positive and negative factors affecting potential behavioral changes in farmworker families to reduce pesticide exposure in their children will assist pediatric health care professionals in planning more effective guidelines for health assessment and education targeting pesticide exposure risk (see Figure 2).

Barriers to Pesticide Safety Behaviors

Varied Levels of Farmworker Knowledge Regarding Health Risks of Pesticide Exposure

The literature reveals many differences in the level of knowledge among farmworkers regarding the health risks associated with chronic pesticide exposure. Factors positively correlated with increased knowledge of pesticide risks include having received pesticide safety training within the past five years, speaking Spanish as a first language (compared with indigenous languages), age over 19 years, living in labor camps, and working directly with pesticide application (Arcury, Quandt, Austin, Preisser, & Cabrera, 1999; Arcury et al., 2002; Liebman, Juarez, Leyva, & Corona,

Figure 2.
Health Belief Model



Source: Adapted from Noar, 2006.

2007; McCauley et al., 2002; McCauley et al., 2004; Quackenbush et al., 2006). These findings suggest that pesticide safety training may not always be culturally or language-appropriate, and that the efficacy of educational information may increase with the greater frequency of its implementation (McCauley et al., 2004; Quackenbush et al., 2006; Rao et al., 2006). The fact that farmworkers directly involved in the application of agricultural pesticides show increased levels of knowledge regarding health risks of exposure could mean that agricultural workers who do not directly apply pesticides to crops may receive less information about safety behaviors (Strong et al., 2008). It could also indicate differences in perceived risks reflected in varying levels of actively obtaining or recalling safety information. It is important to note that spouses and other family members who are not agricultural workers themselves receive little to no information regarding the risks and pathways of exposure to pesticides in the home (Rao et al., 2006; Shipp et al., 2005). Therefore, many mothers do not receive adequate information on pesticide exposure prevention, in spite of their dominant role as caregiver for their families and their responsibility to safeguard the health of their children (Rao et al, 2006; Shipp et al., 2005).

Perception of Risk among Agricultural Workers And their Families

Studies that assess the perception of risk regarding pesticides among agricultural workers show many surprising results. Although most farmworkers express beliefs that exposure to pesticides can be harmful to their health, their understanding of the potential risks varied. For example, in a study conducted by McCauley et al. (2004) among migrant farmworkers in Oregon, almost 50% of farmworkers did not believe that pesticide exposure posed any health risks to pregnant women. In this same study, 65% of farmworkers were unaware that harmful health effects of pesticide exposure can have delayed as well as immediate effects, and over half of farmworkers did not know that pesticides can enter the body through the skin (McCauley et al., 2004). Since pesticide toxicity often does not present with acute signs and symptoms of pesticide poisoning (rash, respiratory symptoms, nausea, vomiting, headache), chronic, low-level pesticide exposure is not recognized by farmworking families as a serious health threat (McCauley et al., 2004).

Coinciding evidence shows that many mothers of farmworking households believe the presence of an odor emitted by pesticides is the primary indicator of the toxicity of the chemical, and if an odor is not present in the treated field or home, or on clothing, toys, shoes, or carpeting, there is no danger of pesticide exposure (Rao, Quandt, Doran, Snively, & Arcury, 2007). Several studies have shown that many farmworkers and their family members believe the risk of pesticide exposure is present only while working in the fields, and that exposure to pesticides in the home does not pose a significant risk (Acosta, Chapman, Bigelow, Kennedy, & Buchan, 2005; Arcury et al., 2008; Rao et al., 2006). Since children do not typically work in the pesticide-treated fields, it is important to address this gap in knowledge regarding pathways of exposure. Children are, in fact, exposed to pesticides at home, even if they are not directly exposed to the fields (Rao et al., 2006; Rao et al., 2007). In most of the studies done on perceived risk among agricultural workers, adolescents scored particularly low in their perception of risk, indicating an even greater need for intervention and education among this population (McCauley et al., 2002; McCauley et al., 2004).

Lack of Feeling in Control of Pesticide Exposure Among Farmworking Families

Research indicates that farmworkers perceive a risk of losing their jobs if they complain about pesticide exposure or ask for protective measures to be taken; in addition, they believe the level of risk would not change even if they were to take action (Arcury et al., 2002; Arcury et al., 2008; Rao et al., 2007; Strong et al., 2008). These findings reflect a degree of perceived helplessness experienced by farmworkers that may affect the degree to which farmworkers are willing to implement safety behaviors in the field and at home (Strong et al., 2008).

Cultural Barriers

Other barriers to implementing changes in health behaviors include gender roles and the perceived lack of power expressed by female farmworkers or spouses of farmworkers to change the behaviors of others in their household (Arcury et al., 2008; Rao et al., 2007). Cultural beliefs also seem to play a role in the likelihood of farmworkers to implement certain pesticide safety behaviors. For example, many Mexican immigrants adhere to humeral medicine beliefs, which consider it harmful to mix metaphorically "cold" and "hot" substances such as water, which is metaphorically cold, with a body that is hot after a day's work (Arcury et al., 2001; Arcury et al., 2008; Spector, 2004). This belief contradicts one of the primary recommendations for preventing pesticide exposure in children of agricultural workers, which is to shower immediately after working with pesticides before holding or playing with children at home (Arcury et al., 2001; Arcury et al., 2008).

Poverty as a Barrier to Implementing Pesticide Safety Behaviors at Home

Agricultural workers earn an average wage of $7.25 per hour, and many have a total family income below the poverty line (Hollinger, 2009; U.S. Department of Labor, Employment Standards Administration, Wage and Hour Division, 2007). Poverty is associated with several barriers to implementing pesticide safety behaviors; among these are the quality of housing and living conditions experienced by many agricultural workers and their families. Housing in agricultural labor camps is often old and in need of repair, making them harder to clean. This increases the level of pesticide residue in the home, and also increases the likelihood of the use of residential pesticides due to increased pests, such as insects and rodents, in and around the home

(Arcury et al., 2008; McCauley, Travers et al., 2006; Quandt et al., 2004).

Multiple families often live in the same home, many of them working as agricultural workers, increasing the amount of pesticide residue tracked into the home from the treated fields where they work. Furthermore, crowded living conditions decrease the ability of many families to implement other recommendations, such as showering and changing clothes before or immediately upon arrival home, storing work clothes separately, and keeping residential pesticides stored safely (Arcury et al., 2008; Quandt et al., 2004; Rao et al., 2006). Poverty may impede farmworking families' access to laundry facilities. This could make it more difficult to separate work laundry from the rest of the household laundry or may actually encourage separation of laundry if workers are given access to company-owned laundry facilities (Rao et al., 2006). Lower income levels may also limit families' ability to own multiple pairs of shoes and/or attire used exclusively for working in the fields. These provisions are generally not available for field workers on most U.S. farms, although the EPA Worker Protection Standard (WPS) does require that all pesticide handlers be provided with protective clothing and equipment (Salvatore et al., 2008).

Perceived Benefits and Motivating Factors For Implementing Safety Behaviors

Access to Culturally Appropriate Information Regarding Pesticide Safety

In general, the adoption of pesticide safety behaviors correlates positively with the level of knowledge about potential exposure risks (Acosta et al., 2005; Arcury et al., 1999; Arcury et al., 2002; Arcury et al., 2008; Liebman et al., 2007; Rao et al., 2006; Salazar, Napolitano, Scherer, & McCauley, 2004; Shipp et al., 2007). Multiple studies have shown that higher levels of understanding regarding pesticide safety, such as pathways of pesticide exposure, health-related risks of exposure, and protective measures that can reduce the family's exposure rate, are linked to the likelihood of implementing measures to reduce exposure (Acosta et al., 2005; Arcury et al., 2008; Liebman et al., 2007). The efficacy of pesticide safety training programs positively correlate with an age of greater than 19, higher literacy levels, and Spanish being the primary language spoken by participants, as opposed to an indigenous language. This demonstrates the need for more customized training programs that are better able to communicate critical information to different age groups, as well as people with varying literacy levels and primary languages (Arcury et al., 2008; Hiott, Quandt, Early, Jackson, & Arcury, 2006; McCauley et al., 2002; McCauley et al., 2004; Rao et al., 2006).

Availability of Information in the Primary Care Setting on the Prevention of Pesticide Exposure

Comprehensive and culturally sensitive guidelines that address key prevention measures for decreasing pesticide exposure in children at varying stages of their development are currently lacking in the primary care setting. Studies show that most health care providers don't feel prepared to provide education on how to minimize or prevent pesticide exposure in children of agricultural workers, and few have been trained to recognize the clinical signs of pesticide poisoning (Arcury et al., 2008; Hiott et al., 2006; McCauley et al., 2006; Quackenbush et al., 2006). Additionally, education materials provided by health care workers do not often address many language or cultural barriers, preventing farmworking families from following the recommended safety precautions for decreasing pesticide exposure risk in children (Arcury et al., 2001; Hiott et al., 2006). Although no recent studies have been conducted to assess the sources where farmworkers and their families receive their information regarding pesticide safety, a study conducted by Arcury et al. (1999) showed that health care providers accounted for only 8.5% of these information sources.

Health care providers are in a unique position to address the immediate and long-term health affects of pesticide exposure at the individual and community levels, and to provide education on how to reduce or eliminate such exposures (Dunn et al., 2003; Strong et al., 2008). Research shows that the correlation between pesticide safety awareness and safety behaviors is strong not only among farmworkers themselves, but also among spouses and other family members (Arcury et al., 2008; Liebman et al., 2007). According to the findings of these studies, by providing pesticide prevention education to agricultural workers and their families, primary care providers would be able increase the likelihood that the families they serve will implement preventative safety behaviors at home, thereby decreasing pesticide exposures among farmworker families and children.

Knowledge as a Tool to Control Pesticide Exposure

Many farmworkers report feeling helpless in preventing pesticide exposure (Strong et al., 2008). Providing farmworking families with the knowledge they need to make positive changes to reduce their exposure risk, as well as the risk to their children, is the first step toward making an effective change (Acosta et al., 2005; Arcury et al., 2002). In a study published by Arcury et al. (2002), receiving information about pesticide safety was shown to increase the sense of control felt by farmworkers, thereby increasing the likelihood that they would implement pesticide safety behaviors. Other studies have shown that frequent access to pesticide training programs was most highly correlated to the motivation for and implementation of behavioral changes to decrease the risks of pesticide exposure among farmworking families (Acosta et al., 2005; Arcury et al., 2002; Arcury et al., 2008; Liebman et al., 2007; McCauley et al., 2002; Rao et al., 2006; Shipp et al., 2007; Strong et al., 2008). Farmworkers living in the community may have less access to pesticide education and prevention programs, and therefore, be less likely to implement pesticide safety behaviors in their homes (Rao et al., 2006; Strong et al., 2008).

Implications for Practice: Guidelines for Health Care Providers

Chronic pesticide exposure has detrimental affects on human health, particularly of children (Alavanja et al., 2004; Dunn et al., 2003; Garry, 2004; Gilbert & Collaborative on Health and the Environment's Learning and Developmental Disabilities Initiative, 2007; Walker et al., 2007; Weiss, Amler, & Amler, 2004). Health care providers have an ethical duty to protect the health of children through family health education and risk management (Gilbert & Collaborative on Health and the Environment's Learning and Developmental Disabilities Initiative, 2007; Quackenbush et al., 2006). Primary care providers can assist farmworking families by providing correct information, preferably in the family's native language, recognizing the literacy level and cultural beliefs the family holds regarding illness and treatment. An opportunity for families to ask questions and voice their concerns regarding pesticide safe-

Table 4.
Risk Factors Associated with Pesticide Exposure in Children at Different Stages of Child Development

Pre-Conception	• Lower sperm counts in men • Higher rate of spontaneous abortion in women exposed to pesticides during preconception period
Prenatal	• Higher incidence of spontaneous abortion • Many pesticides cross the placenta • Increased rates of congenital defects and cancer, especially with exposure in the first trimester
Infancy	• Highly permeable skin allows greater dermal absorption • Rapid neural development increases risk for neurological damage • Highly permeable gastrointestinal system • Immature renal and hepatic systems • Many pesticides are passed on to infants through breast milk
Toddlerhood/Preschool	• Play, crawl, and breathe close to the floor where pesticide residues accumulate • Hand-to-mouth behavior • Higher metabolism leads to greater exposure in proportion to body size • Risk of ingesting pesticides stored in and around the home
School-Age	• Outdoor play increases risk, especially in agricultural areas • Risk of ingesting pesticides stored in and around the home
Adolescence	• Work-related exposure in fields • High risk behaviors and decreased risk perception • Risk for adolescent pregnancy and preconception/prenatal risks

Sources: Alavanja et al., 2004; CEH & AAP, 2003; Dunn et al., 2003; Garry, 2004; Keifer, 2000; Leibman et al., 2007: Ma et al., 2008; McCauley, Travers et al., 2006; National Children's Center for Rural and Agricultural Health and Safety, 2003; Quackenbush et al., 2006; Rao et al., 2006; Salazar, 2004; Weiss et al., 2004.

ty should be provided. Well-child and incidental visits are an excellent opportunity for health care providers to break the myths of perceived risk and provide culturally appropriate education on pesticide risks and prevention strategies. The recommendations outlined in this article were guided by the Health Belief Model, which identifies the perceived risks and perceived benefits of prevention strategies, and addresses topics that most influence the likelihood of families to implement behavioral changes that would result in decreased pesticide exposure of farmworking children.

To reduce pesticide exposure in children of agricultural workers, sometimes changes must be made at the community or policy level as well. As previously mentioned, many farmworkers are hesitant to ask their employers for protective clothing, access to laundry facilities, clean water sources for washing before lunch and after work, masks, gloves, or better housing conditions, due to fear of losing their jobs or for other reasons. Health care providers must be prepared to advocate for their patients in these cases by communicating with agricultural employers about the risks of pesticide exposure in children and adults, and how changes in working and living conditions of agricultural workers can help reduce this risk. If communication with employers is not effective, health care providers may consider working with Departments of Public Health and the EPA to develop policies requiring lists of pesticides used in and around the community, as well as community notification before pesticide application occurs. Providers may also work with Public Health and the EPA to enforce regulations around required pesticide safety training and protective equipment for agricultural employees, or organize informational workshops at nearby farms, labor housing settings, or other community locations.

Risks for pesticide exposure at different stages of child development can help guide primary care providers in giving recommendations to parents for minimizing exposure risk and providing anticipatory guidance. Pesticide safety education at routine well-child visits should focus on developmental risks of children, health effects of pesticide exposure, and specific tools for parents to reduce their children's risk of exposure. Table 4 summarizes key risk factors for pesticide exposure from pre-conception through adolescence and provides guidelines for intervention by the pediatric primary care provider.

Recommendation Guidelines

The following recommendation guidelines address these risk factors and provide suggestions for patient education on how parents can help to minimize these risks.

Pre-Conception

Lower sperm counts and reduced sperm quality have been associated with pesticide exposure in men (Garry, 2004). Higher incidence of spontaneous abortions and birth defects are linked to exposure in women during the pre-conception period and in early pregnancy (Garry, 2004; McCauley, Anger et al., 2006). Personal protective equipment, such as coveralls, gloves, shoes, and facial scarves or masks, have been linked to lesser levels of pesticide toxicity, as well as precautions, such as not eating while working in the fields and washing hands before eating (Keifer, 2000; National Children's Center for Rural and Agricultural Health and Safety, 2009).

- Use protective work clothing, gloves, and masks at all times while working in fields treated with pesticides. If protective personal equipment is not available on the job, the farm employer should be contacted and asked to provide adequate protective work gear. If patients do not feel comfortable with asking their employer, health

care providers can advocate for protective gear on behalf of their patients, while keeping patients' names anonymous.
- Avoid eating while still working in treated fields. Take breaks away from fields and thoroughly wash hands before eating.
- Avoid direct exposure to pesticides when possible while trying to conceive.

Prenatal

Pesticides may cross the placenta and compete for nutrients. Toxins that cross the placenta may significantly affect the development of the rapidly growing fetus, particularly in the first trimester of pregnancy, resulting in increased risk of cancer and/or congenital defects, particularly in the first trimester of pregnancy (Dunn, 2003; Garry, 2004; Ma, 2008; Quackenbush et al., 2006).
- If possible, avoid direct handling of pesticides during pregnancy, especially during the first trimester.
- Avoid working in fields soon after they have been sprayed with pesticides. Although there is no proven "safe" re-entry time after fields have been sprayed, it is presumed that longer re-entry periods after pesticide spraying reduce the level of exposure (Salvatore et al., 2008).
- Continue precautions, such as eating away from treated fields and after hand washing, and the use of protective work clothing, gloves, and masks.

Infancy

Infants have very permeable skin, which increases their risk for exposure when their skin comes into contact with pesticides. This is a time of rapid development of the neurological system in an infant, and pesticide exposure during this period can damage infants' neurological and behavioral development (Dunn et al., 2003). The highly permeable gastrointestinal systems of infants, combined with their immature renal and hepatic systems, put them at higher risk for pesticides to quickly build up in their bodies (Dunn et al., 2003). Many pesticides are passed on to infants through the mother's breast milk, so it is important for nursing mothers to limit their exposure while nursing (Weiss et al., 2004).
- Shower and change clothing immediately after working in treated fields and before holding an infant (CEH & AAP, 2003; National Children's Center for Rural and Agricultural Health and Safety, 2009).
- Wash work clothing separately from household laundry to avoid infants' pesticide exposure through dermal contact with contaminated clothing (CEH & AAP, 2003; Liebman et al., 2007; Rao et al., 2006).
- Continue precautions to limit breastfeeding mothers' occupational exposure by using protective work gear, eating away from treated fields, and washing hands thoroughly.

Toddlerhood/Preschool

Behaviors of toddlers put them at special risk for pesticide exposure. Toddlers play, crawl, and breathe close to the floor where pesticide residues can accumulate (CEH & AAP, 2003; Garry, 2004). Toddlers' hand-to-mouth behavior also increases their risk when their hands and other objects contain pesticide residues. Toddlers have higher metabolism rates than adults, meaning they eat, drink, and breathe more in proportion to their body size than adults, further increasing their risk (CEH & AAP, 2003; Dunn et al., 2003; Garry, 2004; National Children's Center for Rural and Agricultural Health and Safety, 2009).
- Regular cleaning of household surfaces, such as floors, windowsills, and furniture, as well as toys and other objects that toddlers are likely to put in their mouths, can reduce their exposure (McCauley, Travers et al., 2006; National Children's Center for Rural and Agricultural Health and Safety, 2009; Quandt et al., 2003).
- Keep windows closed while nearby fields are being treated (National Children's Center for Rural and Agricultural Health and Safety, 2009).
- Remove work shoes before entering the house to avoid tracking pesticide residue onto the floor (Arcury et al., 2008; CEH & AAP, 2003; National Children's Center for Rural and Agricultural Health and Safety, 2009).
- Practice frequent hand-washing behavior with the toddler.
- Wash all commercially grown fruits and vegetables prior to feeding them to a toddler.
- Limit the use of residential pesticides inside and around the home. Use safer alternatives or pest prevention practices when possible (EPA, 2008a; National Children's Center for Rural and Agricultural Health and Safety, 2009).
- Practice safe storage of pesticides at home. Do not store pesticides in food containers. Keep pesticides and other toxic materials out of reach of toddlers (CEH & AAP, 2003; EPA, 2008a; National Children's Center for Rural and Agricultural Health and Safety, 2009).
- Continue to shower immediately after working in fields and before holding or playing with a toddler. Continue to wash and store work clothes separately from household laundry.

School-Age

Outdoor play may contribute to pesticide exposure in school-aged children, especially in rural areas in close proximity to treated fields (CEH & AAP, 2003; Dunn et al., 2003; National Children's Center for Rural and Agricultural Health and Safety, 2009).
- During nearby aerial spraying of pesticides, either cover outdoor toys or bring them indoors. Wash them before re-use (CEH & AAP, 2003; National Children's Center for Rural and Agricultural Health and Safety, 2009).
- Do not let children swim or play in agricultural drainage ditches that may be contaminated with pesticides (CEH & AAP, 2003; National Children's Center for Rural and Agricultural Health and Safety, 2009).
- Keep children inside while pesticides are being sprayed on nearby fields.
- Continue to practice pesticide safety behaviors at home, such as separating laundry, taking work shoes off before entering the home, showering after work and before playing with children, storing pesticides safely at home, washing hands regularly, and washing fruits and vegetables before consumption.

Adolescence

Adolescents may be working in treated fields themselves, and they should be counseled on the risks of pesticide exposure and safety precautions to minimize exposure. Adolescents may have an altered perception of risk and may have received less information and/or prevention training on the job, putting them at higher risk for exposure (Dunn et al., 2003; McCauley et al., 2002; Salazar et al., 2004; Shipp et al., 2007).
- Counsel adolescents on short and long-term health risks of pesticide exposure and how to reduce occupational exposure.

- Counsel adolescents on the effects pesticide exposure can have on reproduction (lower sperm counts, increased risk of miscarriage, and birth defects).
- Continue regular health screenings and comprehensive physicals, including screening for pesticide exposures.
- Teach adolescents about safety behaviors at home, such as washing work clothes separately, removing work boots before entering the home, and showering immediately after work, to protect any younger siblings or children that might live at home with them.
- Offer pre-conception education to adolescents and explain the risks of pesticide exposure during the pre-conception period, such as reduced sperm counts in men and the higher rate of spontaneous abortion in women.

Conclusions

Health care providers serving patients in agricultural areas are seeing some of the most at-risk individuals for pesticide exposure. Children of agricultural workers are at even greater risk for the serious health effects of chronic pesticide exposure (Dunn et al., 2003; Garry, 2004; Lambert et al., 2005). Since increased knowledge about the risks and safety measures to prevent pesticide exposure is most positively correlated to recent participation in a pesticide prevention program, health care providers can continually influence the likelihood that farmworking families will implement these safety measures by consistently addressing pesticide safety in the primary care setting during scheduled well-child visits. Health care providers can empower families to protect their children from the harmful short and long-term effects of pesticide exposure by providing regular culturally sensitive and language-appropriate education on limiting pesticide exposure in the home and while working in the fields. This educational information may help families to appreciate their risk, as well as gain a sense of control over their ability to minimize this risk.

Consistent prevention strategies can result in fewer pesticide-related chronic health conditions and improved quality of life for the entire family. Some barriers to implementing pesticide safety behaviors may require the advocacy of health care providers to enforce laws and regulations regarding crowded labor camps, substandard housing units, or availability of protective equipment to prevent farmworking families from following recommendation guidelines for greater pesticide safety. Health care providers must intervene at the community, state, and federal levels by advocating for safe working and living conditions for all farmworkers and communities in agricultural areas. Pesticides are known to be harmful to living organisms, and their long-term effects, whether chronic low-level exposure or acute high-level exposure, are unknown. Limiting exposure is the primary health intervention.

References

Acosta, M.S.V., Chapman, P., Bigelow, P.L., Kennedy, C., & Buchan, R.M. (2005). Measuring success in a pesticide risk reduction program among migrant farmworkers in Colorado. *American Journal of Industrial Medicine, 47*(3), 237-245.

Alarcon, W.A., Calvert, G.M., Blondell, J.M., Mehler, L.N., Sievert, J., Propeck, M., et al. (2005). Acute illnesses associated with pesticide exposure at schools. *The Journal of the American Medical Association, 294*(4), 455-465.

Alavanja, M.C.R., Hoppin, J.A., & Kamel, F. (2004). Health effects of chronic pesticide exposure: Cancer and neurotoxicity 3. *Annual Review of Public Health, 25*(1), 155-197.

Alavanja, M.C., Sandler, D.P., Lynch, C.F., Knott, C., Lubin, J.H., Tarone, R., et al. (2005). Cancer incidence in the agricultural health study. *Scandinavian Journal of Work, Environment & Health, 31*(Suppl. 1), 39-45.

Allen, P.J. (2007). *Environmental health screening.* (Course presented at Yale University School of Nursing, New Haven, CT).

Arcury, T.A., Marín, A., Snively, B.M., Hernández-Pelletier, M., & Quandt, S.A. (2008). Reducing farmworker residential pesticide exposure: Evaluation of a lay health advisor intervention. *Health Promotion Practice, 10*(3), 447-455.

Arcury, T.A., Quandt, S.A., Cravey, A.J., Elmore, R.C., & Russell, G.B. (2001). Farmworker reports of pesticide safety and sanitation in the work environment. *American Journal of Industrial Medicine, 39*(5), 487-498.

Arcury, T.A., Quandt, S.A., Austin, C.K., Preisser, J., & Cabrera, L.F. (1999). Implementation of EPA's worker protection standard training for agricultural laborers: An evaluation using North Carolina data. *Public Health Reports, 114*(5), 459-468.

Arcury, T.A., Quandt, S.A., & Russell, G.B. (2002). Pesticide safety among farmworkers: Perceived risk and perceived control as factors reflecting environmental justice. *Environmental Health Perspectives, 110*(Suppl. 2), 233-240.

Buhler, W.G., Langley, R.L., Luginbuhl, R.C., Jones, J.P., & Burnette, J.W., Jr. (2007). Violations of pesticide use and worker safety regulations in North Carolina. *Journal of Agricultural Safety and Health, 13*(2), 189-203.

Centers for Disease Control and Prevention (CDC). (2005). *Preventing lead poisoning in young children.* Retrieved August 10, 2009, from http://www.cdc.gov/NCEH/lead/publications/books/plpyc/contents.htm

Committee on Environmental Health (CEH), & American Academy of Pediatrics (AAP). (2003). Pesticides. In R.A. Etzel, & S.J. Balk (Eds.), *Pediatric environmental health* (2nd ed., pp. 323-359). Elk Grove Village, Ill.: American Academy of Pediatrics.

Dunn, A.M., Burns, C., & Sattler, B. (2003). Environmental health of children. *Journal of Pediatric Health Care, 17*(5), 223-231.

Early, J., Davis, S.W., Quandt, S.A., Rao, P., Snively, B.M., & Arcury, T.A. (2006). Housing characteristics of farmworker families in North Carolina. *Journal of Immigrant and Minority Health, 8*(2), 173-184.

Encyclopedia of Public Health. (2006). *Health belief model.* Retrieved December 18, 2008, from http://www.enotes.com/public-health-encyclopedia/ health-belief-model

Environmental Protection Agency (EPA). (2008a). *An introduction to indoor air quality.* Retrieved April 21, 2009, from http://www.epa.gov/iaq/pesticid.html

Environmental Protection Agency (EPA). (2008b). *Do's and don'ts of pest control.* Retrieved January 11, 2009, from http://www.epa.gov/opp00001/controlling/dosanddonts.htm

Environmental Protection Agency (EPA). (2008c). *Pesticides, health and safety: Worker safety and training.* Retrieved February 23, 2008, from http://www.epa.gov/pesticides/health/worker.htm

Environmental Protection Agency (EPA). (2009). 2000-2001 *Pesticide market estimates: Usage.* Retrieved February 23, 2009, from http://www.epa.gov/oppbead1/pestsales/01pestsales/usage2001.htm#3_1

Garry, V.F. (2004). Pesticides and children. *Toxicology and Applied Pharmacology, 198*(2), 152-163.

Gilbert, S.G., & Collaborative on Health and the Environment's Learning and Developmental Disabilities Initiative. (2007). *Scientific consensus statement on environmental agents associated with neurodevelopmental disorders.* Retrieved November 20, 2007, from http://www.iceh.org/pdfs/LDDI/LDDIStatement.pdf

Grandjean, P., & Landrigan, P.J. (2006). Developmental neurotoxicity of industrial chemicals. *Lancet, 368*(9553), 2167-2178.

Hiott, A.E., Quandt, S.A., Early, J., Jackson, D.S., & Arcury, T.A. (2006). Review of pesticide education materials for health care providers providing care to agricultural workers. *The Journal of Rural Health, 22*(1), 17-25.

Hollinger, B. (2009). Farm worker health risks and physical assessment. *The American Journal for Nurse Practitioners, 13*(4), 8-18.

Hoppin, J.A., Umbach, D.M., London, S.J., Lynch, C.F., Alavanja, M. C., & Sandler, D. P. (2006). Pesticides and adult respiratory outcomes in the agricultural health study. *Annals of the New York Academy of Sciences, 1076*, 343-354.

Human Rights Watch. (2000). *Fingers to the bone: United States failure to protect child farmworkers.* Retrieved April 21, 2009, from http://www.hrw.org/reports/pdfs/c/crd/frmwrk006.pdf

Keifer, M.C. (2000). Effectiveness of interventions in reducing pesticide overexposure and poisonings. *American Journal of Preventive Medicine, 18*(4, Suppl. 1), 80-89.

Lambert, W.E., Lasarev, M., Muniz, J., Scherer, J., Rothlein, J., Santana, J., et al. (2005). Variation in organophosphate pesticide metabolites in urine of children living in agricultural communities. *Environmental Health Perspectives, 113*(4), 504-508.

Liebman A., Juárez P.M., Leyva C., & Corona A. (2007). A pilot program using promotoras de salud to educate farmworker families about the risk from pesticide exposure. *Journal of Agromedicine, 12*(2), 33-43.

Lu, C., Fenske, R.A., Simcox, N.J., & Kalman, D. (2000). Pesticide exposure of children in an agricultural community: Evidence of household proximity to farmland and take home exposure pathways. *Environmental Research, 84*(3), 290-302.

Ma, X., Buffler, P.A., Gunier, R.B., Dahl, G., Smith, M.T., Reiner, K. , et al. (2008). Critical windows of exposure to household pesticides and risk of childhood leukemia. *Environmental Health Perspectives, 110*(9), 955-960.

McCauley, L.A., Anger, W.K., Keifer, M., Langley, R., Robson, M.G., & Rohlman, D. (2006). Studying health outcomes in farmworker populations exposed to pesticides. *Environmental Health Perspectives, 114*(6), 953-960.

McCauley, L.A., Lasarev, M.R., Higgins, G., Rothlein, J., Muniz, J., Ebbert, C., et al. (2001). Work characteristics and pesticide exposures among migrant agricultural families: A community-based research approach. *Environmental Health Perspectives, 109*(5), 533-538.

McCauley, L.A., Shapiro, S.E., Scherer, J.A., & Lasarev, M.R. (2004). Assessing pesticide safety knowledge among Hispanic migrant farmworkers in Oregon. *Journal of Agricultural Safety and Health, 10*(3), 177-186.

McCauley, L.A., Sticker, D., Bryan, C., Lasarev, M.R., & Scherer, J.A. (2002). Pesticide knowledge and risk perception among adolescent Latino farmworkers. *Journal of Agricultural Safety and Health, 8*(4), 397-409.

McCauley, L.A., Travers, R., Lasarev, M., Muniz, J., & Nailon, R. (2006). Effectiveness of cleaning practices in removing pesticides from home environments. *Journal of Agromedicine, 11*(2), 81-88.

National Ag Safety Database. (n.d.). *About Children's Center for Rural and Agricultural Health and Safety.* Retrieved August 20, 2009, from http://www.nasdonline.org/orgs/o000001o000100/o000021.html

National Children's Center for Rural and Agricultural Health and Safety. (2009). *Aunque cerca...sano, una guia para prevenir los riesgos de los pesticides.* Retrieved February 9, 2008, from http://www.migrantclinician.org/files/resourcebox/aunque_comic_book.pdf

Noar, S.M. (2006). A health educator's guide to theories of health behavior. *International Quarterly of Community Health Education, 24*(1), 75-92.

Pope, A.M., Snyder, M.A., Mood, A.L.H., & Committee on Enhancing Environmental Health Content in Nursing Practice, Division of Health Promotion and Disease Prevention, Institute of Medicine. (Eds.). (1995). *Nursing, health & the environment : Strengthening the relationship to improve the public's health.* Washington, D.C.: National Academy Press.

Quackenbush, R., Hackley, B., & Dixon, J. (2006). Screening for pesticide exposure: A case study. *Journal of Midwifery & Women's Health, 51*(1), 3-11, 65-66.

Quandt, S.A., Arcury, T.A., Rao, P., Snively, B.M., Camann, D.E., Doran, A.M., et al. (2004). Agricultural and residential pesticides in wipe samples from farmworker family residences in North Carolina and Virginia. *Environmental Health Perspectives, 112*(3), 382-387.

Rao, P., Gentry, A.L., Quandt, S.A., Davis, S.W., Snively, B.M., & Arcury, T.A. (2006). Pesticide safety behaviors in Latino farmworker family households. *American Journal of Industrial Medicine, 49*(4), 271-280.

Rao, P., Quandt, S.A., Doran, A.M., Snively, B.M., & Arcury, T.A. (2007). Pesticides in the homes of farmworkers: Latino mothers' perceptions of risk to their children's health. *Health Education Behavior, 34*(2), 335-353.

Rosenstock, I.M., Strecher, V.J., & Becker, M.H. (1988). Social learning theory and the health belief model. *Health Education Quarterly, 15*(2), 175-183.

Salazar, M.K., Napolitano, M., Scherer, J.A., & McCauley, L.A. (2004). Hispanic adolescent farmworkers' perceptions associated with pesticide exposure. *Western Journal of Nursing Research, 26*(2), 146-166.

Salvatore, A.L., Bradman, A., Castorina, R., Camacho, J., López, J., Barr, D.B., et al . (2008). Occupational behaviors and farmworkers' pesticide exposure: Findings from a study in Monterey County, California. *American Journal of Industrial Medicine, 51*(10), 782-794.

Schafer, K.S., Reeves, M., Spitzer, S., & Kegley, S.E. (2004). *Chemical tresspass, pesticides in our bodies and corporate accountability.* San Francisco, CA: Pesticide Action Network North America. Retrieved August 5, 2008, from http://www.panna.org/docs Trespass/ChemTresMain(screen).pdf

Sexton, K., Adgate, J.L., Eberly, L.E., Clayton, C.A., Whitmore, R.W., Pellizzari, E.D., et al. (2003). Predicting children's short-term exposure to pesticides: Results of a questionnaire screening approach. *Environmental Health Perspectives, 111*(1), 123-128.

Shipp, E.M., Cooper, S.P., Burau, K.D., & Bolin, J.N. (2005). Pesticide safety training and access to field sanitation among migrant farmworker mothers from Starr County, Texas. *Journal of Agricultural Safety & Health, 11*(1), 51-60.

Shipp, E.M., Cooper, S.P., del Junco, D.J., Bolin, J.N., Whitworth, R. E., & Cooper, C.J. (2007). Pesticide safety training among farmworker adolescents from Starr County, Texas. *Journal of Agricultural Safety & Health, 13*(3), 311-321.

Spector, R.E. (2004). *Cultural diversity in health and illness* (6th ed.). Upper Saddle River, NJ: Pearson Education, Inc.

Strong, L.L., Thompson, B., Koepsell, T.D., & Meischke, H. (2008). Factors associated with pesticide safety practices in farmworkers. *American Journal of Industrial Medicine, 51*(1), 69-81.

United Nations General Assembly. (1948). *Universal declaration of human rights.* Retrieved March 2, 2009, from http://www.un.org/overview/rights.html

U. S. Department of Agriculture, National Agriculture Statistics Service. (2008). *Farm labor.* Washington, D.C.: Retrieved October 22, 2008, from http://www.ers.usda.gov/Briefing/LaborAndEducation/FarmLabor.htm

U.S. Department of Health and Human Services. (2000). *Healthy people 2010* (Conference ed.). Retrieved January 27, 2008, from http://purl.access.gpo.gov/GPO/LPS4217

U.S. Department of Labor, Employment Standards Administration, Wage and Hour Division. (2007). *Child labor requirements in agricultural occupations under the Fair Labor Standards Act (Child Labor Bulletin 102).* Washington, D.C.: Retrieved October 30, 2008, from http://www.dol.gov/esa/whd/regs/compliance/childlabor102.pdf

Walker, K.M., Carozza, S., Cooper, S., & Elgethun, K. (2007). Childhood cancer in Texas counties with moderate to intense agricultural activity. *Journal of Agricultural Safety & Health, 13*(1), 9-24.

Weiss, B., Amler, S., & Amler, R.W. (2004). Pesticides. *Pediatrics, 113*(4), 1030-1036.