

Child Work in Agriculture: Acute and Chronic Health Hazards

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Abstract

An estimated 173 million children are employed worldwide in agriculture. The rural nature of farm work exposes children to extreme climatic conditions, agrochemicals, physical hazards, animals and insects, parasites and infection. The additional risks of migrant accommodation and lifestyles for very young children make this form of employment among the three most hazardous. The health outcomes of child agricultural work in developing countries are under-researched. The majority of published studies focus on acute health outcomes in the U.S. While indicative of hazards, these are likely to underestimate the real risks faced by children in poorer parts of the world. The cross-sectional nature of health surveys means they cannot accurately infer causation and are particularly biased by the healthy worker effect. The long-term health consequences of pesticide exposure, repetitive physical tasks, and inhalation of dust and particles tend to be missed, resulting in an underestimation of chronic health problems such as cancer, asthma and musculoskeletal disorders.

Keywords: [child labor](#), [health hazards](#), [agriculture](#), [migrant labor](#), [pesticides](#)

Introduction

Over 70 percent of all child workers, an estimated 173 million children, work in the agricultural sector (IPEC/ILO 2005a). This includes children who help on family farms, tend livestock, fish, operate agricultural machinery or accompany parents who work in the commercial farming sector. Children account for up to one-third of the global agricultural labor force (ILO 2002).

Agriculture has been identified as one of the three most hazardous types of work (see Table 1). It accounts for almost half of all workplace fatalities in adults and children (ILO 2002). The International Labor Organization's Convention on Health and Safety in Agriculture states that "the minimum age for assignment to work in agriculture *which by its nature or the circumstances in which it is carried out is likely to harm the health and safety of young persons* [hazardous work] shall not be less than 18 years" (paragraph 1, ILO Convention 184, article 16). Signatory countries agree that children will only be employed in non-hazardous forms of agricultural work, and that these should be defined by national laws and regulations (paragraph 2).

Table 1. Distribution of illness/injury by industry and sex as a proportion of all childhood work injuries/illness

Industry (major division)	Percentage of all illness/ injury among working children		
	Both sexes	Boys	Girls
Agriculture, fishing, forestry	70.2	75.8	57.2
Mining and quarrying	0.5	0.5	0.4
Manufacturing	4.7	4.3	5.6
Electricity, gas, water	0.1	0.0	0.1
Construction	2.9	4.1	0.3
Trade, restaurants, hotels	13.4	8.3	25.7
Transport, storage, communications	2.6	3.8	---
Community social/ commercial services	4.9	2.5	10.2
Unspecified industries	0.6	0.7	0.6

Source: Ashagrie (1997)

Child agricultural work is diverse. It occurs in traditional and modern, developing and developed countries, on family farms and commercial plantations. Children often travel long distances alone or with their families, sometimes crossing international borders, to work on farms. In many poor countries children may begin working alongside their parents from 4 or 5 years of age. Some of these children choose to work; others are forced to do so, often as bonded laborers in repayment for a loan taken out by a parent or care-giver. The health effects of agricultural work vary hugely according to the type, conditions of employment, working hours and environment, type of equipment and machinery used, use of protective clothing and enforcement of safety regulations, whether pesticides are used, and a child's

working status (migrant, bonded or voluntary). While working, these children are exposed to the same hazards as adults from injuries with heavy machinery and sharp tools, pesticide poisoning or intoxication, diseases or attacks from animals, respiratory and eye infections from dust or fibers, and strain and musculoskeletal injuries from repetitive or strenuous tasks.

The majority of literature documenting health outcomes of child agricultural work is based on studies carried out in the USA. This research draws attention to the potential health hazards of agricultural work (Landrigan et al. 1995; Pollack and Landrigan 1990; Perry 2003; Wilk 1993) and to issues relating to risk perception, supervision and access to health care in relation to children who work on farms (Zentner et al. 2005; Weathers et al. 2003; Pryor, Caruth and McCoy 2002). Most studies of farm work document cases of injuries (Heyer et al. 1992; Little et al. 2003; Chapman et al. 2003; Gerberich et al. 2001; Parker, Merchant and Munshi 2002). A systematic review of farm injury incidence in children in the U.S. between 1978 and 1998 identified 32 studies, 21 of which specifically look at children (Reed and Claunch 2002). This literature demonstrates that farm and plantation work exposes children to injury, infections, skin diseases, musculoskeletal problems and neurological disorders. In developed countries, work is a marginal activity, serving a very different function than that experienced by working children in the developing world. Worse patterns of morbidity can be expected in less-developed regions of the world where laws regarding occupational safety and health are less rigorously enforced and where work plays a more dominant role in children's lives.

In this paper we draw together evidence of the effects of agricultural labor on the health of children in developing countries from the limited peer-reviewed literature available and supported by research published by the International Labour Organization and other UN agencies. First, we describe the principal health and safety issues associated with agricultural work, the specific vulnerabilities faced by child workers, and the additional hazards imposed by labor migration and employment in the commercial sector. We will then describe in more detail the acute and chronic nature of health hazards, presenting evidence of harm and empirical data demonstrating exposure to these hazards.

In Appendix A we summarize these findings with details of study design and outcomes, type and place of work. The 18 studies identified are evenly distributed across the regions (six from Africa, six from Latin America and five conducted in Asia). The majority did not specify a particular type of agricultural work (e.g., plantation, family farm, day laboring, or type of crop); including all of the secondary data analyses—an indication in itself of one of the main weaknesses of using secondary data. Six studies specifically refer to plantation work (cocoa, tobacco and fruit picking); one is a description of work on family farms and two refer to "rural child work." The non-specific nature of research on child agricultural work suggests there is a real dearth of studies which differentiate between harmful and non-harmful types of work and crop production.

Characteristics of child agricultural work

It is a common misconception that child agricultural work takes place within traditional family farm settings, forming part of the household and community division of labor, where children are unlikely to come to any harm. The majority of agricultural tasks are potentially hazardous when carried out by young children, for long periods, under difficult conditions, or in the vicinity of hazardous substances or equipment. In addition, safety legislation has historically been weaker in agriculture than in other sectors of work (Landrigan et al. 1995; Wilk 1993), allowing occupational exposure to unacceptable levels of risk.

Young Ages

Children tend to start working at younger ages in the agricultural sector, often as part of a family team. A report from the Philippines suggests children as young as 7-8 years weed fields and at 12 are involved in the harvesting of sugarcane, a process which involves swinging a sharp heavy instrument (USDOL 1995). In the U.S., 30 percent of boys working on farms have driven tractors by the age of 9 (Wilk 1993). Reynolds documented the case of children in the Zambezi Valley who are expected to work alongside their parents in the fields for up to 80 hours a week, with little or no supervision (Reynolds 1991). From as young as 12 these children are often given sole responsibility for farming entire fields. The potential for damage and permanent disability is also greater because children's bodies are still growing and developing. Children are more vulnerable to environmental exposures such as agrochemicals than adults because of disproportionately heavy exposures and children's inherent biological susceptibility. The physical spaces that children occupy are also likely to be more contaminated than those of adults because they are closer to the ground (Landrigan et al. 1995; Quang and Woolf 2000; Carlson 2005; Bearer 1995). Evidence suggests that children are more at risk of injury because of inattention, fatigue, poor judgment and because the equipment they use is designed to be operated by adults (Bequele and Myers 1995).

Rural Environment

Rural families in developing countries are among the poorest in the world. Many children are malnourished and in poor health, making them less able to withstand strenuous work and more susceptible to illness and disease (ILO 2002). The climatic conditions of rural life quickly induce fatigue; there is a constant threat of insects, reptiles and other animals; tools are basic; and workers often travel great distances and work long hours. Enforcement of health and safety legislation is an almost impossible task because agricultural work is by nature rural and often both physically and culturally remote. Workers are not usually properly trained or protected when handling hazardous substances or machinery. Protective clothing is often difficult to obtain and where it does exist, it is usually not supplied in children's sizes. Rural families and farmers often only speak local languages and are barely literate, making the packaging and instructions on agrochemical containers incomprehensible (Salinas Alvarez and Díaz Romo 2001).

Migrant and Commercial Labor

In the past decade, impoverishment of rural economies has caused a shift away from small independent farming in favor of plantation and contract agriculture. Many small farmers in developing countries are now forced to supplement their income with waged labor or to enter into exploitative production agreements. Typically, a contract defines the terms by which agricultural corporations lend farmers money to buy seeds and provide technical assistance and equipment. In exchange, farmers are bound to sell their crop back to the lender, often at a rate that is unfavorable to both producer and workers. Anecdotal evidence suggests that multinational corporations such as coffee and tobacco producers make harsh demands on their producers while contractually exonerating themselves from responsibilities for the working and living conditions of workers (Salinas Álvarez and Díaz Romo 2001).

Forty percent of the world's estimated 1.2-1.3 billion agricultural workers are employed as waged laborers in agriculture (ILO 2002). Children constitute as much as one-third of this figure. Globally, Mexico has the highest rates of child agricultural labor (Aitken, López Estrada, and Jennings 2006); an estimated 1.5 million children aged 7-14, or 30 percent of the total agricultural workforce, are employed on commercial farms helping with basic tasks from as young as 4 or 5 years of age (Barriero Garcia and Castellanos Cereceda 2002). The large seasonal workforce required by commercial or contract farms and plantations is most effectively met by migrant laborers—many of whom travel with their family. Since employment in the agricultural sector tends to be paid as piecework, children can contribute to the household income by working as part of a family team. These children often evade statistics and their work is neither recorded nor directly remunerated. Where an hourly or daily rate is paid, it tends to be lower for children than adults (IPEC/ILO 2005a). Most children working as migrant laborers on farms also miss school, therefore perpetuating a cycle of poverty by limiting their future earning capacity.

Methods

To research this phenomenon, we searched Medline, Psych Info and the ISI Web of Knowledge for papers published between 1980 and October 2006 documenting health effects of child agricultural work in developing countries. The bibliographies of selected papers were then hand-searched. Since we could identify very little peer-reviewed literature, we included epidemiological studies documenting potentially harmful exposures and broadened our search to include non-peer-reviewed studies published by United Nations agencies. Literature documenting the health impacts of child work in agriculture is scarce, and even fewer studies document these impacts in the developing world. Many of the studies we identified either use secondary datasets or are methodologically weak: they rely on small sample sizes, lack comparison groups or do not attempt to control for confounders.

To date, assumptions about conditions of work and risks tend to be made based upon knowledge of exposures, literature from developed countries, studies of adult occupational health, and analysis of household data, but direct links have not been established. The unique environmental vulnerabilities of child workers suggest that

extrapolation of studies of occupational environmental health in adults underestimates the risks they face in work. In Table 2 we present advantages and disadvantages of the different types of study design that have been used to measure the health impacts of child work. Longitudinal studies offer the most precise means of analyzing the multiple relationships between child labor and health; unfortunately, we only identified one such study of child agricultural work, carried out in India. Five of the studies present the results of cross-sectional analyses. While this is often the quickest and cheapest means of gathering primary data, it leaves considerable scope for bias and cannot accurately measure causality. For these reasons, several of the studies selected only present descriptive data on injury incidence among the study population (e.g., Daga 2000; Banerjee 1993; Mull and Kirkhorn 2005). A further four studies used a case control design. While useful for comparing exposed and unexposed populations and for measuring rare outcomes, case control studies are prone to selection and recall bias, cannot easily identify the temporal sequence of events or eliminate the "healthy worker effect,"¹ and results cannot be generalized to a wider population. For example, Fentiman and colleagues' study of agricultural labor and fishing in Ghana (2001) suggests these types of work can be harmful but cannot give any indication of how widespread the problem may be. The most popular study design involves the analysis of household survey data. Panel or cohort data of this type can be extremely useful for generating hypothesis of the long-term consequences of work. Two of these studies suggest child agricultural work can negatively affect adult health. But, since the majority of secondary data analyses of child labor rely on data collected for other purposes, by government or multilateral institutions, results are usually very general, often missing crucial variables on, for example, the type and nature of employment. Ultimately, such analyses usually rely on some degree of data manipulation (e.g., extrapolations, standardizations or projections) to prove their point and are only able to provide hypotheses for cause-and-effect relationships. The one qualitative study of child work and health (Reynolds 1991) provides valuable insight into the lives of rural working children but does not attempt to establish any relationship between work and health.

In short, all of the published studies we identified have methodological weaknesses. Most of the better studies on the health impacts of child agricultural work have been carried out in the U.S. While these are not generalizable to the situation in developing countries, this literature does provide an overview of some of the health problems related to this sector of work.

¹ The "healthy worker effect" refers to the fact that workers are usually healthier than non-workers because when workers become ill or are injured (including through work) they usually stop working, either on a temporary or a permanent basis. Thus, this may introduce bias in cross-sectional studies of occupational health, but this bias can be overcome with longitudinal studies.

Table 2. Methods for measuring health impacts of child work

Study Design	Advantages	Disadvantages
Cross-sectional	<ul style="list-style-type: none"> ➤ Possible to study multiple <i>outcomes</i> ➤ Large sample size at low cost ➤ Facilitates rapid assessments ➤ Good for estimating <i>scope</i> of problem ➤ Good for exploratory studies and hypothesis generation 	<ul style="list-style-type: none"> ➤ Problems with temporal sequence of data (what came first, illness or exposure?) ➤ Can't establish causality ➤ Can only measure illness or injury at one point in time—miss diseases still in latent period ➤ Cannot control for "healthy worker effect" ➤ Need large sample size to find rare or uncommon illnesses ➤ Prone to recall bias
Case Control	<ul style="list-style-type: none"> ➤ Can be completed quickly ➤ Can study multiple <i>exposures</i> ➤ Can ensure representation of particular groups ➤ Useful for studying uncommon illnesses or ailments ➤ Useful for studying one specific illness or disease 	<ul style="list-style-type: none"> ➤ Problems with temporal sequence of data (when was problem acquired?) ➤ Prone to recall and selection bias ➤ Cannot calculate incidence in population ➤ Cannot control for "healthy worker effect"
Randomized Control Trial (intervention)	<ul style="list-style-type: none"> ➤ Gold standard for <i>interventions</i> ➤ Only scientific means of assessing effectiveness of programs aimed at reducing child work 	<ul style="list-style-type: none"> ➤ Can present ethical problems for control and intervention groups ➤ Loss to follow-ups may bias study ➤ Expensive to run and complicated to design
Longitudinal Cohort Studies	<ul style="list-style-type: none"> ➤ Best method for measuring exposure ➤ Only means of obtaining prospective information ➤ Can establish temporal sequence of disease and exposures ➤ Possible to identify "healthy worker effect" ➤ Only means of accurately measuring longitudinal effects of work ➤ Can study long-term consequence of child labor 	<ul style="list-style-type: none"> ➤ Expensive ➤ Loss to follow up may introduce bias
Secondary Data Analysis	<ul style="list-style-type: none"> ➤ Good for hypothesis generation ➤ Large sample size at low cost ➤ Panel data can be used to 	<ul style="list-style-type: none"> ➤ No control over questionnaire and interview techniques ➤ Surveys usually designed

	<ul style="list-style-type: none"> ➤ identify possible longitudinal effects 	<ul style="list-style-type: none"> ➤ for other purposes and often miss vital variables ➤ Where governments are responsible for survey, respondents may be less likely to respond truthfully
Qualitative (interviews/observation)	<ul style="list-style-type: none"> ➤ Provides in-depth understanding of social and cultural issues affecting child work while responding to specific question ➤ Purposive selection of participants ensures range of different perspectives 	<ul style="list-style-type: none"> ➤ Less “scientific” ➤ Potential for interviewer and observer bias ➤ Only useful for small sample size
Ethnographic (participant observation)	<ul style="list-style-type: none"> ➤ May provide a deeper understanding of role of work in children’s lives ➤ Children are given opportunity to express their opinions and views ➤ Respondents not limited to responding to a specific hypothesis ➤ May provide insight into issues which children think are important that researcher may not have considered ➤ Good for hypothesis generation for epidemiological studies ➤ Can identify broader issues of exposure (social and cultural) 	<ul style="list-style-type: none"> ➤ Not useful for answering specific scientific questions ➤ Necessarily subjective

Evidence of Acute and Chronic Hazards

We present evidence of harm and exposure to health hazards among children working in the agricultural sector in terms of *acute* or *chronic*, indicative of the length of time between exposure to hazards and manifestation of health outcomes. Acute hazards lead to i) injuries, leading to short term health outcomes; and ii) illnesses with short latency periods. Chronic hazards lead to i) illnesses with long-term latency (often the result of regular, low-level exposure), or illness/injury from ongoing exposures; and ii) lifestyle-related hazards. Specific exposures and medical or health outcomes are given in more detail in Table 3 with possible solutions for minimizing risk. The distinction between acute and chronic hazards is important because first, the latter is usually underestimated due to the cross-sectional nature of most assessments, and second, different strategies are needed for preventing harm from acute and chronic exposures.

Table 3. Acute and chronic exposures for child workers in agriculture

	Principal Exposures	Medical or Health Outcomes	Possible Solutions for Minimizing Risk
Acute i.) Injuries	Machinery, equipment or moving vehicles Heights, grain pits Animals: attacks or butting, bites (snakes, scorpions)	Cuts or severing of body parts, blows to head or body, (falls), crush injuries Severe blows to head or body, asphyxiation (grain pits) punctures or bites, zoonoses, parasites and hygiene-related illnesses, poisoning	<ul style="list-style-type: none"> • Enforcement of safety legislation • Adequate supervision
Acute ii.) Illnesses with short latency periods	Agrochemicals Poor field sanitation Insect bites Excessive heat Repetitive tasks or actions, strenuous labor, vibration Long working hours Dust, gasses and other particles	Poisoning, respiratory illnesses, neurological impairment, immune system abnormalities Gastro-intestinal infections, parasitic infections. Malaria, infection Thermal stress Musculoskeletal injury or strain, fatigue Fatigue or exhaustion Respiratory, eye and skin infections and conditions	<ul style="list-style-type: none"> • Enforcement of safety legislation • Adequate supervision • Use of protective equipment
Chronic i.) Illnesses and injuries with long latency periods	Agrochemicals Repetitive tasks Stress Dust and other particles	Cancers, reproductive problems Repetitive strain injury, long-term or permanent musculoskeletal problems, disability Mental health Asthma	<ul style="list-style-type: none"> • Prohibition of child employment for tasks which can cause serious chronic illnesses or conditions • Regular health checks to identify chronic conditions before they become severe

	Machine noise	Hearing loss or deafness	
Chronic ii.) Lifestyle-related exposures	Poverty, poor sanitation, unclean water, substandard housing Unsafe transportation Ingestion of contaminated food and water and generally poor diet	Gastrointestinal illnesses, dysentery, parasitic infection Injuries Poisoning, cancers, reproductive problems, malnutrition, anemia	<ul style="list-style-type: none"> • Provision of better housing and cooking facilities • Fresh fruit and vegetables

The health effects from hazards that cause immediate harm are predominantly injuries. Short-term acute exposures are those that cause illness or injury within a short period of time, such as bacteria and parasites that cause infection, or bending and carrying that can lead to musculoskeletal problems. Chronic and low-dose exposures that can cause illnesses with long latency periods such as cancer, repetitive strain injury or asthma are categorized as “long term hazards”; and lifestyle-related exposures such as substandard housing and poor nutrition are considered to be continuous health deteriorating hazards. The purpose of this framework is to illustrate the differing effects of hazards and the complications involved with measuring related health outcomes. Although there is overlap between acute and chronic exposures—for example, pesticide exposure can fall into each of the temporal categories or an injury can cause both short-term damage and permanent disability—evidence and epidemiological data continue to indicate the existence of temporal differentiations between hazards.

Acute Hazards Leading to Acute and Chronic Health Outcomes

Injuries

The majority of peer-reviewed documentation of injuries among child workers in the agricultural sector is based on studies undertaken in the U.S. (Allread et al. 2004; Browning et al. 2003; Heyer 1992; CDC 1999; Stueland et al. 1996; Rivara 1996). An ILO study of child work in Honduras found that children working in the agricultural sector were more exposed to injury than children working in other industries (Hernández Cruz 2002). The study, which uses the 2002 Multiple Purpose Household Survey to study the characteristics of children under the age of 18 in “gainful employment,” concludes that 87 percent of fractures, 78 percent of sprains and 67 percent of “minor” wounds were incurred by children working in the agricultural sector, making it the most hazardous sector of work. A study of child work on cocoa plantations in Ghana reports injuries such as lacerations to the head, fractures, dislocated shoulders, severed fingers and eye injuries, as well as heat-related syndromes and dehydration, but no figures are given (Mull and Kirkhorn 2005).

We could not identify any further studies that specifically focus on injuries caused by farm work in the agricultural sector in developing countries. A Nigerian study of eye injuries identified farm work as being responsible for 10 percent of cases (n=204) (Umeh and Umeh 1997). The U.S. Department of Labor's report on the use of child labor in U.S. imports provides extensive examples of injuries and injury to child workers in developing countries, mostly citing routine reports and anecdotal evidence (USDOL 2005). Examples include the case of sugar cane workers in Brazil, who have an average working life of 12 years due to incapacitating injuries. 56.7 percent of child workers in this industry had suffered some type of occupational injury, 85 percent of which were knife wounds. With the exception of this example, details of injuries sustained are anecdotal.

Illness

We identified two studies carried out in India that illustrate the health hazards of agricultural work. A cross-sectional study of 500 child agricultural workers ages 7-14 from three villages in West Bengal found that 68.5 percent were anemic, 15.5 percent suffered from respiratory tract infections, 30.2 percent had eye infections and 22.8 percent had skin diseases, but the study did not include a non-working comparison group (Banerjee 1993). Worm infestation, diarrhea and parasites were also found to be more common among working children from a rural area of Maharashtra than among non-working children. Differences are given in point prevalence and were not significant (Daga 2000). A Honduran study of child workers also found the highest incidence of work-related illness among agricultural workers, with 34 percent reporting respiratory infections, 31 percent reporting skin infections, rashes or blemishes, 10 percent having diarrhea, and 9 percent having eye and ear infections (Hernández Cruz 2002). Finally, a study of 260 Ghanan children aged 8-15 suggested that higher rates of the parasitic infection *schistosoma haematobium* and anemia among non-school attendees (workers and non-workers who do not attend school), compared to school children, were due to the occupational hazard of spending several hours per day in a lake (Fentiman, Hall and Bundy 2001).

Chronic Health Exposures Leading to Chronic Health Outcomes

Chronic exposures and illnesses with long-term latency periods

In a 15-year study of rural children in India, agricultural laborers were found to have significantly lower body mass indices and to be significantly shorter and than children who did not work and attended school, when stratified by early nutritional category (the previous 15 years) (Satyanarayana, Prasanna Krishna and Narasinga Rao 1986). There were no initial differences in heights and weights between the students and the laborers. We did not identify any further peer-reviewed studies or studies using primary data that attempt to analyze the long-term health effects of child work in any sector.

We identified some research that uses secondary data to study the relationship between child work and health. The UNICEF/ILO/World Bank research group's study of child agricultural work in Vietnam using the 1992/3 and 1997/8 Living Standards Surveys concluded that working children are more likely to have health problems

five years later, a probability that increases with duration of work (O'Donnell et al. 2003). A further study of largely rural working children in Guatemala reached the same conclusions, suggesting that child work increased the probability of illness in adulthood by 40 percent (Rosati and Straub 2004). The researchers also identified a healthy worker effect among children in the study, concluding that their results are an underestimation of the real effect of work on health. Two secondary data analyses of adult health in Brazil concluded that early entrance to the labor market and child labor are risk factors for poor adult health (Guiffrida, Iunes and Savedoff 2005; Kassouf, McKee and Mossialos 2001). Using 1998 household survey data in their analysis of health and poverty in Brazil, Guiffrida and colleagues conclude that entering the labor force below the age of 9 is strongly associated with poorer health. This effect was found to be stronger for women than for men. In both Brazilian studies, agriculture is the predominant form of child labor.

In the long term, child labor also appears to affect childhood growth. Stunting is reported among child coffee pickers over 8 years old in the Sierra Negra region of Mexico (Barriero Garcia and Castellanos Cereceda 2002), and among working children in Ghanaian farming and fishing villages (Fentiman, Hall and Bundy 2001). These results concur with a study of working children in Jordan that concluded that work had a negative effect on child growth, even after controlling for socioeconomic status (Hawamdeh and Spencer 2003).

Agrochemicals are consistently identified as a serious health hazard for rural child workers (Gastal Fassa et al. 1999; Ashagrie 1997; Edmonds and Pavcnik 2005; Landrigan et al. 1995; O'Donnell, Rosati and Van Doorslaer 2003). Some studies have demonstrated a negative impact between pesticide exposure and child health (Guillette et al. 1998; Kuruganti 2005) but no proven link has been established between pesticide exposure and the health of working children. We identified two studies of child workers that suggest children working on plantations are exposed to potentially harmful levels of pesticides. A Mexican study of 171 migrant working children exposed to pesticides on tobacco plantations in Nayarit State, northwest Mexico, found that 33 percent of children were exposed to unacceptable levels of pesticides, demonstrated by a depression of at least 15 percent of their post-exposure level. Fifteen percent of children were found to have cholinesterase (AChE) depression levels of ≤ 40 percent, and 5 percent of children saw a depression of over 80 percent (Gamlin, Díaz Romo and Hesketh 2006). Mean levels of AChE among the indigenous child workers were 27 U/g of hemoglobin during the working months, compared to 34.7 U/g at least 8 months after having returned to their communities of origin, suggesting that during that harvest season they were exposed to neurotoxic chemicals which could cause transient or permanent neurological damage (Salinas Álvarez and Díaz Romo 2001). Unacceptable occupational exposures to pesticides among fruit pickers using cholinesterase depression as a biomarker are also suggested among working children in Ecuador on the basis of a sample of ten children and compared to population reference values (Harari, Forastiere and Axelson 1997).

In West Africa, children spray crops with pesticides either as a main activity or as part of general agricultural production activities. The ILO/USDOL study of child

labor on 1,500 cocoa farms in Ghana, Nigeria, Cote D'Ivoire and Cameroon found that 54 percent of the 284,000 children studied applied pesticides without protective equipment, and the same percentage use machetes to clear fields. Fifty-seven percent of these children were unaccompanied migrants, and 64 percent were under the age of 14 (IPEC/ILO 2005b). On cocoa farms in Ghana, children apply pesticides from 14 years and assist with mixing them from as young as 10, but only 5 percent use any protective equipment. Symptoms associated with this exposure, such as headaches, burning eyes and skin, dermal rashes, coughing, nausea and dizziness, were also reported (Mull and Kirkhorn 2005).

Lifestyle-related exposures

As is the case for chronic and long-term exposures, some epidemiological studies document potentially harmful lifestyle-related exposures, although these have not been linked to health outcomes. Epidemiological data on the poor living conditions and lifestyles of migrant families working on vegetable and tobacco plantations in Mexico is documented in two studies published by UNICEF. Cos Montiel (2001), reporting the results of a Rapid Rural Appraisal carried out under the auspices of UNICEF on tomato plantations in Sinaloa in Northwest Mexico, documents the poor hygiene, food and living conditions of migrant families: e.g., water sources contaminated by fertilizers and pesticides are used for bathing; children work as many as 14 hours a day and travel in unhealthy, unsafe transportation for long distances. Indigenous peasants who pick and thread tobacco leaves are similarly exposed. Eighty-one percent of families sleep in the open between pesticide-ridden tobacco plants, 23 percent of families drink from contaminated water sources, and 70 percent bathe in polluted irrigation canals and rivers. Meager salaries and a lack of cooking facilities mean that workers survive largely on instant and snack foods. Because of a lack of sanitation, they defecate in the open air within the vicinity of their working and living spaces (Salinas Álvarez and Díaz Romo 2001). Studies of farm work in the U.S. resonate with these findings. The lives of migrant workers are characterized by political powerlessness, living and working in poor environmental conditions, and low levels of formal education, all of which make them vulnerable to poor general health (Landrigan et al. 1995). Migrant families live in substandard, overcrowded and insalubrious accommodation, often sleeping several families to a room. Poor housing also appears to be the leading cause of illness among migrant workers in the U.S., where at the time of the study the three most common causes of illness were gastroenteritis, dermatitis and parasitic infections. Shenkin (Slesinger 1992) suggests a framework for explaining this (see Table 4).

Table 4. Barriers to health care specific to migrant workers

Root/seminal cause	Political and economic powerlessness	➤ Migrants lack political representation in home and work communities
Pre-proximate causes	Exclusion	➤ Often not native language speakers
	Discrimination	➤ Discrimination on race and ethnic grounds
	Poverty	➤ Poor housing/ no medical insurance
	Low rural health care capacity	➤ Health care inaccessible
	Mobility	➤ No continuity of health care
Proximate causes	Little medical care	➤ Only seek medical care for acute conditions
	Unhealthy environment	➤ Spread infectious diseases
	Poor nutrition	➤ No cooking equipment, lack access fresh food
	Occupational hazards	➤ Work related health complaints unattended

Adapted from Shenkin (Slesinger 1992)

In the U.S., children can legally work in agriculture from 10 years of age outside school hours and carry out hazardous tasks from as young as 16 (Perry 2003). U.S. Department of Labor health and safety regulations require that only farms with more than ten workers must by law supply toilets, drinking water and clean water for washing hands. In 1993, Wilk estimated that only 36 percent of U.S. farms complied with these standards. The 2001-2 National Agricultural Worker's Survey reports a much improved situation, but 20 percent of farms still do not provide drinking water and cups and on 7 percent of farms there were no toilets (USDOL 2005).

Conclusion

Child work in agriculture is characterized by long hours of intensive work. Conditions vary from light work such as threading tobacco leaves to heavy physical work such as picking bananas or cutting sugar cane. Many of the hazards involved in these forms of labor are invisible or hidden, such as agrochemicals, snakes or scorpions, dust and particles, contaminated food and water sources. Some health effects are often not evident for months, years or until adulthood. As a consequence, these are usually missed by cross-sectional surveys or studies that measure disease and morbidity at one point in time. Additionally, cross-sectional studies can miss the more serious injuries and illnesses that require absence from work because of the "healthy worker effect." Because of this and other confounding factors, cause cannot accurately be attributed.

Most literature documenting morbidity and mortality among child agricultural workers focuses on injury among farm workers in the U.S., possibly a reflection of the industrialization of agriculture in developed countries. These studies neglect the consequences of lifestyle-related and chronic exposures and give the impression that in the developed world these hazards do not exist, although this is unlikely to be the case. Research from less-developed countries suggests that agricultural morbidity is both acute and chronic, often caused by repetitive exposures or with long latency periods, the long-term consequences of which have not been properly investigated. The USDOL and UN agencies document the use of child labor and discuss the potential health effects of hazardous exposures, but there is no primary evidence available to support their hypotheses. Migrant workers face additional lifestyle-related risks associated with poor accommodation, hygiene, stress related to mobility, and nutrition.

Many injuries and exposures resulting in immediate health consequences can be reduced with good training, safety equipment and the enforcement of legislation. In contrast, chronic and long-term exposures are often related to the very nature of agricultural work: the repetitive tasks involved in picking and carrying fruit or berries, and the constant exposure to dust, particles and agrochemicals that are part and product of the production process. Therefore, preventing illness or injuries caused by chronic exposures demands legislation and the implementation of labor standards that prohibit children from undertaking the tasks that could cause harm. For this reason child labor legislation is crying out for longitudinal data, broad enough to measure the acute and chronic impacts of occupational exposures during childhood. It is important to know which types, intensities and duration of work are most damaging. If, as appears to be the case, there are significant negative effects of agricultural work on health, then the case for policies that reduce this type of children's work activity is strengthened (Rosati and Straub 2004).

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Appendix A. Summary of studies of child agricultural work in developing countries

Author	Publication and Year	Place and type of work	Study design	Methods	Sample size	Year/ Duration of study	Findings/Health outcome
1. Banerjee	Indian Paediatrics, 1993	West Bengal, agricultural labor	Cross sectional	Baseline survey (questionnaire)	500 child workers aged 7-14	Oct. 1989-June 1990	-High morbidity -Anaemia 69% -Gastrointestinal infections 66% -Vitamin deficiencies 8% -Eye diseases 30% -Skin diseases 23%
2. Daga	Indian Paediatrics, 2000	India, rural child labor	Cross sectional	Household survey (questionnaires)	1,679 children (3.8% working)	1997	Higher prevalence among working children: -diarrhea: 13% -ARI: 8% -worms: 5%
3. Fentiman et al.	Social Science and Medicine, 2001	Ghana, agricultural labor and fishing	Case control study (working children and school children)	Focus group questionnaire. Health assessment: finger-prick blood, anthropometry, urine, physical examination	130 cases, 130 controls	1995	Children from fishing communities have higher rate of Schistosoma haematobium and lower hemoglobin
4. Gamlin et al.	Child: Care, Health and Development 2006	Mexico, child labor and pesticide exposure	Case control (working, non working, exposed and unexposed)	Questionnaire, measurement of blood cholinesterase	62 paired samples-exposed and unexposed	1995-6	Acetylcholinesterase depression in exposed children: 15% sample \geq 40%, 18% sample \geq 15%, Very low hemoglobin among exposed and unexposed children
5. Harari et al.	American Journal of Industrial Medicine, 1997	Ecuador, strawberry picking (and other non-agricultural)	Cross sectional compared to reference values	Questionnaire, blood and urine analysis	10 child laborers	1996	4/10 children found with acetylcholinesterase levels exceeding reference values
6. Hawamdeh and Spencer	Child: Care, Health and Development 2003	Jordan, general child labor including agriculture	Case control	Questionnaire data collected on socio-demographic information and anthropometric measurements	135 working, 405 non-working children	2001	When controlling for SES and other confounders, Work has a negative effect on childhood growth
7. Kassouf et al.	Health Policy and Planning, 2001	Brazil, general child labor including agriculture	Two wave panel (cross sectional)	Brazilian Living Standards Survey	4,940 adults	March 1996-1997	Odds of poor health significantly increased for those who started work aged under 10 or aged 10-14, compared with over-14s.

8. Mull et al.	Public Health Reports, 2005	Ghana, cocoa plantations	Cross sectional	Observational analysis and interviews	61 (48 aged 9-17)	2003 harvest season	Risks found in use of sharp tools, pesticide application, lack of protective clothing. Eye injuries and other symptoms associated with pesticide exposure reported (headaches, skin rashes, nausea, dizziness)
9. Satyanarayana et al.	Human Nutrition: Clinical Nutrition, 1986	India, rural child labor	Longitudinal	Questionnaire and anthropometry, nutritional indicators	410 boys and men aged 5 and under at start of study	1965-1984	When controlling for socioeconomic categories, child laborers were shorter and lighter than children who went to school
10. Umeh and Umeh	Eye, 1997	Nigeria, general child labor	Hospital-based study of eye infections	Hospital-based study of children treated for eye infections	228 children	1996	10% of all eye injuries and illnesses caused by farm work
11. Castro et al.	Public Health Reports, 2005	Philippines	Cross sectional	(Household) Analysis of Survey of Children, (2001) (Philippines National Statistics Office)	6,351 Working Children	Oct. 2001-Sept. 2002	Temporary nature of work contributes to injury highest in agriculture: Injury Incidence Rate per 110 person hours worked: Agriculture 0.08 Non-Agriculture 0.017 (RR 4.74.)
12. Hernández Cruz	ILO, Geneva 2002	Honduras, general child labor (70% agriculture)	Cross sectional	ILO (SIMPOC) Child Labour Survey (household)	11,592 children aged 5-14	2002	-Children working in agriculture most likely to have accidents: 67.2% -87.1% of work-related accidents in agriculture Of children working in agriculture: -33.5% suffered respiratory illnesses -9.9% diarrhea, indigestion or intoxication -31% skin complaints -9.1% convulsions, paralysis, tremors, etc.
13. Sustainable tree crops program, International Institute of	ILO/IPEC, Geneva, 2005	Cameroon, Cote D'Ivoire (RCI), Ghana and Nigeria, cocoa industry	Cross sectional	3 interrelated surveys: - Baseline Producer Surveys (BPS) -Producers/	BPS: 203 villages in Ghana, Cameroon, Nigeria PWS: 250	July-Nov. 2001	29% children in RCI "not free to leave their employment" - 21-70% children reported applying pesticides

Tropical Agriculture (IITA)				workers survey (PWS) (randomly selected households), -Community Surveys (CS)(interviews with key informants)	villages in Cote D'Ivoire CS: 14 villages (sub-sample of PWS) Totals: BPS-3086 PWS-1,500 CS-114 (27 children)		-Approx. 146,00 children <15 use machetes to open cocoa pods (no proportions given)
14. O'Donnell et al.	Understanding Child Work (UCW) UNICEF/ILO /World Bank, 2003	Vietnam, rural child labor	Two wave panel	Vietnam Living Standards Survey (1992-3, 1997-8) (Health measurements include BMI, reported injury and height)		1992-3, 1997-8 (surveys conducted)	Increased risk of illness five years later, risk increases with duration of work (healthy worker effect identified)
15. Reynolds	Zed Books, 1991	Zambezi Valley, family child labor	Ethnographic	Participant observation	Children aged 6+ in households		Lifestyle aspects of subsistence agriculture in Zimbabwe: up to 80 hour work weeks, responsibilities at very young ages
16. Rosati et al.	Understanding Child Work (UCW) UNICEF/ILO /World Bank, 2004	Guatemala, longitudinal effects of labor	Cross sectional	Econometric, using Guatemala National Survey on Living Conditions (sub sample with information on adult siblings); self-reported health	3,409 individuals, 1,396 households (sibling sets)	2000 (survey year)	Disproportionately high numbers of children in agriculture with health problems. Child labor increases by 40% probability of "bad" adult health
17. Salinas Álvarez and Díaz Romo in Del Rio Lugo	UNICEF/ Universidad Autonoma de Mexico, 2001	Mexico, tobacco plantations	Case control	Questionnaire, measurement of blood cholinesterase	171 children ages 0-16	1995-6	During tobacco picking season acetylcholinesterase levels 7.4U/g higher than one year later. Lifestyle-related health risks: 24 hour exposure to pesticides
18. U.S. Department of Labor	USDOL 1995	Child labor in agricultural imports to U.S. (data from various countries)	Cross sectional	Various national household surveys, ILO surveys, USDOL and other studies	Various	Various	Children involved in hazardous and extreme work; worst forms of child agricultural work

Note: Numbers 1-10: peer reviewed studies analyzing primary research data
Numbers 11-18: Non-peer reviewed literature based on primary and secondary research