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Health Outcomes in Adolescent Minority Farmworkers
Final Technical Report

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LIST OF ABBREVIATIONS

AChE	acetylcholinesterase
APHA	American Public Health Association
ATSDR	Agency for Toxic Substances and Disease Registry
BARS	Behavioral Assessment and Research System
CI	Confidence Interval
ChE	cholinesterase
CREATE	Creating Roads to Empowerment and Advancement Through Education
CROET	Center for Research on Occupational and Environmental Toxicology
ESL	English as a Second Language
GED	Graduate Equivalent Degree
MESC	Oregon Migrant Education Service Center
NAS	National Academy of Science
NIOSH	National Institute of Occupational Safety and Health
OP	Organophosphates
WAIS-R 11	Wechsler Adult Intelligence Scale
WHO	World Health Organization

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SIGNIFICANT FINDINGS

1. The major predictor of knowledge of pesticide hazards and safety precautions was found to be the primary language of the adolescents, with adolescents speaking indigenous dialects scoring on an average seven percentage points lower than adolescents with Spanish as their primary language. Adolescents who were working in agriculture during the study period appear to have slightly lower scores than those not employed in agriculture; however the effect of past agriculture experience and/or training in pesticide safety made this difference insignificant.

2. Over half of the adolescents with current or past agricultural work reported the belief that they are exposed to pesticides while working in the fields. However, 52% of these adolescents report never using protection methods while working in the fields. Younger children were less likely to believe that there are ways to protect oneself from pesticide exposure compared to older adolescents. The proportion of youth reporting the belief that pesticides cause health problems was significantly lower among those whose primary language was an indigenous dialect compared to adolescents whose primary language was Spanish. There was some evidence of optimistic bias in the agricultural workers in relation to the likelihood of experiencing health problems from exposure to pesticides.

3. Approximately 20% of the adolescent agricultural workers reported mixing and/or applying pesticides, including eight adolescents 15 years of age or younger. After-work hygiene practices and laundry practices where highly variable in this study population, however 18% reported remaining in their work clothes for up to two hours after returning from the fields. Twenty-five percent of the sample reported that laundry of work clothes was done by hand. The most frequent types of protective clothing worn were long-sleeved shirts (76%), long pants (98%) and caps (86%). The use of gloves, plastic clothes, overalls, and respirators was higher among the group that reported mixing/applying pesticides.

4. There was no evidence that the exposures of this sample of agricultural workers resulted in decreases in levels of erythrocyte cholinesterase activity during the harvesting season in which they were studied. Post-season testing did reveal a significant increase in their levels of erythrocyte cholinesterase. There was no obvious explanation for this increase (e.g., work in Mexico, work activities, age, ethnicity). There was no significant difference between the erythrocyte cholinesterase activity levels of agricultural and non-agricultural adolescents.

5. There were no significant differences in the results obtained from two field tests for acetylcholinesterase (Test Mate OP and Test-Mate ChE). The hemoglobin results produced by the two EQM field kits were significantly different from a benchmark test for field studies of hemoglobin.

6. There was no conclusive evidence that the agricultural adolescents in this study had performance deficits on neurobehavioral tests that could be related to pesticides. Some differences observed could be attributable to the educational differences between agricultural and non-agricultural adolescents.

USEFULNESS OF FINDINGS

Adolescents with indigenous dialects such as Mixteco and Trique are more likely to have less knowledge of levels of pesticide risks and health hazards and also to be less likely to believe that exposure to pesticides can result in health problems. These subgroups need special training consideration. Further research is needed to determine if these differences are also found in adult agricultural workers.

This study provides preliminary information on the risk perceptions of adolescent agricultural workers, but further investigations are needed before these findings can be incorporated into prevention interventions. Future investigations will explore risk perceptions in more depth, including the importance of age and ethnicity, and the relationships between the economic necessity of the work and risk perception.

Despite the hazards associated with applying and mixing pesticides, 20% of this study sample reported engaging in these work activities. Eight of the youth were ages 15 or younger. More information is needed regarding the determinants for this type of work, the hazard communication that is delivered to these youth, and more direct measurements of pesticide exposure and potential health effects in this young population.

The results of this study indicate that the hemoglobin adjusted acetylcholinesterase measurements of the two field tests (Test Mate OP and Test-Mate ChE) are comparable. Therefore comparisons of populations using the two different tests would be valid. The hemoglobin values obtained with either of these two tests are not comparable to a benchmark test for field studies of hemoglobin.

The differences in the agricultural group and the non-agricultural group utilized in this study resulted in difficulty in interpreting the significance of the neurobehavioral findings. While the differences observed can not be attributed to pesticide exposure, the results of this study provide no evidence of a lack of a health effect.

ABSTRACT

Children working in agriculture are exposed to pesticide spray, drift, and residues in the soil and on foliage, however little scientific evidence is available to determine acceptable levels of pesticide exposure to children. Pesticides are thought to pose a considerably higher risk to children than to adults however little is known about the extent or magnitude of health problems related to occupational exposure to pesticides in children. The migrant population, including adolescent workers, has not been frequently studied in the area of agricultural safety and health. Problems that contribute to lack of access to this population include such factors as workers' mobility, undocumented laborers, and rural location, language barriers and the seasonal nature of the work. This study was designed to assess neurobehavioral function in Hispanic adolescents exposed to agricultural pesticides, biomarkers of pesticide exposure in this adolescent population and factors contributing to exposure risk including knowledge of pesticides and associated health hazards, work characteristics and practices, and cultural and/or developmental factors that contribute to risk. This was an interdisciplinary community-based research project in which the Oregon Health Sciences University Center for Research on Occupational and Environmental Toxicology (CROET) joined with the Oregon Migrant Education Program to develop and implement culturally appropriate research methods to study the migrant minority population. A cross-sectional study of 102 migrant Hispanic adolescents, ages 13-18, engaged in agricultural and a comparison group of 51 Hispanic adolescents who were not working in agriculture was conducted. Questionnaires were administered by Spanish-speaking interviewers to solicit information on exposure to agricultural pesticides, work practices and use of protection, and economic, cultural, and other background factors associated with the choice of agricultural work. Pre- and post-season health assessments of cholinesterase activity and neurobehavioral function were conducted. Study results indicate that migrant adolescents are engaged in a variety of agricultural activities, including mixing or applying pesticides. Few youth report the use of protective clothing or equipment, yet most report beliefs about the health hazards associated with pesticide exposure. Laundry practices and after work hygiene practices are highly variable. Adolescents differ in their knowledge of pesticide hazards with primary language the major determinant for differences in knowledge scores. No differences were found between agricultural youth and non-agricultural youth on biomarkers of pesticide exposure. Differences were found in neurobehavioral performance, but there is no conclusive evidence that these differences are related to pesticide exposure.

1 BACKGROUND FOR THE PROJECT

Adolescents working in agriculture are exposed to pesticide spray, drift, and residues in the soil and on foliage, however little scientific evidence is available to determine acceptable levels of pesticide exposure to this population. Pesticides are thought to pose a considerably higher risk to children than to adults, however little is known about the extent or magnitude of health problems related to occupational exposure to pesticides in children. Specifically this study was designed to assess neurobehavioral function in Hispanic adolescents exposed to agricultural pesticides, biomarkers of pesticide exposure in this adolescent population and factors contributing to exposure risk including knowledge of pesticides and associated health hazards, work characteristics and practices, and cultural and/or developmental factors that contribute to risk.

This was an interdisciplinary community-based research project in which the Oregon Health Sciences University Center for Research on Occupational and Environmental Toxicology (CROET) joined with the Oregon Migrant Education Program and an Hispanic youth advocacy group, CREATE, to develop and implement culturally appropriate research methods to study the migrant adolescent agricultural worker population.

1.1 Adolescent Migrant Agricultural Workers: Issues in Studying an At-Risk Population

Any attempt to measure the magnitude of the problem of child agricultural labor in the Hispanic population is hampered by under reporting (APHA, 1995). A large discrepancy exists between the reported number of Hispanic agricultural workers in Bureau of Labor Statistics and that reported by other sources. The migrant worker population has been estimated from 3 to 5 million, with the proportion of Hispanic heritage varying in different regions of the country. If one assumes that 80% of the migrant agricultural workforce is Hispanic, this translates into approximately 3.2 million Hispanic migrant agricultural workers, a significantly larger number than the 218,000 reported by the Department of Labor in 1990. This difficulty in estimating the Hispanic population involved in agriculture stems from such factors as workers' mobility, undocumented laborers, and rural location. Language barriers and the seasonal nature of the work pose further problems.

There are no comprehensive statistics that encompass the total number of children working in agriculture. The American Friends Service Committee estimated in 1975 that about 800,000 agricultural workers were children under age 16 (American Friends Service Committee, 1975), but these numbers don't include undocumented workers. In 1988, Reig et al., estimated that 80% of the child farmworkers are Latino (Reig & Wilk, 1988; Reig & Runyan, 1988). Epidemiological literature is incomplete because studies have largely focused on Midwestern family farms and have not included children living in other areas of the country, minority populations, and nonresident populations who migrate. In a 1991 survey by the US Department of Labor of seasonal agricultural workers (not permanent workers), 4% were under age 18 (US Dept. of Labor, Office of Program Economics, 1991). In 1989, a minority labor survey of the Washington Association of Apple Growers revealed that more than 98% of growers reported employing minors, more than 2,500 children in all, and 73% used children under 16 years of age. Almost 97% of these children were working with older family members. The number of hours

worked per week during the school year ranged from 4 to 32 with 86% reporting less than 24 hours per week. During the summer months, children worked 20-55 hours per week. Almost 80% of the respondents said that minors worked a 40-hour week.

The special health concerns and research needs of the migrant population have been addressed by national groups (National Advisory Council on Migrant Health, 1993; NIH, 1995). Migrant agricultural workers are among the most disadvantaged, medically indigent persons, and have the poorest health of any group in the United States (Dever, 1991; Goldsmith, 1989). The lack of national research and hard data on migrant and seasonal farmworkers has hindered effort to improve the health of this population (National Advisory Council on Migrant Health, 1993). Occupational and environmental diseases, including health problems related to pesticide exposure, warrant increased attention. Sasao & Sue (1993) have described the research challenges inherent in studies of minority communities including the need to obtain representative samples with appropriate control groups, and the use of instruments appropriate for the ethnic-cultural group being studied.

At the state level, Oregon's Commission on Agricultural Labor is charged with identifying specific issues of concern with respect to agricultural workers. The Commission has reported that lack of adequate housing, language difficulties, racial discrimination, and laws affecting agricultural workers are areas that impact the quality of life of migrant agricultural workers. Though minority and socio-economically disadvantaged groups receive a higher exposure to environmental hazards, and suffer greater health problems in general (Montgomery and Pokras, 1993), they are less likely to have access to health-care professionals who can provide the same level of early diagnostic and treatment services available to the majority population. In addition, the access of minority and socio-economically disadvantaged groups to crucial health-related information about risk factors and how to prevent health problems is often severely limited by language and cultural barriers.

Researchers have had difficulty in accessing data on special populations such as migrant laborers and even less has been documented on the migrant children, including those who work in agriculture or who are exposed to occupational hazards due to the nature of their parents' work. We have demonstrated the ability to successfully partner with community organizations that serve migrant youths and also receiving educational services in a rural community in Oregon.

1.2 Work Patterns/Practices

Little information is available on the specific work practices of adolescent migrant agricultural workers. Children working in agriculture are exposed to pesticide spray, drift, and residues in the soil and on foliage (Wilk, 1993). A lack of wash water in the fields means that farmworker children and adults are not able to wash off pesticide residues before eating and going to the bathroom. Pollack et al. (1990) interviewed migrant farmworker children who work in New York State. They found that 48% of the children had worked in fields still wet with pesticides, and 36% had been sprayed directly or indirectly by drift while working in fields or orchards. Despite the prohibition of hazardous work by children under age 16, four boys reported they had mixed pesticides, and three said they had applied pesticides.

There are both positive and negative factors associated with child labor. Employment can bring a sense of responsibility, discipline, and teamwork and provide opportunities of the development of new skills (Pollack & Landrigan, 1990). Employment opportunities in the United States may provide for the migrant adolescent an opportunity to contribute to the family income and also to continue with education when opportunities are available in the agricultural community. However, if educational opportunities are not available, this population may not only be exposed to agricultural hazards, but also may be deprived of a standard education. Migrant families are socio-economically disadvantaged. Poverty may be the leading factor exposing children to agricultural hazards. Minority children have less preventive health care and tend to receive medical care only for acute ailments. These children may also be exposed to inadequate sanitation, poor nutrition and neglect. Many adolescents involved in farm labor fall into a 'limbo' area of public health initiatives. They are too old for maternal and child health programs such as immunizations, and too young for occupational health programs such as pesticide safety training. Therefore, children associated with farming outside of the traditional family farm, are often neglected in efforts to promote health and safety for the typical farm operation in the US.

1.3 Pesticide Susceptibility

Children working in agriculture are exposed to many of the same occupational hazards as those experienced by adult workers. Only about five percent of farms in this country are covered by safety regulations of the Occupational Safety and Health Act. On the remaining 95 percent of farms, the owner/operator is responsible for assessing acceptable levels of risk for adults and children on the farm. Unfortunately, little scientific evidence is available to determine acceptable levels of hazard exposure to children (National Committee for Childhood Agricultural Injury Prevention, 1996). Standards set up to protect workers are often inappropriate for children and pregnant women. For example, threshold limit values for exposure to various pollutants set up by the National Institute for Occupational Safety and Health (NIOSH) are established for an eight hour day for adult white men aged 18 to 65. While the standards may be safe for their target population, no one knows the health effects these levels may have on children and the unborn. To complicate the problem, many physicians do not recognize the symptoms of pesticide poisoning (Coye, 1985). Research is needed to document the effects of pesticide exposure in children.

1.4 Measurement of Biomarkers of Exposure

Organophosphate anticholinesterase pesticides (OP) comprise the largest group of pesticides in current use (Kaloyanova and Batawi, 1991; Lotti, 1992). In Oregon, in 1987, the phosphorthionated chlorpyrifos and diazinon and the phosphorodithioate malathion were used in annual quantities of 162,641, 127,512 and 163,191 pounds, respectively. Occupational and environmental overexposure to these and other organophosphates and carbamates is a well established cause of acute neurological illness associated with cholinergic toxicity (Hayes and Laws, 1991).

Organophosphate and carbamate pesticides work by inhibiting the activity of cholinesterase, an enzyme essential for normal neuromuscular functioning. As exposure levels increase, cholinesterase activity decreases. In an effort to reduce the incidence of overexposure to pesticides, the World Health Organization (WHO) has recommended that agricultural workers who handle pesticides and/or work in fields contaminated with cholinesterase inhibiting

pesticides be monitored for depression of blood cholinesterase (Magnotti et al., 1988). Field studies conducted in various countries around the world have shown the usefulness of biomonitoring for these pesticides (Van der Hoek et al., 1998; Al-Shatti et al., 1997; Innes, et al., 1990; Jeraratnam et al, 1986). In the United States, the National Institute for Occupational Safety and Health (NIOSH) has recommended biomonitoring of agricultural workers exposed to cholinesterase-inhibiting pesticides (Magnotti et al., 1988). The State of California requires medical surveillance and monitoring of blood cholinesterase level of persons who work with category I & II pesticides (organophosphates and carbamates) for evaluation of possible over-exposure (Ames et al., 1989a; Ames et al., 1989b; Ames et al., 1995; Fillmore & Lessenger, 1993; and McCurdy et al., 1994).

Despite inter-individual variability in baseline cholinesterase activity and inter-laboratory measurement variability, any substantial decrease in cholinesterase activity relative to a baseline period or to a control population indicates exposure (St. Omer, 1992). Diagnosis of overexposure to OP compounds can be confirmed by demonstrating a significantly reduced cholinesterase activity in red blood cells (O'Malley, 1997). If the enzyme depression is marked, the individual will be more susceptible to the effects of further exposure to an OP compound. Such an individual should not be allowed to return to work or come into contact with any OP compound until the level of AChE activity has been restored. When cholinesterase levels are depressed a significant level from baseline levels it is generally recommended that the worker be removed from further exposure until the levels return to normal. The level of cholinesterase depression for this action is generally 30% of baseline (Ames et al., 1995). While laboratory testing of blood cholinesterase levels provides somewhat more accurate results, field testing is often preferred because it is more rapid, less invasive and less expensive for initial or definitive (especially in developing countries) evaluation of worker exposure (Wilson et al., 1997).

Use of blood cholinesterase activity levels to monitor exposure to organophosphate (OP) pesticides has been widely reported (Lopez-Carillo et al., 1993; McConnell et al., 1993; Anwar, 1997; Garry et al., 1994; Walker, 1992; Wesseling et al., 1993; Richtar et al., 1992). A study of migrant agricultural workers in North Carolina showed that the mean cholinesterase levels were significantly lower among the agricultural workers than non-agricultural workers. Also, 12% of the agricultural workers (but not non- agricultural workers) had very low levels (Ciesielski, et al., 1994). Differences between baseline and in-season cholinesterase levels have also been demonstrated as an indicator of in-field exposure to anticholinesterase pesticides (Richter, et al., 1992).

For many situations a blood draw and laboratory analysis of cholinesterase level is the appropriate method. However, for evaluation of potential migrant worker exposure to cholinesterase inhibiting pesticides a semimicro filed test such as the spectrophotometric fields assay kit produced by EQM Research, Inc. is often preferred (Wilson et al., 1997).

There have been many reports on the validation and use of these field cholinesterase assay kits (Magnotti, et al., 1988; Wilson et al., 1997; Amaya et al., 1996; Ciesielski et al., 1994; London et al., 1995; Magnotti et al., 1987; McConnell et al., 1994). In an extensive study comparing the EQM field kit with laboratory analysis of blood cholinesterase among 76 field workers in South Africa, erythrocyte cholinesterase levels obtained with the field kit were found to be sufficiently

repeatable, sensitive and specific to be used for regulatory compliance (London et al., 1995). A letter published in 1996 (Amaya, et al.) indicated that the rate of thermal equilibrium in the EQM field may be sufficiently slow to cause error in the indicated cholinesterase levels. In 1988 Magnotti, et al. evaluated the performance of the EQM field kit and compared it with the tintometric field method which has been in use for over 30 years. They found that erythrocyte cholinesterase activity was highly correlated with hemoglobin levels and that calculation in terms of activity units program hemoglobin would correct for differences in blood volume when the sample was obtained from a "finger-stick" where tissue fluid might be mixed with the blood. The calorimetric assay was found to be superior to the tintometric method and as a result would allow regulatory agencies to set more narrow criteria for medical removal from the exposure setting.

The earliest report of the actual field use of the EQM field kit involved 63 Nicaraguan crop duster aviation mechanics, of which 61% were found to have cholinesterase levels below the normal lower limit (McConnell et al., 1990). This resulted in protective changes being made at the airport for increased worker safety and demonstrated the effective use of the EQM field kit. In another field study 23 workers at a Mexican pesticide formulation plant, the EQM field kit was demonstrated to reliably identify workers with depressed blood cholinesterase levels (McConnell et al., 1992). The EQM field kit was used in an epidemiological study conducted among migrant agricultural workers in North Carolina (Ciesielski et al., 1994). Erythrocyte cholinesterase activity levels were predictive of whether the person came from a farm or non-farmworker environment. M c Connell & Magnotti (1994) evaluated the EQM field kit among 79 workers heavily exposed to OP pesticides in comparison to values obtained with the tintometric method. It was found that the EQM was more sensitive than the tintometric method resulting in six more workers being identified as overexposed to OP pesticides. The EQM kit was effectively employed to correlate symptom and cholinesterase activity among 100 Nicaraguan field workers (Keifer et al., 1996). The field kit was also effectively utilized in a survey of 199 residents of three communities in Mexico (Tinoco-Ojanguren et al., 1998).

In each of these reviewed studies the Test-mate OP model 176 kit was employed. This kit has recently been replaced with the Test-mate ChE model 400 cholinesterase field kit. Comparisons between the two kits in field investigations have not been published.

1.5 Health Effects of Pesticides

Despite the large amounts of pesticide chemicals being used and the potential of many to cause adverse health effects in humans, there are still insufficient data to accurately determine the true impact of pesticides on human health (Task Force of Environmental Cancer, 1990). Epidemiological studies are needed on potential chronic adverse health effects in humans, however the general absence of specific indices of chronic toxicity, the extremely low and variable exposure to pesticides, and the presence of a multitude of confounding factors combine to make meaningful epidemiological studies in the general population difficult. Such studies should be carefully designed around clinical or other measurements based on toxicity endpoints or target organs established in animal studies. Clearly there is a need to focus on carefully selected "high risk" population subgroups, such as agricultural workers.

Insecticides designed to attack the insect nervous system (organochlorines, pyrethroids, organophosphous and carbamate esters) are capable of producing acute and chronic neurotoxic effects in humans. Many of the pesticides used by agricultural workers are synaptic transmitters (carbamates, organophosphates); some (organochlorines) cause tremor and seizures, and others (organophosphates) may induce axonal neuropathy. Extrapyramidal and cognitive dysfunction is associated with a number of chemicals that impair energy generation and find use as fungicides, fumigants or rodenticides. Mild psychological and behavioral deficits, such as changes in the speed and precision of answering questions, impaired judgment, poor comprehension, and decreased ability to communicate have been reported to occur after exposure to anticholinesterase pesticides and can persist for weeks to months (Sidell, 1992). Chronic effects of pesticide exposure, particularly exposure to organophosphates, are not well characterized and no published studies have examined the neurotoxic effects of low-level pesticide exposure to children (NAS Report, 1993).

1.6 Assessing Neurotoxicity in Human Populations:

Assessments of neurotoxic effects in human populations have focused on adults exposed to well-established neurotoxicants such as lead and mercury, typically from occupational exposures (Echeverria, 1995). Assessments of children have primarily been aimed at the evaluation of childhood lead exposures (e.g., Bellinger et al., 1992). From the early days of this field when clinical psychologist H. Hanninen (1966) introduced methods from clinical psychology for assessing occupational carbon disulfide exposure, behavioral tests have been the methods of choice to detect neurotoxic effects. Recently interest has turned to cognitive effects (Anger, 1990; Eckerman and Bushnell, 1992; Chang, 1995). While clinical evaluations by neurologists (Rosenberg et al., 1991), neuropsychologists (White et al., 1990), and imaging techniques (Rosenberg et al., 1991) can provide more specificity in established areas (lead poisoning, solvent neurotoxicity especially of peripheral neuropathic chemicals), they remain prohibitively expensive for screening purposes. Behavioral tests, however, especially when employing sophisticated analytic methods are providing increasing functional specificity (e.g., Stollery, 1996). For cost-effective screening, this project has selected behavioral tests to identify early indices of neurotoxicity in both adults and children. Evidence collected from over 185 studies demonstrates the validity of these tests--that is their ability to discriminate between exposed and non-exposed populations (Anger, 1990). This evidence continues to mount (Chang, 1995; Anger et al., 1996). The reliability of typical tests used in this field has also been demonstrated in different studies (Letz, 1990; Campbell et al., in press). Thus, behavioral tests used to assess neurotoxicity are reliable and valid measures of neurotoxic deficit.

1.7 Neurotoxicity Testing in Children

The need to extend neurotoxicity assessments to children and adolescents has been informally discussed in toxicology circles for decades. While individuals have occasionally tackled testing of younger populations (e.g., Winneke et al., 1994), only recently have the principles for a consensus test battery for children been developed (Krasnegor et al., 1994) and implemented by the Agency for Toxic Substances and Disease Registry (ATSDR) and consultants (Amler et al., 1996). The ATSDR battery can be criticized on two grounds, however. First, many of the ATSDR tests require a knowledge of language and may be culturally unfair to Hispanic subjects who are not fluent in English. The developers of the ATSDR battery recommend that the appropriateness of neurobehavioral measures be evaluated in minority or socio-economically

disadvantaged populations, and if necessary, to develop new or modified instruments to service this population (Krasnegor et al., 1994). Second, there are no performance tests in the ATSDR battery. The present study employed standard neuropsychological tests implemented in a new computer based testing system (Anger et al., 1994, 1996; Rohlman et al., 1996), named Behavioral Assessment and Research System (BARS), assisted by a technically trained individual fluent in Spanish and conversant with indigenous languages. Additional neuropsychological tests that have limited cultural bias were also employed to assess their utility in disadvantaged minority youth.

1.8 Neurotoxicity Testing of Latin-American Populations

Behavioral tests are widely used to detect neurotoxicity, although much of the research has been conducted in Western populations from industrialized countries. The use of these behavioral tests to evaluate minority populations in the US poses unique challenges, in part because this topic has not been extensively studied. While evidence is limited, research on cultural differences in performance testing indicates that some motor (e.g., Bernard, 1989) and cognitive processes are affected by racial or cultural differences, although it is difficult to eliminate educational factors in this research (Matarrazzo, 1972; Lezak, 1995). However, research employing inter-country or inter-culture comparisons suggests that cognitive processes are fundamentally similar in diverse cultures studied (D'Andrade, 1990), although sporadic tests and functions are associated with very poor performance in some cultural groups (Lezak, 1995).

Results from 106 males in Nicaragua (Anger et al., 1993) revealed very low performance scores on cognitive tests (Digit Symbol, Digit Span, Benton visual memory). Correlations between years of education in the Nicaraguans and performance on the cognitive tests suggested the difference was attributable to the lack of education in these subjects, a hypothesis with some support in the literature (Ostrosky et al., 1985). The Nicaraguan group had a mean of only three years of schooling, compared to ten or more in subjects from the other nine countries (Anger et al., 1993). A high proportion of adults in migrant families in the Northwest area of Oregon has less than six years of education (39% of mothers and fathers in the same family). Only 36% of families report both parents have more than six years of education (Packard, 1994). A group of 150 Mexican immigrants (between 0 and 12 years education in Mexico) working day jobs in San Francisco were given the NCTB tests using the same Spanish instructions and protocols as the Nicaraguans in Anger et al. (1993). The same tests (and protocols and instructions though in English) were given to over 400 US majority subjects, 100 African American subjects, and 50 Native Americans, all educated in the US. Results demonstrated the expected relationship between years of education and performance on all cognitive NCTB tests and that Hispanics with 10-12 years of education perform at a level consistent with people from other cultural groups with the same levels of education (thus the tests are not overly culturally biased), but that Hispanics (and certainly others) with less education may perform poorly on such tests.

A series of improvements were made in BARS software and response input hardware to minimize subject reluctance to use computers. The BARS tests employ larger stimuli and clearly written instructions presented in large-size letters. The instructions are divided into component steps and the subject is required to make correct responses at each instruction step (Rohlman et

al., 1996). Since the experiments were conducted in children and migrant workers, a durable input device (the DataSled) with large response buttons has been developed that is less computer-like (Anger et al., 1996).

1.9 Agriculture in Oregon

Agriculture is a major industry in Oregon. In 1995 more than 17,500,000 acres were devoted to agriculture (Oregon Department of Agriculture, 1996). This acreage was divided among roughly 38,500 farms, with an average size per farm of 455 acres. Oregon is a US leader in the production of grass seed, hazelnuts, peppermint, cranberry crops and potted florist azaleas. It is ranked second nationwide for the cultivation of hops, sweet cherries, snap beans and onions and ranked third in production of blueberries, strawberries and pears. The Oregon Department of Agriculture estimates that 54,000 people lived on farms in Oregon during 1992 (Oregon Department of Agriculture, 1995). This number reflects both unpaid and self-employed workers. The fluctuation in total farm labor in Oregon varies between 26,800 in January and 54,000 in June. Within Oregon, more than 90% of all farm laborers are from Latin America, almost exclusively from Mexico. In Washington County, which includes the Hillsboro School District, the estimated number of agricultural workers is 7,275 and the estimated number of migrant workers is 5,000. The major crops are nurseries, berries, fruit trees and vegetables.

These crop types are particularly advantageous for studying pesticide exposure in youth because they include crops with high to moderate field-worker exposure including, apples, tomatoes, strawberries, vegetables, grapes, and tree crops, and are based primarily on labor intensity (Nigg, Beirer, et. al, 1992). These crops also involve heavy use of organophosphates. In 1987, more than 90% of the pesticides used in Oregon were on land crops. Pesticide-use patterns continually change due to pest and weed growing variations, new chemical registrations and especially discontinued pesticide registrations. Between 1990 and 1994 the fifteen crops with the highest reported pesticide use estimates, listed in descending order were: potatoes, grass seed, pears, peppermint, wheat, sugar beets, onions, berries, apples, hazelnuts, nurseries, bush beans, sweet corn, hops and peaches. The crops that are both chemically intensive and also employ a large number of seasonal workers include: strawberries, blackberries, nursery and greenhouse crops and apple and pear orchards. These represent the primary crops in the geographical areas in which our study population worked.

2 SPECIFIC AIMS/RESEARCH QUESTIONS

The major goal of the study was to assess health hazards associated with agricultural exposure to pesticides in an adolescent minority population. Specific research questions addressed included:

1. What is the knowledge level of pesticide hazards and safety precautions in an adolescent Hispanic population working in agriculture?
2. What are the common work characteristics and worker protection practices reported in an adolescent Hispanic population working primarily in fruit and berry crops and nurseries in the Northwest United States?
3. Is there evidence that exposure to anticholinesterase pesticides results in changes in levels of red blood cell cholinesterase in Hispanic adolescent agricultural workers? Do cholinesterase levels differ in adolescents employed in agriculture compared to adolescents who do not work in agriculture?

4. Is there evidence that chronic pesticide exposures in adolescent agricultural workers produce subtle cognitive or motor deficits over the course of a working season?
Two additional research questions were explored in this study:
5. What are the major beliefs of Hispanic adolescents regarding the health hazards associated with exposure to pesticides and do these beliefs differ between migrant adolescents and adolescents that do not work in agriculture?
6. How are two field tests for acetylcholinesterase similar or different when used to measure organophosphate exposure in a sample of migrant agricultural workers?

3 METHODOLOGY

3.1 Overview

A cross-sectional study was conducted on adolescent Hispanic agricultural workers in a western county of Oregon. All adolescents ages 13-18 who were present in the migrant labor camps in that county were eligible for the study if they were engaged in agricultural work. A convenience sample of Hispanic adolescents who were not currently working in agricultural served as the control group. Upon entry into the study, all subjects received interviews soliciting information about their background, work history, knowledge of pesticides, beliefs about the hazards of exposure to pesticides and current agricultural work practices. Biomarkers of pesticide exposure were collected upon entry into the study and each subject completed a computerized neurobehavioral test battery. The adolescents working in agriculture were administered biomarker tests and the neurobehavioral test battery a second time, either just before they were leaving the area for work elsewhere or at the conclusion of the Migrant Education Summer Program.

3.2 Target Population

The sample for this study was recruited from the adolescent population enrolled in the Hillsboro, Oregon Migrant Education Program. The Migrant Education Program is a national program that provides supplemental educational and supportive service to more than 800,000 eligible migrant children to help them overcome educational disruptions and disadvantages. The US Department of Education allocates funds to the individual states based on each state's identified migrant population. The Oregon Migrant Education Service Center (MESC) is the educational supportive agency of the State Department's Migrant Education Office. It serves as an umbrella organization in coordinating services to the Oregon projects funded by the national Migrant Education Program. The primary objective of the MESC is to assist school districts to meet the needs of eligible migrant students. The MESC also functions as a liaison with other agencies that provide services to migrant children. During the regular school year, Oregon's numerous migrant education projects operate in support of, and in coordination with, the regular school program. During the summer, at the peak of Oregon's harvesting season, educational programs are set up exclusively for migrant children since regular school programs are not in operation.

The Hillsboro School District in Washington County, Oregon maintains one of the most active migrant programs in the state. The migrant population, including adolescent workers, has not been frequently studied in the area of agricultural safety and health. Problems that contribute to lack of access to this population include such factors as workers' mobility, undocumented laborers, and rural location. Language barriers and the seasonal nature of the work pose further

problems. By partnering with organizations that deliver educational services to this population, we found that some of the barriers to access to this population could be surmounted.

To qualify for the Oregon Migrant Education Program, a migrant child must have moved within the past three years across state or school district lines with a migrant parent, guardian, or spouse, or a member of the child's immediate family to obtain temporary or seasonal employment in an agricultural or fishing activity. The child may be any grade between preschool and grade 12, and between 3-21 years of age, and has not received a high school diploma or GED.

In addition to the Oregon Migrant Education Program, we partnered with another Hispanic community organization, CREATE, to assist in reaching Hispanic youth not currently working in agriculture. The CREATE program (Creating Roads to Empowerment and Advancement Through Education) provides Hispanic youth and their families with support, resources, and opportunities which encourage educational, vocational, and economic success. Services provided focus on empowering youth and families to be self sufficient, to reduce youth involvement in risky behavior, to strengthen family cohesiveness, and to develop youth as leaders. CREATE staff have extensive experience with program development, implementation, evaluation and grants management. Ninety-five percent of the staff are bilingual. CREATE staff are widely viewed as experts in dealing with Hispanic families. CREATE is built on the fundamental premise that the alienation and isolation which results from the existence or perception of cultural/ethnic differences and racism is the most powerful factor in the development of risky behavior in Hispanic youth. The program seeks to build positive self-image and to teach the academic and life skills needed to constructively deal with the barriers created by the perception and existence of bias and racism.

An advisory board composed of teachers, school administrators, parents, students, etc., guides program direction. An example of general services provided in two program areas is listed below: Activities of CREATE include:

- Student retention and retrieval through skill building;
- English as a Second Language for parents and youth;
- GED completion program;
- Parent training; and
- Gang reduction activities.

CREATE assisted the research team in dissemination of information on the research study to Hispanic youth enrolled in the Hillsboro School District. In addition, CREATE also provided Hispanic, bilingual youth to assist in the data collection efforts of the project.

3.3 Study Sample

We used two Migrant Education Programs in the Hillsboro School District to recruit our study population with a goal of recruiting 100 adolescents that were working in agriculture and 50 non-agricultural adolescent controls. Youth ages 13-18 were eligible for the study.

1. Regular school year program, middle and senior high school: Approximate 200 Hispanic migrant youth are enrolled in the Hillsboro middle school program each year and 200 in the

senior high school program. We used this population to recruit non-agricultural youth. The first population approached was the group of students enrolled in the regular school year program. Information regarding the research study was given by a Migrant Education staff person during the last quarter of the school year (April-May). In addition, information on the project was also given by CREATE staff members. These staff provided information in Spanish on the purpose of the study, the amount and nature of involvement required should the student choose to participate, and the monetary incentives for participating. Youth who indicated an interest in the study were scheduled for a time in which informed consent forms were signed and the study protocol explained in more depth.

2. Summer Evening Migrant English as a Second Language (ESL) Program: This program enrolls approximately 300 students per summer. Many of these enrollees are emancipated minors living in migrant camps. We recruited adolescents under the age of 19 in this population for our study. Recruitment began in early May 1998, as migrant youth began arriving in the migrant labor camps in Washington County. The majority of these youth were only in Washington County for the berry harvesting season. We recruited youth that had registered for the ESL summer program and youth that were non-enrolled at the time of our first encounter. The agriculture work sample had to be working at least eight hours per day in fields or nurseries. In the initial recruitment stage, the research recruitment team accompanied the Migrant Education staff to the migrant labor camps. Preliminary information regarding the research study was given by the research staff after the youth had been approached for enrollment in the ESL program. This staff person provided information in Spanish on the purpose of the study, the amount and nature of involvement required should the youth choose to participate, and the monetary incentives for participating. All youth under the age of 18 available in the labor camp at the time of the recruitment visit received information on the study. Youth who indicated an interest in the study were given detailed information on the study procedures and written informed consent was obtained. Informed consent was obtained from both the adolescent subject and the parent/guardian. In the case of an emancipated minor (some of the subjects enrolled in the summer program, and living in migrant camps were not in residence with their parent or guardian), the youth signed for their own informed consent. The subject was also informed of the day that his/her testing would take place and that transportation would be provided to the testing location.

4 PROCEDURES

4.1 Development of Culturally-Sensitive and Appropriate Study Instruments and Techniques

Few of the Hispanic migrant population in Oregon are fluent in English, and many speak indigenous dialects. To increase the cultural appropriateness of our study methods and instruments, we completed multi-step translation and interpretations of consent forms to be used with the subjects.

1. The original forms were written in English and approved by the University Human Subjects Committee
2. The English forms were translated to Spanish by the Medical Interpretive Office of the University.

3. The Spanish forms were reviewed by staff members who work with the migrant population. Though the consent forms read as "proper" Spanish, they were not appropriate to be "spoken" to potential subjects who could not read Spanish. The forms were then adjusted to be more appropriate to read to potential subjects.
4. The consent forms were pilot tested with migrant persons for understanding of the content. All unclear examples or sentences were removed or substituted with an example that was relevant to the migrant experience.
5. The culturally appropriate forms were then sent back to the Medical Interpretive Office for review of the changes and to assure that the legality of the document was not affected by the changes in the wording.

Similar processes were used in the development of all interview questionnaires that were used with the adolescent migrant population. All study instruments (English and Spanish forms) are included in Appendix A. The developmental stage of the adolescent was a major factor effecting comprehension of the purposes of the study, the procedures, and the study instruments.

4.2 Testing Procedures

Subjects were scheduled for testing in groups of 6-12. During the pre-season testing, subjects were transported to the testing site by bus from the migrant labor camps. After the ESL program began, subjects were excused from their evening classes to participate in the second testing. Non-agricultural subjects were responsible for their own transportation to the testing site. All testing took place at a Hillsboro School District location in the evening hours. Subjects received $25 compensation for each test session.

The study protocol included data collection in the following three areas:

A. Completion of questionnaires on beliefs and knowledge level of pesticides, nature of work and work practices associated with reducing pesticide exposure. Three questionnaires were utilized. The questionnaire to measure agriculture work was adapted from the "Agricultural Work Practices Questionnaire" that we are currently using in a study of pesticide exposure in minority agricultural families. The questionnaire contains items on type of work (thinning, picking, packing, pesticide application, flagging, etc.), type of crop (s), hours per week, use of insect repellents, use of protective clothing, bathing, laundry, and wearing of clothing outside of fields. It was pre-tested on a sample of Hispanic adolescents and modifications made. Questionnaires were administered by interviews with bilingual research staff.

   A "Pesticide Knowledge" questionnaire was developed to measure knowledge about pesticides. This 20-item questionnaire was designed to measure knowledge in three general areas, 1) General Knowledge, 2) Health Problems, and 3) Protective Clothing and Safety. Responses were either True or False and a total score was assessed for each respondent based on the number of correct answers given. For the agriculture adolescents at the conclusion of the post-season testing sessions, copies of the answer key were distributed to all of the study subjects. CREATE distributed the answer key to the adolescent controls. This was to ensure that any erroneous impressions gained from the "false" statements in the questionnaire would not be taken as fact by the teenagers. It was

pre-tested on a sample of Hispanic adolescents and modifications made. Questionnaires were administered by interviews with bilingual research staff.

A third questionnaire was used to measure adolescent beliefs regarding the hazards of pesticide exposure. This questionnaire was adapted from an instrument previously used with adult migrant workers. Dr. Elaine Vaughan, the developer of the original instrument lent her expertise in risk taking behaviors in adolescents and environmental risks to the adaptation of the study questionnaire (Vaughan, 1993, 1995). The questionnaire contains items on sources of and previous information received on pesticides, and beliefs about the risks associated with pesticides.

B. Completion of a computerized test battery designed to detect toxic effects of pesticides on response time, memory and concentration. Testing was done at the beginning of the work season in Washington County and at the time the farm work was completed and the adolescent was preparing to move to another agricultural site, or at the end of the ESL program. Adolescents not working in agriculture were only tested once.

Neurobehavioral function was measured with a computerized battery of eight BARS performance tests: Symbol Digit), Digit Span, Serial Digit Learning, Tapping, Selective Attention Test, Simple Reaction Time, and Continuous Performance Test, Progressive Ratio. A brief description of each test follows:

1. The Symbol-Digit Test is a computerized adaptation of the Digit-Symbol test from the Wechsler Adult Intelligence Scale (WAIS-R, 11). In the task, nine unique symbols are paired with the numbers one through nine at the top of the screen and a matrix that contains only the symbols is presented at the bottom of the screen. Subjects are asked to press the numbered DataSled button for each symbol, and latencies for each button press are recorded. Subjects completed one practice trial and seven test trials (Symbol-Digit matrices).
2. In the Simple Reaction Time Test, subjects are asked to press a key as quickly as possible when the target stimulus, a large square, appears on the screen. Subjects completed 50 trials, and the latencies for each reaction time are recorded.
3. The Digit Span Test sequentially presents a series of numbers on the screen, and the Participant is asked to reproduce the sequence of numbers by typing them in the same sequence (forward), or in the reverse sequence (backward) in the second part of the test. Forward sequences are presented in increasing length starting from three numbers. The test terminated when the Participant failed two consecutive trials with the same number of digits, or when they completed a span of nine correctly. This was followed by backward sequences which was conducted in the same way as forward sequences except that the sequence started with two numbers instead of three. All responses were recorded, and data are presented as the longest span correctly reproduced.
4. The Selective Attention Test displays two squares located in the middle of the left and right halves of the screen. The Participant is instructed to press the 3 key when a dot appears in the left square, to press the 7 key when a dot appears in the right square, and to make no response when the dot is outside the squares. The location of the dot was randomly selected and correct responses shortened the interval prior to the next dot

presentation while errors lengthened the interval until the next dot presentation. The total number of completed trials and the response latency for each trial was recorded.
5. The Serial Digit Learning Test sequentially presents a nine digit number on the screen and the Participant is asked to reproduce the sequence. The test terminated after twelve trials or when the Participant correctly reproduced the span twice in a row. All responses are recorded, and trials to criterion is the measure for this test.
6. The Tapping Test instructs subjects to press a key as many times as they can for 20 seconds. Multiple trials are given for both the dominant and non-dominant hands. An alternating trial instructs subjects to tap sequentially with the left and then the right hand for a fixed duration. The number of taps per trial is recorded.
7. The Continuous Performance Test involves the presentation of two stimuli, one of which the participant responds to by pressing a response key, and for the other the participant withholds a response. Correct responses, errors and response latencies were recorded.
8. The Progressive Ratio test requires the Participant to press a button multiple times to earn a "smiling face" which serves to maintain performance. The number of button presses required to achieve a "smiling face" increased following each appearance of the "face" on the screen. The total number of presses in two minutes was recorded.

The eight BARS performance tests were administered to subjects in groups of six people each. Prior to data collection, all tests and the shaping procedures were "piloted" with Hispanic youth to verify the accuracy and effectiveness of the instructions for each test. The Spanish instructions were presented in both written and spoken form. Pilot subjects were recruited from districts other than the Hillsboro Migrant Education Program.

C. Erythrocyte cholinesterase levels were measured at two times: pre-season and at the completion of the subjects work in Washington County. Adolescents not working in agriculture were only tested once. Erythrocyte cholinesterase (AChE) was examined in each subject with both the EQM Test-mate OP and the EQM Test-mate ChE (EQM Research, Inc. Cincinnati, OH) field test systems. Before collecting blood samples subjects were instructed to wash their hands with warm water and soap. Then the skin of a selected finger (or thumb) was thoroughly cleaned with an ethanol swab, and the skin was then pierced with a sterile lancet and 10 μl of blood was collected for each test. AChE activity was assayed in a clinic-type environment where the temperature was controlled to 25° C. If blood samples were not tested immediately after collection they were stored at 4° C until assayed and equilibrated to 25° C before the assay. Control samples were run each test day.

Test-mate ChE cholinesterase test system (model 400, the new-type kit) was used with the AChE cholinesterase assay kit (model 460). When used according to manufacturer instructions in the AChE mode the kit photometrically analyzes and displays 1) AChE activity in U/ml, 2) Hb (hemoglobin) in g/dL, and 3) Q (quotient) in U/g of Hb. The assay is based on the Ellman (1961) method and AChE activity is based on the amount of thionitrobenozic acid formed and measured by absorbency at 450nm. Hemoglobin is measured by the absorbency of the same blood sample at 450nm before the AChE assay reagent is added.

The Test-mate OP field kit functions similarly to the Test-mate ChE test system and provides the same three test values. However, there are important differences that make it more dependent on operator technique (see research question #6).

Hemoglobin determinations were made on using the HemoCue® B-Hemoglobin system (HemoCue® AB, Angelhom, Sweden) blood samples obtained from finger-sticks. This system is designed to be used in settings such as clinics and utilizes a reaction that causes hemolysis of the erythrocytes and the released hemoglobin is converted to azidemethemoglobin and absorbency is measured at two wavelengths (570 and 880 nm).

4.3 Statistical Analysis

Responses to the questionnaires were tabulated and described. Analysis of variance and regression were used to investigate how knowledge is influenced by variables such as a subject's age, amount of agricultural training, and level of agricultural experience. Chi-square tests of association were used to compare worker protection practices according to age.

The responses of the agricultural and non-agricultural adolescents on the questionnaires measuring pesticide knowledge/beliefs were compared using chi-squared tests of association. In instances of prohibitively small cell counts a simulated version of Fisher's exact test was performed (Manly, 1997).

Mean levels of cholinesterase activity between end-of-season agricultural youth and non-agricultural youth were compared (t-test). Pre- and post-season cholinesterase activity levels are evaluated for the group of agricultural adolescents with a paired t-test.

Differences on neurobehavioral tests between the agricultural and non-agricultural groups were examined with t-tests; paired t-tests were used to compare pre- and post-season scores within the agricultural group. A Bonferroni correction was used to accommodated the large number of test items in this study.

5 RESULTS

5.1 Demographic Characteristics of the Sample

In partnership with Hillsboro Migrant Education and CREATE, 142 Hispanic adolescents working in agriculture and 63 adolescents not employed in agriculture were recruited for our study. Of these 205 adolescents indicating an interest in participating in the study, 102 of the agricultural adolescents (72%) and 51 (81%) of the non-agricultural adolescents were present on their scheduled day of testing and were entered into the study. Table 1 shows that 102 of these adolescents were currently working in agriculture and 51 were not employed in agriculture. Of the 102 agricultural workers, 96 were migrant workers and six were seasonal workers. Eighteen of the controls had previous work experience in agriculture but were no longer working in that area (35.3%). The remainder of the controls had never done agriculture work.

The mean age of the agricultural adolescents was 16.3 (S.D.=1.5) years and that of the adolescent controls was 15.2 years (S.D.=1.4). The study sample was stratified into two age

groups for some analyses, with the first group consisting of subjects between the ages of 13 and 15 and the second group youth ages 16-18. The agriculture group contained 28.4% in the 13-15 age range and 71.6% in the 16-18 age range. The converse was observed for the adolescent controls with 58.8% within the younger age group and 41.2% in the older age group. Due to this difference, some analyses comparing the agricultural group and controls were age-adjusted.

Males were disproportionally represented in the agricultural group. Of the agricultural group, 92.2% were male and 7.8% were female. For the adolescent controls, the numbers of males and females observed were almost equal with 47.1% being female and 52.9% male. Overall, 79.1% of the study subjects (N=153) were male.

The primary country of origin was Mexico for both the agricultural group and the controls (94.1% compared to 98.0%). The primary language spoken for both groups was Spanish, but 36.3% of the agricultural groups spoke indigenous dialects as their primary language (Mixteco or Trique). All of the non-agricultural controls were currently enrolled in US educational programs, but only 15.7% of the agricultural adolescents had any previous US education. Overall the non-agricultural group had significantly more education than the agricultural group.

5.2 What is the knowledge level of pesticide hazards and safety precautions in an adolescent Hispanic population working in agriculture?

Eleven possible demographic variables were examined for association with the percent of correct responses on the Pesticide Knowledge Questionnaire.

Variable	Measurement
1. Currently working in agriculture	Yes, no
2. Any agriculture work experience	Yes, no
3. Age	13 - 18
4. Age group (13-15 years, 16-18 years)	Younger, Older
5. Years of education in country of origin	0-13
6. Years of education in USA	0 - 13
7. Any education in USA	Yes, no
8. Gender	Male, Female
9. Primary language	Spanish or indigenous dialect
10. Ethnicity	Mexican or other Central American
11. Previous Agriculture Safety Training	Yes, no

All possible subsets of these variables were examined using the *leaps* function in SPLUS (MathSoft, 1995) with Mallow's Cp statistic used as the criterion for model performance. Models with less than four explanatory variables appeared to be heavily biased while those with six or more terms were over specified. The final regression model for variables predicting scores on the Pesticide Knowledge Questionnaire follows:

Estimated mean % correct = 0.74 + 0.07*ag exp + 0.04*ag train - 0.07 * lang – 0.06* ag
Est. standard errors (0.02) (0.03) (0.02) (0.02) (0.03)

s = 0.12 on 148 df
R-squ = 0.11

Subjects speaking an indigenous dialect were estimated to score an average of seven percentage points (95% CI from two to 11 percentage points) lower than a Spanish speaking subject with similar levels of agricultural training and experience. Similarly, after controlling for effects of language and training, those with agricultural experience have total scores that average seven percentage points (95% CI from 0.5 to 14 percentage points) higher than subjects with no agricultural experience. Adolescents with agricultural employment during the summer of 1998 appear to have slightly lower scores (by approximately six percentage points) than those not employed in agriculture; however, the effect of past agriculture experience and/or training makes this difference insignificant.

5.3 What are the major beliefs of Hispanic adolescents regarding the health hazards associated with exposure to pesticides and do these beliefs differ between migrant adolescents and adolescents that do not work in agriculture?

The Farmworker Health Beliefs Questionnaire adapted from Vaughan (1993, 1995) was used as an instrument to test the major beliefs of Hispanic adolescents regarding hazards associated with exposure of pesticides. The questionnaires were given to migrant Hispanic adolescents with current or past agricultural work experience and Hispanic adolescents with no agricultural work experience to evaluate any difference in their beliefs. The number of adolescents with current or past agriculture experience was 120 (102 currently working and 18 with past experience). The number of adolescents with no agriculture experience was 33.

Economic Necessity (of current agriculture workers):
Of the Hispanic adolescents currently working in agriculture, only 22% reported having worked previously in non-agricultural jobs (Table 2). When asked how difficult it would be to find work outside of agriculture, 86% reported that it would be a little difficult to impossible. Fifty four percent were unsure of any other available jobs.

Current agricultural workers were asked if they believed that the benefits of continuing to do farm work were worth any possible health effects of pesticide exposure. Of the current workers only 19.6% reported that the economic benefits were worth the risk of health effect. Sixty-five percent reported that the economic benefits were somewhat or definitely less important than the health risks. Sixteen percent were unsure.

Perceptions of Exposure:
Of adolescents with current or past agriculture work, 54% reported that they have been exposed to pesticides while working in the fields, while 46% reported that they have never been exposed (Table 3). Subsequently, the adolescents were asked to indicate from a list read to them, possible ways that they could have been exposed to pesticides. The more common reported means of exposure was by touching crops (42.5%) and breathing pesticides in the air (38.3%). Nineteen percent reported they came in contact with pesticides while mixing/loading/applying pesticides.

When read the list of ways one could be exposed to pesticides 33% reported no contact with pesticides. This is a lower than the percent that reported not being exposed to pesticides while working in the fields (46%). It is possible that the subjects interpreted the first question to mean pesticide exposure ONLY if working in the fields. This would account for the higher percent that reported contact with pesticides by other mechanisms such as nursery work.

Only thirteen percent of the past and current agricultural workers reported always using protection methods, and 52.2% reported never using protection methods. Of those workers who reported some use of protection, 41 gave examples of what they used. The most frequent examples given were clothing (long sleeved shirts, long pants, 53.7%), gloves (53.7%), a mask or face covering such as a kerchief (31.7%) and shoes or boots (31.7%).

The most frequently reported source for information on pesticides came from supervisors (61.7%), friends or family (58.3%), and fellow workers (51.7%). Only 22.5 % reported that they received pesticide information from a union, while 35% have received pesticide information in schools, and specifically 11.7% reported that the Migrant Education Program had given them information on pesticides.

Beliefs about protection from pesticides:
All study subjects were asked if there are ways to protect against from exposure to pesticides, with 48% responding no. Table 4 shows that 71.9% percent of non-agriculture group reported that protection was not possible compared to 41.7% of the agricultural subjects ($p = 0.002$). Agricultural adolescents between the ages of 16-18 were more likely to believe that there are ways to protect one's self from pesticides (65.5%) compared to 41.7% of the adolescents between the ages of 13-15 (data not shown, $p = .015$).

Seventy-nine of the adolescents in the study (agricultural and non-agricultural) reported that there are ways to protect oneself against pesticides. Seventy-four of the adolescents gave examples of what one could do. The most frequent examples given was some type of barrier method or covering of the body such as gloves clothing, kerchiefs or masks, and protective boots or shoes. Eleven percent of the adolescents gave examples of staying clean or showering, and 13.5% avoiding spray areas.

All subjects where asked how effective safety precautions are in reducing the health effects of pesticides. All but four answered the question, and 49% reported safety precautions are somewhat effective, 17% not at all, and the remainder (33%) reported safety precautions were either completely or mostly effective. There is no significant difference in the perceived effectiveness of safety precautions between persons with or without agriculture experience.

Perceived health risks of pesticides:
All subjects in the study were queried regarding their perceptions of the health risks associated with pesticides. Of the total sample (N=153), 76% percent reported the belief that pesticides cause health problems (Table 5). A significantly higher proportion of subjects with current or past agriculture experience (81%) reported that pesticides cause health problems compared to persons with no agriculture experience (58%) ($p = 0.008$).

Within the agriculture group, the proportion of youth reporting the belief that pesticides cause health problems was significantly lower among those whose primary language was an indigenous dialect (62.2%) compared to subjects whose primary language was Spanish (89.2%), (data not shown, $p=.001$). The perceptions of the health risks associated with pesticide exposure did not differ between subjects in the older and younger age groups.

Of the subjects that reported the belief that pesticides cause health problems, 95 answered an open-ended question as to what health problems could be caused by pesticides. Of these responses the largest percentage of problems reported where of skin welts/rashes (25.3%), headaches (22.1%), stomach pain/vomiting (17.9%), and breathing problems/asthma (16.8%). All subjects were asked if they knew of any effects that pesticides had had on themselves or their families. There were 14 positive responses, all of which were from agriculture workers currently working in the fields. Three responded skin irritation, two vomiting and each of the following were mentioned once: dizziness, eye problems, blood sickness, foot problems, infection, toxicity, headaches, pain.

Forty-nine percent of the youth that had work experience in agriculture experienced fears about the health effects of pesticides compared to 19% of the youth who have never worked in agriculture. Fifteen percent of the agricultural youth stated that the belief that they have become sick from being around pesticides is enough to result in worrying a great deal Only 6.5% of adolescents who don't work in agriculture worry about pesticide sickness, compared to 40% of the adolescents in agriculture.

Risk perceptions and judgements of harm to others:
All study subjects were asked if they believed that pesticides could affect the health of children born to agricultural workers (Table 6). Forty-four percent of the sample said that the possibility was not enough to cause concern, or not at all concerned. There were no significant differences between persons with or without agriculture experience.

Questions were asked to determine the judgements of perceived harm to others that may be exposed to pesticides. This questions are useful to make comparisons between beliefs about others and beliefs about oneself or testing for optimistic bias (Vaughan E, 1993, Nordenstam B & Vaughan E, 1991). When youth with agricultural experience were asked if they believed that a teenager working in the field would experience some health problems in the future, 65.9 % percent reported that it was very likely or definitely likely. Only 15.8% of the youth with current or past agricultural experience reported there was no chance that a teenager working in the field would experience some health problem in the future. However, 25.2% of these youth reported there was no chance that they personally would experience any health problem in the future.

General Risk Beliefs:
Subjects were asked to respond to several questions assessing their general risk beliefs about hazardous substances or chemicals in the environment (Table 7). Subjects were given the statement "The government should not wait for absolute proof that a chemical is harmful. Even if we are not sure, if there is any evidence at all that something might be harmful, the government should act to protect the public," and were asked if they agreed or disagreed with the statement. Of the responders with past or present agriculture experience, 82 % either strongly agreed or somewhat agreed with the statement compared to 91% of the youth with no agricultural experience (a non-significant difference).

Subjects were asked, "Suppose a group of scientists report that a certain chemical found in some foods might cause cancer, but the evidence is not certain. If many people eat this food, what would you most likely do?" Thirty nine percent reported that they would avoid food no matter what the cost, 39% responded that they would reduce exposure to these foods, no matter what the cost and 22% where not concerned at all. There were no significant differences between persons with or without agriculture experience.

Subjects were asked, "Suppose that scientists have concluded that coming in contact with very large amounts of a chemical occasionally causes cancer. How concerned would you be about coming in contact with very small amounts of this chemical?" Thirty-five percent reported that they would be extremely concerned, 61% somewhat concerned and 5% not at all. There were no significant differences between persons with or without agriculture experience.

Subjects were given the statement "Most cancers are caused by things that people cannot avoid, for example, things in the environment," and asked if they agreed or disagreed with the statement. Of the 152 subjects 62.5% strongly or somewhat agreed and 17.8% either strongly or somewhat disagreed and the remainder where unsure. There were statistically significant differences between the subjects with current or previous agricultural experience and those with none. Youth with current or previous agricultural experience were more likely to disagree with the statement ($p = 0.021$).

5.4 What are the common work characteristics and worker protection practices reported in an adolescent Hispanic population working primarily in vegetable and berry crops and nurseries in the Northwest United States?

Interviews were conducted at the time of arrival to Hillsboro, Oregon. Most of the subjects were waiting for the ripening of crops for harvest work. Table 8 shows the work characteristics of the agricultural group. Approximately 72% of our sample had worked in other agricultural areas in the month preceding their arrival to Hillsboro. Approximately half of our study sample had worked in other Oregon locations during the month prior to arriving to Hillsboro. The remainder of the study subjects reported that they were coming from agricultural work in California, Arizona, Washington and Mexico. Ninety-one percent of our sample were fieldworkers harvesting berry or vegetable crops. Twenty-two subjects reported that their current work involved mixing/applying pesticides, herbicides, fungicides or other chemicals. Of these 22, 38.1% indicated that they mix or apply these chemicals daily or once a week. The remainder (59.1%) reported that they do so less frequently (once a month or sometimes). Eight of these

subjects were ages 15 or younger, with the remainder 16-18 years of age. The eight younger subjects were less likely to report frequent mixing/applying these chemicals (two of the eight younger subjects compared to six or the fourteen older adolescents).

End of Work Day Hygiene Practices

Subjects were asked about their end-of-workday practices (Table 9). Seventy four percent of the subjects stated that they changed out of their work clothes within two hours after work, however only 10 percent changed at work or within 30 minutes of arriving home. Nineteen percent stayed in their work clothes for two or more hours. Almost two-thirds of the sample reported that they entered their home with their work clothes on, but 77% reported they removed their footwear before entering their dwelling. Subjects were asked when they usually washed off after arriving home. Thirty-nine percent washed off right after arriving home, and 46% within 30 minutes or an hour. Seventy-six percent reported showering to remove dust after work, with 86.2% showering either immediately or within an hour after their return home.

Laundry Practices

Table 10 shows the responses of the subjects to the handling of work clothes. Three-quarters of the sample indicated that they kept them separate from the family laundry. Approximately 7% soaked them separately then mixed them in with the family laundry and 9% reported washing work clothes with the family laundry. Commercial laundromats were utilized by 44% of the sample, 21% utilized a communal washing machine and approximately 24.5% washed their laundry by hand. Only 13.7% reported having access to a private washing machine in their home dwelling.

Use of Protective Clothing

Table 11 shows the most frequent protective clothing reported by the subjects was long pants (98%), long sleeved shirts (75.5%) and caps or hats (85.7%). More specific types of protective clothing or equipment were not reported by this sample. More than one half of the sample reported that they never used overalls, goggles or glasses, plastic clothes, or respirators. The use of protective clothing was examined for the 21 of the 22 adolescent youth that reported they were involved in mixing/applying pesticides, herbicides, fungicides or other chemicals. The likelihood of use did not differ between youth that reported frequent handling compared to those with less frequent handling. The frequency of use of protective equipment was greater than that reported of the total study sample of agricultural youth.

5.5 Is there evidence that exposure to anticholinesterase pesticides results in changes in levels of red blood cell cholinesterase in Hispanic adolescent agricultural workers? Do cholinesterase levels differ in adolescents employed in agriculture compared to adolescents who do not work in agriculture?

We recruited 102 adolescent agricultural youth and 51 non-agricultural youth for our study. Of the original 102 agricultural youth, 70 subjects were available for repeat testing of acetylcholinesterase (AChE) activity at the conclusion of the Migrant Education Summer Program. The 70 subjects with two acetylcholinesterase (AchE) measurements and the 51 controls were used for these analyses.

During the period from 5/29/98 to 6/11/98 blood acetylcholinesterase (AChE) activity levels were measured in a group of Hispanic youth who were presently or soon to be engaged in agriculturally-related work activities. This population was found to have blood acetylcholinesterase (AChE) activity levels ranging from 2.17 Units/ml blood to 5.13 Units/ml blood with a mean of 4.11 Units/ml blood (Table 12). When the AChE activity was corrected for hemoglobin (Hb) concentration the range was from 20.3 Units/ g Hb to 34.8 Units/ g Hb with a mean activity of 28.51 Units/ g Hb. During the period from 6/9/98 to 6/17/98 blood acetylcholinesterase (AChE) activity levels were measured in a reference group of 51 Hispanic youth who were not engaged in agriculturally-related work activities. In comparison to the agricultural group the reference group was found to have a mean AChE activity of 4.0 Units/ml blood or a corrected mean activity of 29.4 Units/g Hb. Thus the mean corrected AChE activity found in the population involved in agricultural work was not significantly different from the control group.

The blood acetylcholinesterase (AChE) activity levels were measured in the agricultural group from 12 to 35 days after the initial AChE measurement was taken, during which time this sample was involved in agricultural work in a variety of settings in Hillsboro, Oregon. The blood acetylcholinesterase (AChE) activity levels at this second testing ranged from 3.17 Units/ml blood to 5.19 Units/ml blood with a mean of 4.19 Units/ml blood (see Table 1). When the AChE activity was corrected for hemoglobin (Hb) concentration the range was from 23.9 Units/ g Hb to 38.6 Units/ g Hb with a mean activity of 29.76 Units/ g Hb (see Table 12). Differences in the mean between the first and second AChE measurements were 0.18 U/ml blood and 1.26 Units/g Hb for the blood AChE and Hb corrected AChE activities, respectively. The increase in mean Hb corrected activity was statistically significant ($p < 0.001$).

Overall the data suggest that there was no depression of blood acetylcholinesterase (AChE) activity levels during the period between the first and second testing. The increase in blood acetylcholinesterase (AChE) activity levels suggests that the group was possibly exposed to cholinesterase-inhibiting substances during the month preceding the initial test and were in a recovering period when tested in our study, however any conclusions are outside our realm of inference. The initial AChE activity levels were slightly lower, but not significantly different than the reference population and they demonstrated an increase with measurement a second time two to four weeks later.

5.6 How are two field tests for acetylcholinesterase similar or different when used to measure organophosphate exposure in a sample of migrant agricultural workers?

We wanted to determine 1) if the new EQM field kit yields similar results for acetylcholinesterase, hemoglobin and hemoglobin adjusted cholinesterase as the old kit, and, 2) if the hemoglobin result produced by the EQM field kit compare with benchmark laboratory test for hemoglobin.

Although the Test Mate OP proved to be a reliable unit in the hands of a trained operator, our experience with the kit demonstrated a number of limitations, particularly in the hands of a novice operator. The Test-Mate ChE includes a number of modifications to improve the ease of use and to eliminate operator error resulting from variation in sample preparation techniques and enzyme assay conditions. Table 13 presents a summary of the key differences between the OP-

Test Mate (old) and Test-Mate ChE (new) kits. Using the old kit, it was often difficult to reproducibly deliver the blood sample to the assay cuvette and then rapidly and thoroughly mix the blood with the enzyme reagents for the colorimetric analysis. The new kit overcomes these problems by thoroughly rinsing the capillary tube used for the blood draw and by increasing the mixing time. Other improvements offered by the new kit include single-use vials instead of a washable cuvette, premeasured buffer solution, improvements in procedures for developing a method blank, and single-use disposable assay vials. Our operators found the new kit to be much more convenient and more likely to generate reproducible results under field conditions in the hands of minimally trained operator.

Blood acetylcholinesterase (AChE) results obtained with the old and new test kits were compared in paired-difference testing of a group of 81 adolescent Hispanic agricultural workers (Table 14). The raw acetylcholinesterase levels, reported as U/ml blood, were significantly different and consistently lower when the analysis was performed with the Test-mate OP field kit as compared to the Test-mate ChE field kit (mean difference = 0.26, standard deviation = 0.36, $p < 0.0001$). The mean of values obtained with the Test-mate OP kit was 3.96 U/ml with a range from 3.11 U/ml to 4.96 U/ml, while when the Test-mate ChE kit was used a mean of 4.22 U/ml, range from 3.15 U/ml to 5.13 U/ml, was obtained. Hemoglobin (Hb) levels, reported as g Hb/dL, were also significantly different when measured with the old and new test kits (mean difference = 0.74, standard deviation = 0.82, $p << 0.0001$). In contrast, the paired hemoglobin-adjusted acetylcholinesterase analysis results from the old and new test kits were not significantly different (mean difference = 0.35, standard deviation = 2.04, $p = 0.127$), and both kits reported a mean hemoglobin-adjusted acetylcholinesterase level of approximately 28 U/g Hg for this group of 81 subjects. This level was comparable to the normal expected values quoted by EQM Research, Inc. (range 21.9 – 37.3, mean = 27.1, standard deviation = 2.9) for a group of 40 donors between the ages of 20 and 60 years located in the midwestern United States (Test-mate, 1996).

The results from paired testing of 76 adolescent agricultural workers to compare the hemoglobin values obtained with the two EQM kits with those recorded using a HemoCue® test kit are shown in Table 16. The HemoCue® kit, which measures hemoglobin by the hemoglobincyanide method, is considered a benchmark test for field studies of hemoglobin (HemoCue, 1996). The HemoCue® is factory calibrated against the clinical hemoglobincyanide method at 14 g Hb/dL, and subsequent field check samples maintain the instrument performance within a $\pm$ 0.3 g Hb /dL tolerance level. The hemoglobin results obtained with the old test kit, reported in g Hb/dL blood, were significantly different from those obtained with the HemoCue® kit (mean difference = 1.52, standard deviation = 0.88, $p < 0.0001$). Results obtained with the new kit were also significantly different from those obtained with the HemoCue® kit (mean difference = 0.75, standard deviation = 0.70, $p < 0.0001$). All hemoglobin results measured using the EQM kits or the HemoCue® fell within normal age- and gender-adjusted levels (normal range is 11.7 to 16.6 g Hb/dL blood for 15 – 17 year old males (Tietz , N.W., 1995).

We also investigated the precision of the EQM test kits and the HemoCue® kit by analyzing sets of duplicate samples and computing the coefficient of variation for duplicate measurements (data not shown). For the old test kit, we analyzed duplicate samples from a group of three subjects from our study group. The coefficients of variation for duplicate testing of acetylcholinesterase, hemoglobin, and hemoglobin-adjusted acetylcholinesterase were 3%, 2%, and 2 %, respectively.

Comparable results for the new test kit, obtained from a random group of 2 subjects from our study group and two volunteers from our research staff, were 4%, 1%, and 3%, respectively. We also measured the precision of the hemoglobin measurement with the HemoCue® test kit on a group of two subjects from the agricultural worker group and three volunteers from our staff. The coefficient of variation for this measurement was 3%. We are currently developing a comparison study between the EQM test kit and a standard benchmark laboratory test of acetylcholinesterase to examine the accuracy of the EQM test kit. EQM Research, Inc. has shown that there is a strong correlation between results obtained with the EQM kit and with the Boehringer Mannheim Cholinesterase Kit No. 450035 (EQM Research, Inc.), but differences in assay conditions and reporting units prevent a direct comparison of the results obtained with these two kits.

5.7 Is there evidence that chronic pesticide exposures in adolescent agricultural workers produce subtle cognitive or motor deficits over the course of a working season?

The agricultural group results from the pre-season testing on most motor tests were comparable to the non-agricultural group tested at the same pre-season time period. With the exception of the Simple Reaction Time test, the differences were not significant after correcting for multiple comparisons (Bonferroni correction of $p=0.05$ to $p=0.0029$ for 17 measures). By contrast, performance on the cognitive tests favored the non-agricultural group on all but the Continuous Performance Test on which results were roughly comparable between the non- agricultural and agricultural groups, Performance on the Digit Span, Symbol-Digit, and Serial Digit Learning tests revealed significant ($p<.0001$) differences between the agricultural and non-agricultural groups, even after correcting for multiple comparisons. Performance on the Selective Attention test favored the non-agricultural group, but the differences were not significant (Table 16).

When the agricultural group was retested at the post-season period (mean 23 days after the pre-season test, range 6-36 days), the agricultural group had slightly higher performance on some Tapping measures and on the Progressive Ratio test, and significantly improved performance on the Simple Reaction Time, Selective Attention Test (latencies), Continuous Performance Test (hit latency), Digit Span Forward and Backward, Serial Digit Learning, and Symbol Digit latency. When the improved post-season agricultural performance was compared to the non-agricultural performance, significant (Bonferroni-corrected) differences disappeared on all but the Simple Reaction Time test, although non-corrected significant differences remained on the Continuous Performance (latency) and the second administration of the Symbol-Digit test (Table 16). Typical pre- to post-improvement in the agricultural group compared with the non-agricultural group is exemplified in the Serial Digit Learning task (Figure 1).

6 DISCUSSION

6.1 The Study Sample

There have been few published studies of the occupational health and safety problems encountered by migrant agricultural workers. A large cause of this scarcity of research is the difficulty encountered in recruiting members of this population for research purposes and the lack of culturally-appropriate research methods and instruments (National Advisory Council on Migrant Health, 1993; Sasao & Sue, 1993). We have demonstrated that through partnering with community groups that serve this population, these much needed investigations can be

successfully conducted. Once the study was explained to the population, in culturally appropriate terms and by bilingual research staff of their own ethnicity, the participation rates (the rates of attending scheduled testing periods) were comparable to those that we have achieved in research studies of healthy adult migrant populations. A crucial component of the study was our actual presence in the migrant labor camps, and the provision of transportation from the camps to the testing site. Also the payment of $25 for each test session was viewed as a major incentive for participation.The working partnership with the Migrant Education Program in Hillsboro, Oregon was viewed as a positive outcome of the study. Our original research plan called for recruiting adolescent agricultural workers for the study AFTER they had enrolled in the migrant education program. We found that our study recruiters could just as easily enter an adolescent into the study and then subsequently, on the evening of the initial testing, the adolescent could be enrolled in the migrant education program. The importance of providing educational opportunities for these youth has been described by Pollack & Landrigan, 1990. The partnership enabled the research team to introduce a group of youth to the migrant education opportunity, that might not have enrolled in the educational program otherwise.

The recruitment of youth that had not previously enrolled in the Migrant Education Program minimized any bias introduced by only studying migrant youths who have selected to obtain a US education. However, we were unable to assess any characteristics of the youths who refused to participate in our study. Therefore, the generalizability of these research findings is not known.

A particular challenge of this study was recruitment of a comparable control group. In Hillsboro, Oregon, there is not a migrant adolescent population group that does not work in agriculture. The educational, and to some extent the age differences, are particularly problematic for the neurobehavioral testing. As more Hispanic families migrate to the United States, the potential of locating comparable non-agricultural controls groups will increase, but still will remain a serious methodological problem.

6.2 Knowledge Level of Pesticide Hazards and Safety Precautions

As we progress in our research program with migrant agricultural workers, the primary language of the study populations is becoming increasingly important. We found that subjects speaking an indigenous dialect were estimated to score an average of seven percentage points lower than subjects whose primary language is Spanish, but who have comparable agricultural experience and agricultural safety training. The knowledge questionnaire was administered by Hispanic adolescents with Spanish as their primary language, so it is possible that the difference in scores is due to language difficulties, and not actually knowledge differences. Even so, this finding underscores the importance of language-appropriate training for this population. In Oregon, agricultural training is conducted most frequently by Spanish-speaking individuals. We know of no practice of providing this training in indigenous dialects.

6.3 Beliefs Regarding Health Hazards Associated with Pesticides and Agricultural Work

The findings of this study demonstrate the economic necessity of agricultural work in this migrant population. Clearly the large majority of this migrant adolescent population comes to Oregon to work in agriculture and 86% reported that it would be difficult, to impossible, to find

other types of work. While agriculture employment is needed by these adolescents, they are also concerned about the health effects associated with exposure to pesticides. Approximately half of the sample believe that they are exposed to pesticides, most commonly by touching crops or through the air, yet 42% of the sample of agricultural youth reported that protection from pesticides was not possible. Older adolescents were more likely to believe that protection was possible compared to younger adolescents.
Agricultural adolescents were more likely to believe that pesticides could cause health problems then their non-agricultural controls. Within the agricultural group, the adolescents speaking indigenous dialects were less likely to believe that pesticides could cause health problems than adolescents whose primary language was Spanish. This difference, coupled with the knowledge difference between these two groups, is a strong indication of a need for more focused agricultural training with this high risk group.

The results of this study indicate that the migrant adolescent agricultural work population has some element of optimism regarding their own health risks. Literature from the United States indicates that most people, under most conditions, view their own chances of misfortune as lower than those of other people (Whalen et al., 1994). Vaughan, 1995 reported that adult migrant agricultural workers' chances of future personal harm from pesticide exposure were judged to be significantly less than the chances for other agricultural workers. We found that when youth with agricultural experience were asked if they believed that a teenager working in the field would experience some health problem in the future, 16% reported that there was no chance, compared to 25% that reported no chance of themselves experiencing health problems. The phenomena of optimistic bias has been studied in adults and less frequently in children. More investigations are needed of this phenomena in culturally diverse populations before any findings can be incorporated into prevention interventions. Within this migrant adolescent population, optimistic bias regarding the health risks associated with pesticide exposure, needs to be studied in relation to ethnicity, education, age, and reported use of protection, and knowledge level of pesticide hazards.

6.4 Work Characteristics and Worker Protection Practices

The results of this study indicate variability in the reported end of work day hygiene practices. Only 10 percent of the sample changed out of their work clothes within 30 minutes of arriving home. Within two hours of completing work, 74% of the sample reported that they had changed clothes. The majority entering their homes with work clothes on, usually removing only shoes or boots (which would be muddy in the early summer growing season in Oregon). Almost all of the sample showered within an hour after their return home. Due to communal bath facilities in many circumstances, all workers can not logistically shower immediately upon arriving back at the camp.

Only 14% of this sample had access to private washing machines and 25% washed their laundry by hand. These findings reinforce the need to provide educational training that is appropriate to the settings in which this population live and work. Studies are also needed to quantify the amount of pesticide residue on clothing and in the homes of this migrant population.

Our study results indicate that almost 20% of our study sample were involved in the mixing or application of pesticides, herbicides, fungicides and other chemicals. This finding is similar to

that of Pollack et al., 1990 who surveyed migrant agricultural worker children in New York State. While the use of protective clothing or equipment in this pesticide apply/mix group exceeds the levels reported by the entire agricultural sample, this finding is of major concern. Of the twenty-two subjects, eight were ages fifteen or younger. Future research investigations are needed to focus on the particular exposures of this group and the factors associated with adolescents being engaged in this work activity.

6.5 Measurement of Biomarkers of Exposure

We found no evidence that adolescents working in primarily berry and vegetable crops had decreases in their levels of red blood cell acetylcholinesterase activity, nor that the levels differed between agricultural and non-agricultural youth. These findings differ from those reported by Ciesielski (1994) that compared migrant agricultural workers in North Carolina to non-agricultural workers.

We were surprised to find that the hemoglobin corrected blood acetylcholinesterase activity of the agricultural adolescents did change from the pre-test to the post-test. The change was in the direction of a "recovery" from organophosphate exposure. We were unable to discern any obvious group characteristic which could explain this difference (e.g., travel from Mexico, type of crops worked previously, or mixing/applying pesticides).

6.6 Neurobehavioral Tests

The agricultural group's pre-season test performance was significantly poorer than the non-agricultural group's performance on cognitive tests (Selective Attention, Continuous Performance, Digit Span, Serial Digit Learning, and Symbol-Digit), and on Simple Reaction Time but not on the other motor tests. These group differences remained on Simple Reaction Time, Continuous Performance (latency), and Symbol-Digit (second administration) when comparing the non-agricultural group to the agricultural group's post-season performance, although the appropriateness of this comparison cannot be evaluated. The most consistent differences in organophosphate-poisoned or exposed agricultural workers tested long after their over-exposure, are on Simple Reaction Time, Tapping, Digit Span, and Symbol-Digit tests (Savage et al., 1988; Rosenstock et al., 1991; Steenland et al., 1994; Stephens et al., 1995). While the differences in our agricultural group are very consistent with this evidence of organophosphate pesticide damage, concerns over the comparability of the control group (years and location of education) make it impossible to conclude that the differences result from any influences other than education.

7 CONCLUSIONS

This study was conducted with adolescent Hispanic agricultural workers working primarily in berry and vegetable crops in western Oregon. Less than 10% of the adolescents approached to participate in the study refused to participate, and 75% of the adolescents attended their scheduled testing sessions. While participation rates were high, the results of this study can not be generalized to other groups of migrant adolescent agricultural workers due to the differences in crops and work activities in different regions, and different ethnic, cultural, and gender mixes of agricultural workers throughout the United States.

This is the first study to our knowledge that has documented the risk perceptions of migrant adolescents who work in agriculture. Over one half of the agricultural sample believe that they are exposed to pesticides while working in the fields, yet 52.2% report never using protection methods. Younger children were less likely to believe that there were ways to protect oneself from pesticide exposure compared to older adolescents. There is some evidence of optimistic bias in this adolescent sample. Future investigations should compare the risk perceptions of adult migrant agricultural workers to those of adolescent agricultural workers. Also future research studies should focus on recruiting larger numbers of female agricultural workers to investigate gender differences in risk perception.

The large majority of this study sample was engaged in berry or vegetable fieldwork. Approximately 20% of the sample reported currently mixing and/or applying pesticides. Future investigations are needed on this high risk sub-sample of the adolescent migrant agricultural work population. Particularly, more information is needed regarding the determinants for this type of work, the hazard communication that is received, and direct measurement of biomarkers of pesticide exposure.

The after work hygiene practices and laundry practices of this study sample were highly variable. Eighteen percent of the sample remained in work clothes for greater than two hours after returning from the fields and 41% entered their homes with work clothing on. Nine percent of the sample reported mixing work clothes with family laundry and 25% reported doing laundry of work clothes by hand. Future investigations should focus on any associations between these laundry and hygiene practices and pesticide residues in the home or biomarkers of pesticide exposure.

There was no difference in the erythrocyte acetylcholinesterase activity levels in adolescent migrant agricultural workers and controls. The adolescent agricultural workers did not show evidence of acetylcholinesterase activity depression during the harvesting season in which they were studied. Conversely, the acetylcholinesterase activity levels rose during this period, possibly suggesting a recovery from previous organophosphate exposures.

There is no conclusive evidence that the agricultural (or other) experiences of the adolescent agricultural workers tested in this project are associated with neurobehavioral performance deficits that can be related to pesticide exposure. While it is possible that the performance differences between the agricultural and non-agricultural groups reflect deficits associated with pesticide exposure (e.g., Savage et al., 1988; Rosenstock et al., 1991; Steenland et al., 1994; Stephens et al., 1995), the marked improvement in the performance tests administered post-season to the agricultural group suggests that educational factors could also explain the differences. The agricultural group was educated entirely in Mexico whereas all members of the non-agricultural group had received some education in the United States which could have benefited their performance on these neurobehavioral tests (Anger et al., 1997). It is possible that the non-agricultural group would have shown improvement on these neurobehavioral tests had they been re-tested, and indeed they showed more improvement on the Symbol-Digit test in the second administration of that test than did the agricultural group. However, the lack of a second administration three weeks after the initial administration to the non-agricultural group leaves us without evidence on this point. Thus, the most important conclusion that can be drawn

from this research series is that is essential to select a comparable comparison group, and that a one-time cross-sectional comparison can be misleading when the control group is demonstrably different from the exposed group.

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APPENDICES

Appendix 1

Questionnaire Number 1

ADOLESCENT MIGRANT WORKERS
DEMOGRAPHICS

Name:_____ **# de**
ID:_____
First name *Surname*

Interviewer: _____ **Date:**
_____

Gender: _____

Ethnicity: Hispanic/Latin American:

_____ **Mexican**

_____ **Central American, if so from what country?**_____

_____ **Latin American, if so from what country?** _____

Address: _____

_____

Date of Birth: _____

Place of Birth:_____

What grade have you completed in _____**:** **0 1 2 3 4 5 6 7 8 9 10 11 12 >12**
country of origin

What grade have you completed in the U.S.: **0 1 2 3 4 5 6 7 8 9 10 11 12 >12**

What is your first language: _____ **S S/R S/R/W**[1]

What is your second language: _____ **S S/R S/R/W**

_____

[1] S=Speak; S/R=Speak and Read; S/R/W= Speak, Read and Write

Do you plan to work or are you currently working in the fields this summer?: Y N

Where did you work last month? Town: _____

State/Country: _____

What type of work did you do? _____

_____

When do you plan to leave Oregon this summer? Yes No
If Yes, When? _____

The number of moves your family has made during the last 12 months: _____

Have you attended Migrant Head Start?: Y N

Have you attended Migrant Education?: Y N

Do you live in a camp? Y N

In what type of housing do you live?
1. House
2. Apartment
3. Cabin
4. Trailer
5. Duplex
7. I don't know
6. Other _____

Questionnaire Number 2

AGRICULTURAL WORKER HEALTH BELIEF SURVEY

SUBJECT NAME:_____ ID:_____	SUBJECT
INTERVIEWER NAME:_____ DATE:_____	

Please tell us which of the following describes your working status:
1. Currently working in agriculture
2. Worked in agriculture in the past
3. Plan to work in agriculture in the summer
4. Never worked in agriculture

PART I: **For current agriculture workers:**

1. Have you ever worked in jobs other than agriculture in the United States?

___Yes ___No

If "yes," why did you return to agricultural work? _____

2. How difficult do you think it would be to find another job outside of agriculture?
   1 _____ not difficult
   2 _____ a little difficult
   3 _____ very difficult
   4 _____ impossible

3. Do you know of any other jobs that are available to you at this moment that pay the same as or more than your current work?
   1 _____ I can think of several other possibilities.
   2 _____ I can think of maybe one or two possibilities.
   3 _____ I'm not sure of any other jobs

PART II: Now I would like to ask you about pesticides.
For current and past agricultural workers:

4. Are you exposed to pesticides while working in the fields?
   1. _____ Daily
   2. _____ Once a week
   3. _____ Once in a while
   4. _____ Never

5. There are many ways for individuals to be in contact with pesticides. Have you been in contact with pesticides by: (Check all that apply.)

1. _____ by touching crops or plants after pesticides had been applied
2. _____ by breathing pesticides in the air
3. _____ by being sprayed unintentionally by crop dusters
4. _____ when mixing/loading/or applying pesticides
5. _____ when driving a tractor
6. _____ in the nursery
7. _____ other mode of contact (Specify) _____
8. _____ no contact

Ask all subjects

6. Are there ways to protect yourself from exposure to pesticides?

_____Yes ____No

7. If "Yes," what are some of the things that a person can do to be protected?

_____

_____

Ask only current and past agriculture workers

8. Do you use any methods of protection from pesticides?

1. _____Yes, Always
2. _____Yes, but only sometimes
3. _____No, Never
4. _____Not applicable or blank

9. If "Yes," what methods do you use?

_____

_____

10. From where do you get information about pesticides or chemicals that may be used on the job? (**Check all that apply.**)

1_____ Supervisors?
2_____ Fellow workers?
3_____ Migrant Education or Migrant Head Start?
4_____ Books?
5_____The Union?
6_____ Friends or Family?
7_____ School?
8_____ Pamphlets?
9_____ Other ways?(Specify) _____

SECTION 3: SOME PEOPLE THINK THAT EXPOSURE TO PESTICIDES MIGHT CAUSE SOME HEALTH PROBLEMS IN HUMANS, WHEREAS OTHERS THINK THAT THIS IS NOT TRUE. I WOULD LIKE TO KNOW HOW YOU FEEL ABOUT THIS ISSUE.

11. Do you think pesticides can cause health problems?

Yes Not Sure No

12. If yes, what kinds of health problems do you think could be caused by pesticides?

_____

_____

_____

_____

13. How often in the past month have you had thoughts or fears about the health effects of pesticides?

1. _____ Never
2. _____ 1 time per month
3. _____ 1 time per week
4. _____ Daily

14. Do you know of any effects that pesticides have had on you or your family? Please mention any and all problems that come to mind.

_____ _____

_____ _____

_____ _____

_____ _____

15. Do you believe that you have become sick from being around pesticides?

1. _____ Enough to worry a great deal
2. _____ Enough to cause a little concern
3. _____ Not enough to cause concern
4. _____ Not at all

16. Do you believe that pesticides can affect the health of children born to agricultural workers?

1. _____ Enough to worry a great deal
2. _____ Enough to cause a little concern
3. _____ Not enough to cause concern
4. _____ Not at all

17. What are the chances that a teenager working in the field will experience some health problems in the future?

1. _____ Definitely likely
2. _____Somewhat likely
3. _____ Very likely
4. _____ No chance

18. What are the chances that you will experience some health problems in the future due to pesticides?

1. _____ Definitely likely
2. _____Somewhat likely
3. _____Very likely
4. _____ No chance

19. How effective do you think safety precautions are in reducing the health effects of pesticides?

1. _____ Completely effective
2. _____ Mostly effective
3. _____ Somewhat effective
4. _____ Not at all effective

Ask only current and past agriculture workers

20. Do you believe that the benefits of continuing to do farm work are worth any possible health effects of pesticide exposure?

1. _____ Benefits are definitely more important than the health risks.
2. _____ Benefits are somewhat more important than the health risks.
3. _____ I'm not sure.
4. _____ Benefits are somewhat less important than the health risks.
5. _____ Benefits are definitely less important than the health risks.

SECTION 4: NOW I WOULD LIKE TO ASK YOUR OPINION ABOUT THINGS THAT MIGHT CAUSE CANCER. FOR THE NEXT TWO QUESTIONS, I WILL READ A STATEMENT AND ASK IF YOU AGREE OR DISAGREE WITH THE COMMENT.

21. "The government should not wait for absolute proof that a chemical is harmful. Even if we are not sure, if there is any evidence at all that something might be harmful, the government should act to protect the public."

1 _____ I strongly agree.
2 _____ I somewhat agree.
3 _____ I'm not sure.
4 _____ I somewhat disagree.
5 _____ I strongly disagree.

22. "Most cancers are caused by things that people cannot avoid, for example, things in the environment."

1 _____ I strongly agree.
2 _____ I somewhat agree.
3 _____ I'm not sure.
4 _____ I somewhat disagree.
5 _____ I strongly disagree.

SECTION 5: FOR THE FINAL TWO QUESTIONS, I WOULD LIKE TO KNOW YOUR THOUGHTS ABOUT SCIENTIFIC INFORMATION THAT MIGHT BE USED TO DECIDE IF CHEMICALS OR PESTICIDES MIGHT CAUSE CANCER.

23. Suppose a group of scientists report that a certain chemical found in some foods might cause cancer, but evidence is not certain. If many people eat this food, which of the following responses is most like what you would do?

1. _____ Avoid these foods no matter what the costs.
2. _____ Reduce my exposure to these foods, but not at a great expense.
3. _____ I would not change my behavior regarding these foods.

24. Suppose that scientists have concluded that coming in contact with very large amounts of a chemical occasionally causes cancer. How concerned would you be about coming in contact with very small amounts of this chemical?

1. _____ Extremely concerned
2. _____ Somewhat concerned
3. _____ Not concerned at all

Questionnaire Number 3

Pesticide Knowledge Questionnaire

NAME:_____	SUBJECT ID:_____
INTERVIEWER:_____	DATE:_____

Before we begin:

Have you received any pesticide safety training at your current job? Yes☐ No☐

If "yes":
When did this occur? _____

General Knowledge:

1. A pesticide is used to control weeds and insects.	Yes	No
2. Pesticides are dangerous to humans or animals.	Yes	No
3. It is safe to apply pesticides on a windy day.	Yes	No
4. In time, pesticides are broken down in the environment	Yes	No

Health Effects:

5. Some pesticides can cause cancer in humans.	Yes	No
6. Some people can get sick form pesticides more quickly than others, even if they are working in the same place.	Yes	No
7. It is easy to identify an illness due to pesticides.	Yes	No
8. Contact with some pesticides can cause a rash on the skin.	Yes	No
9. Pesticides may be harmful to pregnant women and children.	Yes	No

Protective Clothing and Safety:

10. Protective clothing is only necessary when mixing or applying pesticides.	Yes	No
11. It is necessary to read the instructions on a pesticide container before mixing or applying.	Yes	No
12. When applying or mixing pesticides, cloth gloves can provide more protection than rubber gloves.	Yes	No
13. Soap and water will wash pesticides off your hands.	Yes	No
14. A pesticide powder is more dangerous than a liquid pesticide.	Yes	No
15. Pesticides can enter the body through the skin.	Yes	No
16. Eating, drinking or smoking in the field increases the chances of pesticide exposure.	Yes	No
17. It is important to read the signs at the edge of a field/orchard before entering.	Yes	No
18. In hot weather, it is better to work in shorts, a short-sleeved shirt and sandals.	Yes	No
19. Pesticides can be carried from the fields into your home on your clothing and shoes.	Yes	No
20. It is safe to eat fruit directly off the tree or plant.	Yes	No

Questionnaire Number 4

Agriculture Work Practices

Name:_____ Study
ID:_____
First Last

Interviewer:_____
Date:_____

1. Are you currently working in agriculture? a. Yes b. No

2. Where do you work?
   a. Farm
   b. Orchard
   c. Other: _____
   d. Nursery
   e. Cannery

3. What kind of work do you do? (*Check all that may apply)*
   a. Fieldwork
   b. Child care
   c. Pesticide formulator/mixer
   d. Packer, sorter (cannery)
   e. Housecleaning
   f. Foreman
   g. Nursery
   h. Pesticide applicator
   i. Other:

4. The following questions address specific information about your work in *agriculture*. Please record the following information:

Specific Orchard/Crop	Location (City, State, Country)	Months (01 = Jan.,etc)	Hours per week	Activities (Probe for specifics)
1.		01 02 03 04 05 06 07 08 09 10 11 12		1.
2.		01 02 03 04 05 06 07 08 09 10 11 12		2.
3.		01 02 03 04 05 06 07 08 09 10 11 12		3.
4.		01 02 03 04 05 06 07 08 09 10 11 12		4.

5. In your current job do you mix/apply or both pesticides, herbicides, fungicides or other chemicals?

a. Yes b. No

If **Yes**, How often?:

a_1. Daily b_2. Once a week c_3. Once a month d_4. Sometimes

6. In the past, have you ever mixed/applied or both pesticides, herbicides, fungicides or other chemicals at work?

a. Yes b. No

If **Yes**, How often?:

a_1. Daily b_2. Once a week c_3. Once a month d_4. Sometimes

7. Do you use insect repellent while you work?

a. Yes b. No

If **Yes**, How often?:

a_1. Daily b_2. Once a week c_3. Once a month d_4. Sometimes

8. If you use insect repellent, what kind do you use?

a. Cream b. Liquid c. Spray d. Other: _____

9. If you use insect repellent, where do you apply to:

a. Skin (hands, face, etc.) b. Clothes

10. Do you or have you ever used the following protective clothing?:

Protective Clothing	Current Job			Job During The Past Year		
	Yes, always	Sometimes	Never	Yes, always	Sometimes	Never
a. Long sleeved shirt						
b. Long pants						
c. Rubber Boots						
d. Cap/Helmet/Hat						
e. Overalls						
f. Goggles/glasses						
g. Rubber gloves						
h. Handkerchief over the mouth & nose						
i. Plastic clothes						
j. Respirator						
k. Other types						

11. When do you change out of your work clothes?

a. At the work place
b. At home, less than 30 mins later
c. At home, 1-2 hrs later
d. At home, more than 2 hrs later
e. I am not sure
f. Do not change

12. Do you enter your home after work with your work clothes on?

a. Yes b. No c. Sometimes

13. Do you take your shoes or boots off before entering your home?

a. Yes b. No c. Sometimes

14. How long after arriving home do you wash off?

a. Right after arriving home
b. 30 mins to 1 hour
c. More than 1 hour
d. Before going to sleep
e. The next morning
f. I am not sure

15. After arriving home from work what do you do to remove dirt and dust from your hands and body?

a. Wash hands b. Take shower c. Change clothes d. Do nothing

16. How are the clothes that have worn to work usually handled before washing?

a. Kept with rest of family laundry
b. Soaked separately, then mixed with family wash
c. Left outside to air out
d. Kept separate from the rest of family laundry
e. Other:_____

17. Who usually does the laundry for the household?

a. You c. Other member of the family e. Other: _____
b. Mother d. Wife

18. Where is the wash typically done?

a. Private machine in home
b. Washing machine at common facility
c. By hand in house
d. By hand at common facility
e. Commercial Laundromat
f. Other: _____

19. **If work clothes are washed by hand**, is there a separate facility to prepare food?

a. Yes b. No

20. Who typically prepares the evening meal?

a. You c. Other member of the family e. Other: _____
b. Mother d. Wife

21. Do you take any fruits/vegetables from the orchard (*remember, your answers are strictly confidential)*?

a. Yes b. No c. Sometimes

22. Are these fresh fruits/vegetables stored separately from the rest of the household's food?

a. Yes b. No c. Sometimes

23. Do you rinse/wash these fresh fruits/vegetables?

a. Yes b. No c. Sometimes

24. When do you rinse/wash these fresh fruits/vegetables?

a. Before bringing home
b. Before storing in home
c. Before preparation
d. Other:

Cuestionario Número 1

ADOLESCENT MIGRANT WORKERS DEMOGRAPHICS

NOMBRE:_____ # de ID:_____
Nombre Y *Apellido*

NOMBRE del ENTREVISTADOR:_____
FECHA:_____

Sexo: _____

Ethnicidad: **Hispano/Latino Americano:**
_____ **Mexicano**
_____ **Centro Americano País de origen?** _____
_____ **Sud Americano País de origen?** _____

Dirección:

_____

_____

Fecha de nacimiento: _____

Lugar de nacimiento: _____

¿Hasta que grado llegó en la escuela en _____?: 0 1 2 3 4 5 6 7 8 9 10 11 12 >12
(país de origen)

¿Hasta que grado llegó en la escuela en los EE. UU?: 0 1 2 3 4 5 6 7 8 9 10 11 12 >12

¿Qué es su primera idioma?: _____ **S S/R S/R/W**[2]

[2] **S=Habla S/R= Habla and Lee S/R/W= Habla, Lee and Escribe**

¿Qué es su segunda idioma?: _____ S S/R S/R/W

¿Tiene usted planes de trabajar en los campos este verano?: Sí No

¿Esta trabajando ahora en los campos? Sí No

¿Dónde trabajo el mes pasado? Ciudad: _____
Estado/País: _____

¿Qué tipo de trabajo hizo? _____

¿Tiene Ud. planes para salir el Estado de Oregon? Sí No
Si contesta Sí: ¿Cuando? _____

¿Cuántas veces se ha movido durante el último año? _____

¿Ha atendido usted el programa de Head Start para Migrantes? Sí No

¿Ha atendido usted el programa Nocturno de Verano del Distrito Escolar para Migrantes? Sí No

¿Vive Ud. en el campo de trabajo? Sí No

¿En qué tipo de vivienda vive Ud?:
1. Casa
2. Apartamento
3. Cabina
4. Trailer
5. Duplex
7. No sé
6. Otro _____

Cuestionario Número 2

ESTUDIO SOBRE LAS CREENCIAS DE LOS TRABAJADORES DE CAMPO

NOMBRE:_____ # de ID:_____
Nombre Y *Apellido*

NOMBRE del ENTREVISTADOR:_____
FECHA:_____

En este estudio, no hay respuestas "correctas" o "incorrectas". Queremos saber lo que usted cree. También, "expuesto a pesticidas" o "contacto con pesticidas" significa estar en un lugar donde han fumigado o han usado pesticidas.

Díganos por favor, cuál de los siguientes describe su trabajo:

1.____ Trabajo ahora en el campo.
2.____ He trabajado antes en el campo.
3.____ Pienso trabajar en el campo durante el próximo verano
4.____ Nunca he trabajado en el campo.

PARTE I: ***Para las personas que están trabajando en el campo***

1. ¿Ha trabajado usted en los Estado Unidos en otros tipos de trabajo que no eran relacionados al campo, la huerta o la nursería?

Sí ____ No____

Si la respuesta es "Sí", ¿Por qué regresó usted al trabajo de campo?

2. ¿Qué difícil sería para usted encontrar otro tipo de trabajo fuera del campo?

1.____ No sería muy difícil
2.____ Un poco difícil
3.____ Muy difícil
4.____ Imposible

3. ¿Sabe usted, si hay en este momento, otros tipos de trabajo que le pagaría igual o quizás más de lo que gana ahora?

1. _____Yo pienso que hay muchas otras posibilidades
2. _____Yo pienso que hay quizás una o más posibilidades
3. _____ No estoy seguro si hay otros tipos de trabajo

PARTE II: Ahora quisíeramos preguntarle algo acerca de pesticidas.

Para aquellas personas que trabajan ahora o han trabajado en el campo.

4. ¿Ha estado en contacto con pesticidas durante su trabajo en el campo?

1. _____ Diario
2. _____ Una vez por semana
3. _____ Una vez por temporada
4. _____ Nunca

5. Hay muchas maneras en que uno se puede exponer a pesticidas. ¿Ha tenido contacto o estado espuesto con pesticidas en las siguientes maneras? (Marque los que le han pasado a Ud).

1. _____Tocando plantas después de que se las ha fumigado
2. _____ Respirando pesticidas del aire
3. _____Ha sido fumigado accidentalmente por una avión
4. _____ Mezclando, cargando o aplicando pesticidas
5. _____ Manejando un tractor en el trabajo
6. _____ En la nursería
7. _____ De otra manera (explique por favor)_____
8. _____ Ningún contacto

Para todos los participantes

6. ¿Sabe usted si hay maneras de protejerse de pesticidas?

Sí _____ No _____

7. Si la respuesta es "Sí", ¿Qué cosas puede hacer una persona para protejerse de pesticidas?

_____

_____

Solo para aquellas personas que están trabajan o han trabajado anteriormente en el campo.

8. ¿Si hay pesticidas donde trabaja, usa usted algún método de protección contra pesticidas?

1. _____ Sí, siempre
2. _____ Sí, pero solamente algunas veces
3. _____ No, nunca

9. Si la respuesta es "Sí", ¿Qué métodos usa usted?

_____

_____

10. ¿Cómo aprendió sobre pesticidas y otros productos químicos que se podría usar en su trabajo? (Marque todo lo que es apropriado)

_____ ¿El mayordomo o patrón? _____ ¿Amigos o miembros de su familia?
_____ ¿Compañeros de trabajo? _____ ¿La escuela?
_____ ¿La Educación Migrante o Head Start para Migrantes?
_____¿Libros? _____ ¿Folletos?
_____ ¿La Unión?
_____ ¿Otros medios? (Explique que por favor): _____
_____

SECCIÓN 3:

Hay algunas personas que piensan que la exposición con los pesticidas puede causar problemas de salud en los seres humanos, mientras que otros piensan que eso no es verdad. Quisíeramos saber que piensa usted acerca de este tema.

11. ¿Piensa usted que los pesticidas pueden causar problemas de salud?

Sí _____ No estoy seguro _____ No _____

12. Si la respuesta es "Sí", ¿Qué problemas de salud, piensa usted pueden ser causados por los pesticidas?

_____

_____

13. ¿Durante el mes pasado, cuántas veces ha pensado o ha tenido miedo acerca de los efectos de los pesticidas en la salud de las personas?

1. _____ Nunca
2. _____ Una vez al mes
3. _____ Una vez a la semana
4. _____ Diario

14. ¿Sabe usted de algunos efectos que los pesticidas han causado a usted o en su familia? (Por favor mencione todos los problemas que recuerda.)

_____

_____

_____

15. ¿Piensa que usted se ha enfermado solo por estar donde han usado pesticidas?

1. _____ Sí, ¡me preocupa muchísimo!
2. _____ Sí, suficiente para preocuparme
3. _____ Sí, pero no tanto para alarmarme
4. _____ No

16. ¿Piensa usted que los pesticidas pueden afectar la salud de los hijos de los campesinos?

1. _____ Sí, ¡me preocupa muchísimo!
2. _____ Sí, suficiente para preocuparme
3. _____ Sí, pero no tanto para alarmarme
4. _____ No

17. ¿Cuáles son las posibilidades de que un jóven que trabaja en el campo sufra problemas de salud en el futuro?

1. _____ Definitivamente
2. _____ Es muy posible
3. _____ Es posible
4. _____ Imposible

18. ¿Cuáles son las posibilidades de que usted tuviera problemas de salud en el futuro a causa de pesticidas?

1. _____ Definitivamente
2. _____ Es muy posible
3. _____ Es posible
4. _____ Imposible

19. De acuerdo a usted, ¿qué tan seguro están los metódos de prevenir los efectos de pesticidas en la salud?

1. ____ Totálmente seguro
2. ____ Muy seguro
3. ____ Un poco seguro
4. ____ No es seguro

Pregunte solamente a personas que trabajan ahora o han trabajado en el campo.

20. ¿Cree usted que su sueldo del trabajo en el campo es más importante que el riesgo de los efectos de exponerse a los pesticidas?

1. _____ El sueldo de trabajo es definitivamente más importante que los riesgos de pesticidas
2. _____ El sueldo tiene un poco más importancia que los riesgos de pesticidas
3. _____ No estoy seguro
4. _____ El sueldo es un poco menos importante que los riesgos de pesticidas
5. _____ El sueldo es definitivamente menos importante que los riesgos de pesticidas

PARTE 4:

Ahora en las dos preguntas que siguen, quisieramos preguntarle su opinión acerca de ciertas cosas que pueden causar cáncer. Le voy a leer un commentario y voy a preguntarle a usted si está de acuerdo o no con el commentario.

21. "El govierno no debe esperar una prueba absoluta de que los químicos son peligrosos. Aunque no estamos seguros, si hay alguna evidencia de que pueda ser peligroso, el govierno debe hacer algo para proteger al público."

1. _____ Estoy firmemente en acuerdo
2. _____ Estoy un poco en acuerdo
3. _____ No estoy seguro
4. _____ Estoy un poco de desacuerdo
5. _____ Estoy firmemente en desacuerdo

22. " La mayoría de los cánceres son a causa de cosas que las personas no pueden evitar, por ejemplo, algo en el ambiente".

1. _____ Estoy firmemente en acuerdo
2. _____ Estoy un poco en acuerdo
3. _____ No estoy seguro
4. _____ Estoy un poco de desacuerdo
5. _____ Estoy firmemente en desacuerdo

PARTE 5:

En las dos últimas preguntas, quisiéramos saber su opinión acerca de la información ciéntifica que se puede usar para decidir si los productos químicos o los pesticidas pueden causar cáncer.

23. Supongamos que un grupo de ciéntificos han reportado que ciertos productos químicos encontrados en algunos alimentos podrían causar cáncer, pero la evidencia no es clara. ¿Si muchas personas comen este alimento, qué haría usted?

1. _____ Evitar de comer estos alimentos, aunque no sería conveniente
2. _____ Evitar de comer estos alimentos, solamente si es conveniente
3. _____ Yo no cambiaría mis costumbres con respecto a estos alimentos

24. Supongamos que los científicos han llegado a una conclusión que contacto con un producto químico en bastante cantidad causa cáncer de vez en cuando. ¿Cuánto se preocuparía el contacto con una pequeña cantidad de este producto químico?

1. _____ Extremamente preocupado
2. _____ Un poco preocupado
3. _____ No me preocupa

Cuestionario Número 3

Cuestionario Sobre Información de Pesticidas

NOMBRE:_____ # de ID:_____
Nombre Y *Apellido*

NOMBRE del ENTREVISTADOR:_____
FECHA:_____

Antes de empezar:

¿Ahora, en su trabajo, ha recibido algun entrenamiento sobre el uso de los pesticidas?	Sí	No

Si contesta sí:
¿Cuando?_____

Voy a leerle algunos comentarios de pesticidas. Me va a decir Sí o No.

Entendimiento:

1. Se usan pesticidas para matar hierbas e insectos.	Sí	No
2. Los pesticidas son peligrosos para las personas.	Sí	No
3. Es muy bueno aplicar pesticidas en un día con mucho viento.	Sí	No
4. Con tiempo, pesticidas se deshacen en el ambiente.	Sí	No

Problemas de Salud:

5. Los pesticidas pueden causar cáncer en las personas.	Sí	No
6. Algunas personas se pueden enfermar de los pesticidas con más rapidez que otras personas aunque todos están trabajando en el mismo lugar.	Sí	No
7. Es muy fácil identificar una enfermedad acausionada por pesticidas.	Sí	No

8. A veces, contacto con pesticidas causa un sarpullido o ronchas en la piel. Sí No

9. Los pesticidas hacen daño a las mujeres embarazadas. Sí No

Ropa Protectiva y Seguridad:

10. Solamente debe de usar ropa protectiva cuando mezcla o aplica los pesticidas. Sí No

11. Es necessario que lea la etiqueta del bote que contiene pesticidas antes de mezclar o aplicar. Sí No

12. Cuando mezcla o aplica los pesticidas, guantes de tela protejen las manos mejor que los guantes de ule. Sí No

13. El agua y el jabón lavan los pesticidas de las manos. Sí No

14. Un pesticida de polvo es más peligroso que un pesticida de líquido. Sí No

15. Los pesticidas pueden entrar al cuerpo por la piel. Sí No

16. Comiendo, bebiendo o fumando en el campo aumenta la posibilidad de meter los pesticidas dentro del cuerpo. Sí No

17. Es importante que lea los letreros o rótulos al borde del campo o la huerta antes de entrar. Sí No

18. Es mejor que trabaje en "shortes", camisa con manga corta y huaraches cuando hace sol. Sí No

19. Cuando está trabajando en el campo, los pesticidas pueden pegarse a su ropa y a sus zapatos. Sí No

20. Es peligroso comer la fruta directamente del arból o arbusto. Sí No

Cuestionario Numero 4

Cuestionario Sobre Prácticas del Trabajo Agrícola

NOMBRE:_____ # de ID:_____
Nombre Y *Apellido*

NOMBRE del ENTREVISTADOR:_____
FECHA:_____

1. ¿Trabaja usted ahora en el campo? a. Sí b. No

2. ¿Dónde trabaja usted?
   a. Campo
   b. Huerta
   c. Otro:_____
   d. Nursería
   e. Canería

3. ¿Qué tipo de trabajo hace usted? (*marca todos aquellos que son apropriados)*
   a. Trabajo de campo
   b. Cuidado de niños
   c. Mesclador de pesticidas
   d. Empacador, seleccionar (caneria)
   e. Limpieza de casa
   f. Mayordomo
   g. Nursería
   h. Aplicador de pesticidas
   i. Otro: _____

Queremos saber informaciones específicas sobre su trabajo en *el campo* durante el año pasado.
4.

Huerta/Cultivo	Localidad (Ciudad, Estado, País)	Meses (01 = Enero, etc)	Horas de trabajo por semana	Actividades (Tipos de trabajo)
1._____	_____	01 02 03 04 05 06 07 08 09 10 11 12		1.
2._____	_____	01 02 03 04 05 06 07 08 09 10 11 12		2.
3._____	_____	01 02 03 04 05 06 07 08 09 10 11 12		3.
4._____	_____	01 02 03 04 05 06 07 08 09 10 11 12		4.

5. ¿Ahora en su trabajo aplica o mezcla usted pesticidas, herbicidas, insecticidas, fungicidas u otros productos químicos?

a. Sí b. No

Si contesta Sí, ¿Con qué frecuencia?:

a_1. Diario b_2. Una vez a la semana c_3. Una vez al mes d_4. A veces

6. ¿En el pasado, ha aplicado o mezclado usted pesticidas, herbicidas, insecticidas, fungicidas u otros químicos en su trabajo?

a. Sí b. No

Si contesta Sí, ¿Con qué frecuencia?:

a_1. Diario b_2. Una vez a la semana c_3. Una vez al mes d_4. A veces

7. ¿Usa usted en su trabajo producto o productos para protejerse de los insectos?

a. Sí b. No

Si contesta Sí, ¿Con qué frecuencia?:

a_1. Diario b_2. Una vez a la semana c_3. Una vez al mes d_4. A veces

8. Si usted usa productos para protejerse de los insectos, ¿Qué tipo usa?

a. Crema b. Líquido c. Spray d. Otro:

9. Si usted usa productos para protejerse de los insectos, ¿en que parte de su cuerpo los aplica?

a. La piel (manos, cara, etc.) b. La ropa

10. ¿Usa ahora o ha usado alguna vez la siguiente ropa protectiva en el trabajo?:

Ropa Protectiva	Trabajo de ahora			Trabajo en el año pasado		
	Sí, siempre	A veces	Nunca	Sí, siempre	A veces	Nunca
a. Camisas con manga larga						
b. Pantalones largos						
c. Botas de ule						
d. Gorra/Casco/Sombrero						
e. Pecheras, overoles						
f. Gafas/anteojos						
g. Guantes de ule						
h. Pañuelo sobre la boca y la nariz						
i. Ropa de plástico						
j. Respirador						
k. Otros tipos						

11. ¿Cuándo se cambia la ropa que usted usó en el trabajo?
    a. En el trabajo
    b. En casa, media hora o menos despues de llegar
    c. En casa, 1-2 horas despues de llegar
    d. En casa, mas de 2 horas
    e. No estoy seguro
    f. No me cambio

12. Después de trabajo, ¿entra usted a la casa vestido con la ropa de trabajo?
    a. Sí b. No c. A veces

13. ¿Se quita usted las botas o zapatos antes de entrar a la casa?
    a. Sí b. No c. A veces

14. ¿Cuanto tiempo después de llegar a casa se baña usted?
    a. Immediatamente, despues de trabajo
    b. 30 mins a 1 hora
    c. Más de una hora
    d. Antes de dormir
    e. La próxima mañana
    f. No estoy seguro

15. Después de trabajo, ¿Qué hace usted para remover el polvo de sus manos y de su cuerpo?
    a. Lavo la manos b. Tomo un baño y cambio de ropa c. Cambio de ropa d. Nada

16. ¿Cómo se mantiene la ropa de trabajo antes de lavarla?
    a. Mezclada con la ropa de la familia
    b. Remojada separadamente, y después mezclada con la ropa de la familia
    c. Dejada afuera al aire libre
    d. Separada de las otras ropas de la familia
    e. Otramanera:_____

17. ¿Quién lava la ropa en la familia?
    a. Usted
    b. Mamá
    c. Otro miembro de la familiae. Otra persona: _____
    d. Esposa/Esposo

18. ¿Dónde se lava la ropa?
    a. En la casa, en una máquina lavadora privada
    b. En la facilidad comunal, en una máquina
    c. En la casa, a mano
    d. En la facilidad comunal, a mano
    e. En una lavanderia commercial
    f. De otra manera: _____

19. Si la ropa de trabajo se lava a mano, ¿Hay una facilidad diferente para preparar la comida?
    a. Sí b. No

20. ¿Quíen prepara la comida en la casa?
    a. Usted
    b. Mamá
    c. Otro miembro de la familia
    d. Esposa/Esposo
    e. Otra persona:

21. ¿Lleva usted frutas or verduras de la pisca a la casa? (*recuerde que todo lo que nos dice es absolutamente confidencial)*

a. Sí b. No c. A veces

22. ¿Guarda usted estas frutas o verduras separada de las otras comidas en la casa?

a. Sí b. No c. A veces

23. ¿Lava o enjuaga usted estas frutas o verduras?

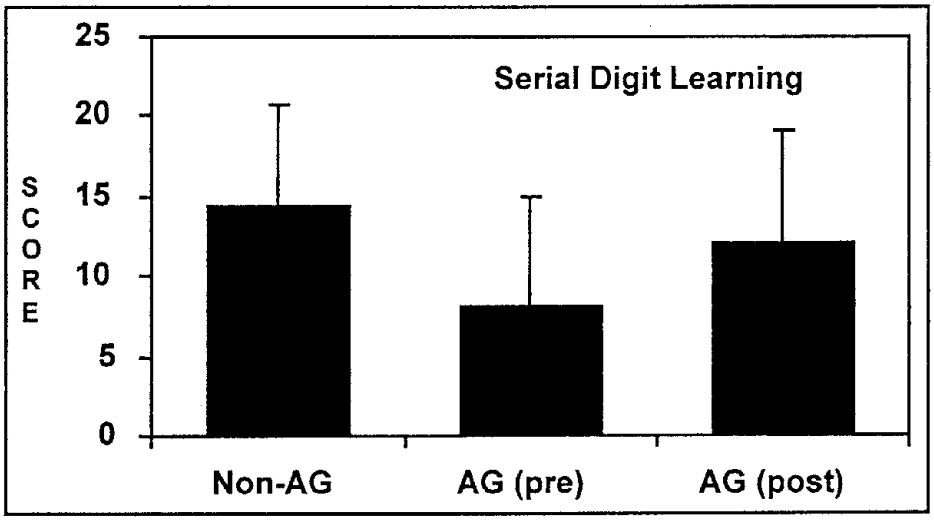
a. Sí b. No c. A veces

24. ¿Cuándo lava o enjuaga estas frutas o verduras?

a. Antes de traerlas a la casa
b. Antes de guardarlas en la casa
c. Antes de preparlas para comer
d. Otro: _____

Appendix 2

Figure 1. Neurobehavioral test performance for adolescent non-agricultural and agricultural workers (pre and post-season) on Serial Digit Learning test



Appendix 3

Table 1. Demographic characteristics of adolescent study sample

Demographic Characteristics	Agriculture Adolescents n=102		Adolescent controls N=51		Total N=153	
	N	(%)	N	(%)	N	(%)
Mean Age	16.3±1.5		15.2±1.4			
Gender						
Female	8	(7.8)	24	(47.1)	32	(20.9)
Male	94	(92.2)	27	(52.9)	121	(79.1)
Total	102	(100.0)	51	(100.0)	153	(100.0)
Country of Origin						
Mexico	96	(94.1)	50	(98.0)	146	(95.4)
Guatemala or Nicaragua	6	(5.9)	1	(2.01)	7	(4.6)
Total	102	(100.0)	51	(100.0)	153	(100.0)
Primary Language						
Spanish	65	(63.7)	51	(100.0)	116	(75.8)
Other dialect	37	(36.3)	0	(0.0)	37	(24.2)
Total	102	(100.0)	51	(100.0)	191	(100.0)
Education						
With any US education	16	(15.7)	51	(100.0)	67	(43.8)
No US education	86	(84.3)	0	(0.0)	86	(56.2)
Total	102	(100.0)	51	(100.0)	153	(100.0)
Emancipated Minors						
Yes	66	(64.7)	1	(2.0)	67	(43.8)
No	36	(35.3)	50	(98.0)	86	(56.2)
Total	110	(100.0)	89	(100.0)	199	(100.0)

Table 2. Economic characteristics of Hispanic adolescents currently working in agriculture

N=102	N	(%)
Worked in jobs other than agriculture		
Yes	21	(21.9)
No	75	(78.1)
Total	96	(100.0)
Difficulty in finding non-agriculture job		
Not difficult	13	(14.1)
A little difficult	52	(56.5)
Very difficult	20	(21.7)
Impossible	7	(7.6)
Total	92	(100.0)
Availability of work other than agriculture		
Several other possibilities	27	(28.7)
Maybe one or two possibilities	16	(17.0)
Not sure of any other jobs	51	(54.2)
Total	94	(100.0)
Benefits are worth the risk of health effects?		
Definitely more	9	(8.8)
Somewhat more	11	(10.8)
Not sure	16	(15.7)
Somewhat less	38	(37.2)
Definitely less	26	(27.5)
	102	(100.0)

Table 3. Perceptions of pesticide exposure in Hispanic adolescents with past and present agricultural work experience

N=120	N	(%)
Are you exposed to pesticides while working in the fields?		
Daily	15	(13.0)
Once a week	17	(14.8)
Once in a while	30	(26.1)
Never	53	(46.1)
Total	115	(100.0)
Have you been in contact with pesticides by:		
Touching crops or plants	51	(42.5)
Breathing air	46	(38.3)
No contact	39	(32.5)
Mixing/loading/or applying pesticides	23	(19.2)
When driving a tractor	18	(15.0)
In the nursery	12	(10.0)
Sprayed by crop duster	7	(5.8)
Other mode of contact	4	(3.3)

(Each question above asked of all 120 workers, number indicates affirmative responses, percent obtained using 120 as the denominator)

Table 3. Perceptions of pesticide exposure in Hispanic adolescents with past and present agricultural work experience (continued)

N=120	N	(%)
Do you use protection methods?		
Yes, always	15	(13.3)
Sometimes	39	(34.5)
No, never	59	(52.2)
Total	113	(100.0)
Of the 54 yes and sometimes responses above, 41 persons answered the open ended question as to what type of protection methods do they use.		
Clothing	22	(53.7)
Gloves	22	(53.7)
Mask	13	(31.7)
Boots / Shoes	13	(31.7)
Goggles	8	(19.5)
Cap	7	(17.1)
(Number indicates affirmative responses, percentages calculated using 41 as the denominator.)		
Sources of Pesticide Information		
Supervisors	74	(61.7)
Friends or family	70	(58.3)
Fellow workers	62	(51.7)
School	56	(46.7)
Books	42	(35.0)
Pamphlets	33	(27.5)
Union	27	(22.5)
Migrant education	14	(11.7)
Other	10	(8.3)
(Each of the 120 subjects could respond to more than one source of information. Number indicates affirmative responses, percent obtained using 120 as the denominator)		

Table 4. Beliefs about protection from pesticides in Hispanic adolescents with or without agriculture work experience

	Ag Exp. n=120		No Ag Exp. n=33		Total N=153	
	N	(%)	N	(%)	N	(%)
Are there ways to protect yourself against pesticides?						
Yes	70	(58.3)	9	(28.1)	79	(52.0)
No	50	(41.7)	23	(71.9)	73	(48.0)
Total	120	(100.0)	32	(100.0)	152	(100.0)
		P = 0.002				
How effective do you think safety precautions are reducing health effects of pesticides?						
Completely	17	(14.4)	4	(12.9)	21	(14.1)
Mostly	22	(18.6)	7	(22.6)	29	(19.5)
Somewhat	59	(50.0)	14	(45.2)	73	(49.0)
Not at all	20	(17.0)	6	(19.3)	26	(17.4)
Total	118	(100.0)	31	(100.0)	149	(100.0)
		P = 0.933				
Of the 79 persons above that responded yes that there are ways to protect your self against pesticides, 74 gave examples of the ways that a person can protect against pesticides.						
Wear gloves					26	(35.1)
Wear overall, shirt, long-sleeve, long pant, sock etc.					24	(32.4)
Cover nose or mouth or wear a mask					19	(25.7)
Wear protective boots/shoes					13	(17.6)
Cap or hat					10	(13.5)
Read signs/stay away from spray					10	(13.5)
Stay clean/shower					9	(11.4)
Goggles					8	(10.8)
Respirator					4	(5.4)
Rubber/plastic clothing					3	(4.1)
Other					14	(18.9)
(Percentages calculated using 74 as the denominator.)						

Table 5. Beliefs about the health problems associated with pesticide exposure in Hispanic adolescents with or without agriculture work experience

	Ag Exp. (n=120)		No Ag Exp. (n=33)		Total N=153	
	N	(%)	N	(%)	N	(%)
Do you think pesticides can cause health problems?						
Yes	97	(80.8)	18	(58.1)	115	(76.2)
No or not sure	23	(19.2)	13	(41.9)	36	(23.8)
Total	120	(100.0)	31	(100.0)	151	(100.0)
		P = 0.008				
Of the total 115 responders above that said pesticides cause health problems, 95 responded to the open-ended question asking what kind of health problems are caused by pesticides.						
Skin welts/rashes					24	(25.3)
Headaches					21	(22.1)
Stomach pain/vomiting					17	(17.9)
Breathing problems/asthma					16	(16.8)
Dizziness/Fainting					12	(12.6)
Eye/vision problems					12	(12.6)
Fever					7	(7.4)
Sore throat					7	(7.4)
Confusion, brain or mental problems					7	(7.4)
Reproductive problems					7	(7.4)
Get sick					6	(6.3)
Allergies					5	(5.3)
Cough					5	(5.3)
Cancer					4	(4.2)
Infection					3	(3.2)
Death					3	(3.2)
Not sure					9	(9.5)
Other					8	(8.4)
(Percentages calculated using 95 as the denominator.)						
How often in the past month – had fears about health effects of pesticides						
Never	61	(50.8)	25	(80.7)	86	(57.0)
1 time / month	28	(23.3)	5	(16.1)	33	(21.9)
1 time / week	10	(8.3)	1	(3.2)	11	(7.3)
Daily	21	(17.5)	0	(0)	21	(13.9)
Total	120	(100.0)	31	(100.0)	151	(100.0)
		P = 0.01				

Table 5. Beliefs about the health problems associated with pesticide exposure in Hispanic adolescents with or without agriculture work experience (continued)

	Ag Exp. (n=120)		No Ag Exp. (n=33)		Total N=153	
	N	(%)	N	(%)	N	(%)
Do you believe that you have become sick from being around pesticides:						
Enough to worry a great deal	18	(15.1)	0	(0)	18	(12.0)
Enough to cause a little concern	14	(11.8)	0	(0)	14	(9.3)
Not enough to cause concern	15	(12.6)	2	(6.5)	17	(11.3)
Not at all	72	(60.5)	29	(93.5)	101	(67.3)
Total	31	(100.0)	119	(100.0)	150	(100.0)

P = 0.006

Table 6. Risk perceptions of pesticides and potential harm to others and self in Hispanic adolescents with or without agriculture work experience

	Ag Exp. n=120		No Ag Exp. N=33		Total N=153	
	N	(%)	N	(%)	N	(%)
Do you believe that pesticides can affect the health of children born to agriculture workers?						
Enough to worry a great deal	44	(36.7)	10	(32.3)	54	(35.8)
Enough to cause a little concern	24	(20.0)	6	(19.3)	30	(19.9)
Not enough to cause concern	25	(20.8)	7	(22.6)	32	(21.2)
Not at all	27	(22.5)	8	(25.8)	35	(23.2)
Total	120	(100.0)	31	(100.0)	151	(100.0)
	P = 0.962					
What are the chances that a teenager working in the field will experience some health problems in the future?						
Definitely likely	8	(6.7)	5	(16.1)	13	(8.6)
Somewhat likely	22	(18.3)	6	(19.4)	28	(18.5)
Very likely	71	(59.2)	17	(54.8)	88	(58.3)
No chance	19	(15.8)	3	(9.7)	22	(14.6)
Total	120	(100.0)	31	(100.0)	151	(100.0)
	P = 0.348					
What are the chances that you will experience health problems in the future:						
Definitely likely	9	(7.6)	2	(6.5)	11	(7.3)
Somewhat likely	16	(13.4)	0	(0)	16	(10.7)
Very likely	64	(53.8)	12	(38.7)	76	(50.7)
No chance	30	(25.2)	17	(54.8)	47	(31.3)
Total	31	(100.0)	119	(100.0)	150	(100.0)
	P = 0.01					

Table 7. General risk beliefs in Hispanic adolescents with or without agriculture work experience

	Ag Exp. n=120		No Ag Exp. n=33		Total N=153	
	N	(%)	N	(%)	N	(%)
The government should not wait for absolute proof that a chemical is harmful. Even if we are not sure, if there is any evidence at all that something might be harmful, the government should act to protect the public.						
Strongly agree	62	(51.7)	20	(62.5)	82	(54.0)
Somewhat agree	36	(30.0)	9	(28.1)	45	(29.6)
Not sure	10	(8.3)	3	(9.4)	13	(8.5)
Somewhat disagree	8	(6.7)	0	(0.0)	8	(5.3)
Strongly disagree	4	(3.3)	0	(0.0)	4	(2.6)
Total	120	(100.0)	32	(100.0)	152	(100.0)
	P = 0.425					
Suppose a group of scientist report that a certain chemical found in some foods might cause cancer, but the evidence is not certain. If many people eat this food, which of the following responses is most like what you would do.						
Avoid these foods no matter what the cost	42	(35.0)	17	(53.1)	59	(38.8)
Reduce my exposure, but not at a great expense	49	(40.8)	10	(31.3)	59	(38.8)
I would not change my behavior	29	(24.2)	5	(15.6)	34	(22.4)
Total	120	(100.0)	32	(100.0)	152	(100.0)
	P = 0.169					
Suppose that scientists have concluded that coming in contact with very large amounts of a chemical occasionally causes cancer. How concerned would you be about coming in contact with very small amounts of this chemical?						
Extremely concerned	41	(34.2)	12	(37.5)	53	(34.9)
Somewhat concerned	75	(62.5)	17	(53.1)	92	(60.5)
Not at all concerned	4	(3.3)	3	(9.4)	7	(4.6)
Total	120	(100.0)	32	(100.0)	152	(100.0)
	P = 0.322					
Most cancers are caused by things that people cannot avoid, for example, things in the environment.						
Strongly agree	32	(26.7)	4	(12.5)	36	(23.7)
Somewhat agree	43	(35.8)	16	(50.0)	59	(38.8)
Not sure	20	(16.7)	10	(31.3)	30	(19.7)
Somewhat disagree	20	(16.7)	0	(0)	20	(13.2)
Strongly disagree	5	(4.2)	2	(6.3)	7	(4.6)
Total	120	(100.0)	32	(100.0)	152	(100.0)
	P = 0.021					

Table 8. Work characteristics of Hispanic agricultural adolescents in the study sample

Work characteristics	**Agriculture Adolescents**	
N=102	**N**	**(%)**
Worked in agriculture the month preceding interview	73	(71.6)
Location of work prior to arriving in Hillsboro, OR (n=73)		
Oregon	37	(50.7)
California	27	(36.9)
Arizona	4	(5.5)
Washington	1	(1.4)
Mexico	4	(5.5)
Total	73	(100.0)
Places of work (participant could choose more than one response)		
Field	82	(80.4)
Orchard	19	(18.6)
Cannery	7	(6.9)
Other	2	(2.0)
Type of work (participants could choose more than one response)		
Fieldwork	93	(91.2)
Housecleaning	16	(15.7)
Packer or sorter in cannery	15	(14.7)
Pesticide applicator	10	(9.8)
Nursery	10	(9.8)
Pesticide formulator/mixer	7	(6.9)
Foreman	5	(4.9)
Childcare	4	(3.9)
Other	8	(7.8)
Mix/apply pesticides currently (n=22)		
Daily/once a week	8	(36.4)
Once a month/sometimes	13	(59.1)
Total	21 (1 missing)	(96.5)

Table 9. Self-reported removal of work clothing, shoe/boot removal and wash practices in migrant adolescent agricultural workers

Practices N=102	Agricultural adolescents N	(%)
Removal of work clothing		
At the work place	1	(1.0)
<30mins after arriving home	9	(8.9)
1-2hrs after arriving home	65	(64.4)
>2hrs after arriving home	18	(17.8)
Do not change	2	(1.9)
Not sure	6	(5.9)
Total	101 (1 missing)	99.0
Entry into home with work clothing		
Yes	42	(41.2)
Sometimes	25	(24.5)
No	35	(34.3)
Total	102	(100.0)
Shoe/Boot removal prior to entry into home		
Yes	79	(77.4)
Sometimes	11	(10.8)
No	12	(11.8)
Total	102	(100.0)
Washing up to remove dust from fields (participant could select more than one response)		
Washing hands	22	(21.6)
Showering and changing clothing	77	(75.5)
Changing clothing	18	(17.6)
Nothing	2	(2.0)
Showering Practices upon arrival home after work (participant can select more than one response)		
Immediately	40	(39.2)
30 mins-1hr	48	(47.0)
More than 1hr	6	(4.9)
Before going to sleep	8	(7.8)
Not sure	1	(1.0)

Table 10. Self-reported laundry practices in migrant adolescent agricultural workers

Laundry Practices N=102	Agricultural adolescents N	(%)
Handling of work clothes (participants could select more than one response)		
Kept separate from family laundry	78	(76.5)
Left outside to air	13	(12.7)
Soaked separately, then mixed with family laundry	7	(6.9)
Washed with family laundry	9	(8.8)
Responsible for laundry (participants could select more than one response)		
Self	56	(54.9)
Other family/camp member	48	(47.1)
Laundry facilities (participants could select more than one response)		
Private machine in home	14	(13.7)
Communal washing machine	21	(20.6)
By hand	25	(24.5)
Commercial laundromat	44	(43.1)

Table 11. Self-reported use of protective clothing/equipment in migrant adolescent agricultural workers

Protective clothing or Equipment N=102	**Yes**		**Sometimes**		**Never**	
	N	**(%)**	**N**	**(%)**	**N**	**(%)**
Self –reported use of protective clothing/equipment in migrant adolescent agriculture workers						
Long sleeved shirt(4)	74	(75.5)	21	(21.4)	3	(3.1)
Long Pants(4)	96	(98.0)	2	(2.0)	0	(0.0)
Rubber boots(4)	40	(40.8)	37	(37.8)	21	(21.4)
Cap/Helmet/Hat (4)	84	(85.7)	11	(11.2)	3	(3.1)
Overalls(5)	13	(13.4)	24	(24.7)	60	(61.9)
Goggles/Glasses(6)	12	(12.5)	21	(21.9)	63	(65.6)
Rubber gloves(6)	32	(33.3)	37	(38.5)	27	(28.1)
Handkerchief over nose and mouth(5)	23	(23.7)	27	(27.8)	47	(48.5)
Plastic clothes (5)	13	(13.4)	30	(30.9)	54	(55.7)
Respirator(5)	13	(13.4)	17	(17.5)	67	(69.1)
Other types(42)	5	(8.3)	1	(1.7)	36	(60.0)
(n)-denotes the number of missing responses						
Self –reported use of protective clothing/equipment in 21 migrant adolescent agriculture workers mixing/applying pesticides, herbicides, fungicides or other chemicals.						
Rubber boots	12	(57.1)				
Overalls	5	(23.8)				
Goggles/Glasses	5	(23.8)				
Rubber gloves	11	(52.4)				
Plastic clothes	6	(28.6)				

Table 12. Test-retest blood (erythrocyte) acetylcholinesterase (AChE) activity levels in adolescent migrant agricultural workers

		Current Ag Workers N=70		**Non-Ag N = 51**
		First	Second	Initial
AChE U/ml blood	Range	2.2-5.1	3.2-5.2	3.0-5.3
	Mean	4.1	4.2	4.0
	Mean difference ± SD[a]	0.2 ± 0.4		
Hemoglobin (Hb) (g Hb/dl)	Range	8.8-16.6	8.9-16.2	11.2-15.9
	Mean	14.5	14.2	13.6
	Mean difference ± SD[a]	0.2 ± 0.9		
Hb corrected AChE (U/g Hb)	Range	20.3-34.8	23.9-38.6	23.0-34.1
	Mean	28.5	29.8	29.4
	Mean difference ± SD[a]	1.3 ± 2.9*		

[a]SD: standard deviation
*p <0.001

Table 13. Comparison of selected parameters in the analysis of blood cholinesterase with the Test-mate OP (model 176) and the Test-mate ChE (model 400) assay kits

Parameters	Test-mate OP	Test-mate ChE
Cuvette	Reusable graduated plastic cuvette w/o lid	Single use glass, screw-top vials
Buffer solution	Prepared by the operator prior to sample analysis	Prepared and lyophilized by the manufacturer
Blood sample – addition	10 µl sample dispensed from a capillary tube into cuvette	Entire capillary tube with 10 µl sample placed into vial
Blood sample – mixing	Blood sample mixed into buffer with plastic paddle	Filled assay cuvette vigorously shaken for 15 seconds
Reagent blank	Specially prepared buffer filled cuvette used as reagent blank	Any vial can be used as a reagent blank
Wavelength	470 nm	450 nm
Disposal of sample	Cuvettes washed and reused	Vials are discarded after use

Table 14. Comparison of blood acetylcholinesterase (AChE) analytical results obtained with the Test-mate OP (model 176) and the Test-mate ChE (model 400) field assay kits

	AChE (U/ml) n = 81		Hemoglobin (g Hb/dl) n = 81		Corrected AChE (U/g Hb) n = 81	
Field kit model #	176	400	176	400	176	400
Range	3.1-5.0	3.2-5.1	11.5-15.8	11.4-17.2	23.6-37.9	20.3-39.1
Mean	4.0	4.2	13.9	14.7	28.4	28.8
mean of differences ± SD [a]	0.3 ± 0.36*		0.7 ± 0.82*		0.4 ± 2.0	

[a]Values obtained with the Test-mate ChE (model 400) field kit were compared with those obtained with the Test-mate OP (model 176); SD: standard deviation

*$p < 0.001$

Table 15. Comparison of hemoglobin analytical results obtained with the HemoCue® B-Hemoglobin system with the Test-mate OP (model 176) and Test-mate ChE (model 400) field assay kits

	Hemoglobin (g Hb/dl)		
	Model 176 n = 76	Model 400 n = 76	HemoCue® n = 76
Range	10.2 – 16.3	11.4 – 17.2	11.7 – 17.8
Mean	13.9	14.6	15.4
mean of differences ± SD [a]	1.5 ± 0.88*	0.8 ± 0.70*	NA[b]

[a]Values obtained with the HemoCue B-Hemoglobin system compared with either the Test-mate OP (model 176) or the Test-mate ChE (model 400) field kit; SD: standard deviation
[b]NA: not applicable.
*p <0.001

Table 16. Means (and standard deviations) on neurobehavioral tests for non-agricultural adolescents and agricultural adolescents (pre-season and post-season)

	Pre-Season Non-Agriculture N=51		Pre-Season Agriculture N=96		Post-Season Agriculture N=66		Significant Differences[1]
Tapping Preferred	93.5	(14.4)	93.7	(16.1)	101.2	(20.0)	
Tapping Non-preferred	82.4	(12.4)	82.7	(17.4)	88.6	(19.3)	
Tapping Alternating	50.2	(16.1)	46.2	(17.5)	46.4	(16.5)	
Progressive Ratio	514.7	(85.0)	547.2	(109.2)	562.9	(91.5)	
Reaction Time Latency	323.8	(40.8)	384.6	(105.6)	354.3	(54.6)	A, B, C
Select. Attention: # of trials	428.2	(76.3)	381.3	(92.4)	415.2	(78.2)	B
Select. Attention: ISI	456.0	(161.9)	572.6	(519.6)	493.8	(297.7)	
Select. Attention: Latency	324.8	(55.6)	359.8	(81.5)	336.6	(60.9)	B
Cont Perform: % Hits	0.90	(0.11)	0.89	(0.13)	0.91	(0.15)	
Cont Perform: Hit Latency	375.5	(68.2)	412.7	(72.7)	426.1	(67.1)	C
Cont Perform: % Cor Reject	0.96	(0.06)	0.96	(0.04)	0.97	(0.03)	
Cont Perform: False Alarm Lat	446.8	(142.6)	516.8	(133.7)	501.4	(133.2)	
Digit Span Forward	5.1	(1.1)	3.9	(1.0)	4.5	(1.0)	A, B
Digit Span Backwards	4.4	(1.2)	3.4	(1.2)	4.2	(1.1)	A, B
Serial Digit Learning	14.4	(6.3)	8.4	(7.2)	12.4	(6.9)	A, B
Symbol-Digit Latency	2310.4	(422.5)	3235.6	(665.0)	2516.2	(446.0)	A, B
Symbol-Digit 2: Latency	1999.6	(345.6)	2743.7	(727.6)	2387.3	(452.9)	A, B, C

[1] A indicates a significant difference between the NA and pre-season AG group. B indicates a significant differences between the pre-season and post-season AG groups. C indicates a significant difference between the NA and the post-season AG group. All differences are significant with a Bonferroni corrected alpha of .0029.

LIST OF PRESENT AND POSSIBLE FUTURE PUBLICATIONS

Manuscripts in Preparation

1. Comparison of two field tests for monitoring cholinesterase depression in agricultural workers
2. Changes in cholinesterase levels during a growing season in adolescent agricultural workers.

Possible Future Publications

1. Comparison of worker practices and protection in adult and adolescent migrant agricultural workers.
2. Individual and Cultural Differences in Adaptation to Risks of Pesticide Exposure
3. Neurobehavioral Testing in Migrant Agricultural Populations
4. Individual and Cultural Differences in the Pesticide Knowledge of Migrant Adolescent Agricultural workers