

Personal Protective Equipment Use and Safety Behaviors Among Farm Adolescents: Gender Differences and Predictors of Work Practices

Deborah B. Reed, RN, PhD;^{1,2,3} Steven R. Browning, PhD;^{1,2,3} Susan C. Westneat, MA;^{1,3} and Pamela S. Kidd, PhD^{4,5}

ABSTRACT: *Context:* Children on farms perform work that places them at risk for acute and chronic negative health outcomes. Despite strategies for preventing and reducing the risk of disease and injury, children's use of personal protective equipment and safely equipped farm machinery has generally remained unreported. **Purpose:** This paper reports the use of personal protective equipment, self-protective work behaviors, and selected risk exposures of children aged 14-19, who perform farm work. **Methods:** Survey results of adolescent high school students (n = 593) enrolled in agriculture class in Kentucky, Iowa, and Mississippi. Students were part of the sample that participated in the Agricultural Disability Awareness and Risk Education Project. **Findings:** Boys were at a significantly higher risk of exposure compared to girls, and boys engaged more frequently in risky behavior. Hearing and respiratory protection was used minimally and sporadically. Physical symptoms influenced use of hearing and respirator use, as did physician recommendation to use such protection. Of students who operated farm tractors, only half most frequently operated tractors with safety bars and seat belts. Sixty percent of the students reported using equipment with damaged or missing safety shields. **Conclusions:** In addition to the usual risks of farm work, adolescents may be at even greater risk by not using personal protective equipment or not having access to machinery that is properly equipped for maximum protection. Health care providers should incorporate advice to adolescents and their parents on risk reduction, particularly on the use of personal protective equipment.

consequence of their work in this industry, have been well documented.¹ Exposures to noise, to organic and inorganic dusts, and to farm equipment pose substantial hazards to children working in agriculture. Despite strategies for preventing and reducing the risk of disease and injury, adolescents' use of personal protective equipment (PPE) and safely equipped farm machinery has generally remained low. Researchers have investigated adults' safety decisions regarding use of tractors equipped with rollover protective structures (ROPS), PPE, and pesticides;⁵⁻⁷ however, limited attention has focused on adolescents' use of PPE and safety behaviors in agricultural work.

Adolescent farm workers are at risk for fatal and nonfatal farm injuries. Hard et al reported that young agricultural production workers were 3 times more likely to die on the job than their nonagricultural counterparts.⁸ In addition to deaths, adolescents experience a high number of the nonfatal injuries of all

¹College of Nursing, University of Kentucky, Lexington, Ky.

²College of Public Health, University of Kentucky, Lexington, Ky.

³Southeast Center for Agricultural Health and Injury Prevention, University of Kentucky, Lexington, Ky.

⁴Arizona State University, Tempe, Ariz.

⁵Pamela S. Kidd is deceased.

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Two million children and youth live or work for hire in US farms and ranches.¹ By the time these children reach their teens, they frequently perform agricultural work unsupervised, with heavy machinery, and in roles that would be prohibited in other industries.²⁻⁴ The morbidity and mortality among children, as a

children who work on farms.¹ When adjusted for work exposure time, adolescent injury rates on farms may surpass those of adults.⁹ The Federal Code of Regulations includes the Hazardous Occupations Orders for Agriculture that specify 11 domains of work prohibited to children; compared with other industries, these regulations are difficult to enforce and they exempt children who work on their parents' farms.¹⁰ Regulatory statutes or laws regarding agricultural work of persons under age 16 also vary by state.¹¹ Despite the obvious need for stricter regulation of children's farm work, support for such advances comes slowly; thus, the burden of protecting children continues to rest upon voluntary adoption of safety precautions.

Children learn farm work by modeling their parents and other authority figures. They strive to please adults^{2,12,13} and frequently try to perform tasks that exceed their abilities in an effort to please. The focus of farm work is often chore completion, rather than strict adherence to safe behaviors, so adolescents who model adult behavior may adopt unsafe work practices. Children appraise risk in different ways as their cognitive skills develop. Kidd et al held focus groups with farm children to examine the process of learning farm chores and safety rules.¹³ Children admitted to taking short cuts even though it meant breaking safety rules. A similar study conducted in Colorado with 36 Future Farmers of America members found that adolescents recognized the importance of safety rules but made conscious decisions to bend or break them based on their perceived risk of injury.¹² Finally, children are dependent upon decisions made by adults with respect to availability of PPE, investment in newer equipment with safety features, and training and supervision in the tasks that they perform.

In addition to acute trauma, children who perform farm work are at risk for more subtle chronic disorders including hearing loss and decrements in respiratory health. Hearing loss for farm resident teens may exceed that of their urban counterparts.¹⁴ Hearing should be protected during many farm chores commonly performed by adolescents, including working in close proximity to tractors and grain dryers and working in swine or poultry confinement buildings. A report of a hearing conservation project for Wisconsin adolescents¹⁵ noted determinants of hearing protection use included male gender, use of lawn mowers, and use of farm tractors. In addition, respiratory protection is indicated in many farm environments to protect the worker from organic materials such as dust and animal dander, as well as chemical irritants and potentially toxic gases from fermenting crops and animal waste.

Self-protective practices used by farm adolescents to prevent hearing loss, respiratory disease, and acute injury

from machinery and equipment are examined by gender in this study. Practices include using PPE, operating tractors with roll bars and seat belts, using equipment in good repair, and actively avoiding stepping over a rotating power take-off (PTO) shaft on equipment. Adolescents engaged in selected, high-risk tasks on farms in Kentucky, Iowa, and Mississippi were the population of interest in this investigation. Gender differences in the performance of farm tasks have been recently described in a number of reports, with males more often involved in tasks involving tractors, farm machinery, and cattle.^{3,16,17} Since work exposures, farm tasks, hours worked per week on the farm, training, risk perceptions, and susceptibility may vary by gender and age, it is necessary to consider these differences in the analysis of these safety practices. Understanding the patterns of use of such practices may help researchers develop interventions to decrease injury and illness risk in this population.

Methods

This paper is based on the results of a preintervention demographic survey administered to participants at the onset of the Agricultural Disability Awareness and Risk Education project prior to their participation in a safety program.¹⁸ Farm terms were defined before administering the survey to clarify items. If a participant had a reading disability, the teacher or the researcher administering the survey read the questions to the student. Students were encouraged to ask questions to enhance validity of responses.

Data were collected on participant demographics and on 4 specific farm work exposures that were part of the Agricultural Disability Awareness and Risk Education educational curriculum: exposure to excessive noise, exposure to high levels of dust, unsafe tractor driving practices, and exposure to equipment operated by a PTO. Students were queried about work exposure, use of protective equipment, and physical symptoms related to farm work. Students were asked about tractor overturns and injury outcomes. All surveys were reviewed for completeness or signs of blatant disregard. Surveys that included more than 1 page of missing data were eliminated. None of the surveys exhibited signs of disregard.

Data were entered in EpiInfo version 6 (Centers for Disease Control and Prevention, Atlanta) and converted to SAS (SAS Institute Inc, Cary, NC) data sets for the analysis after error checking of variables.¹⁹ Analyses were performed using SAS version 8. Preliminary analyses included computing frequencies and descriptive statistics for all variables. Descriptive analyses were conducted to examine gender differences in farm work exposures, use of PPE, and injury and

health outcomes. Prevalence estimates for the affirmative responses to questions and the corresponding prevalence odds ratios (OR) and 95% confidence intervals (CI) were calculated, comparing males to females (referent). Maximum likelihood estimates of the ORs were computed using multiple logistic regression to estimate the associations between age, gender, state of residence, symptoms from specific farm work exposures, and physician recommendations on the use of respirators and hearing protection.

Sample. A subset of the 1,138 high school agriculture students who participated in the research project between 1997 and 2000 was used in the analysis.¹⁸ The project took place in 21 high schools located in Kentucky, Iowa, and Mississippi and focused on 9th- and 10th-grade students enrolled in agriculture classes. States were selected because of previous cooperative working relationships with the researchers, cultural diversity seen across the region, and differences in agricultural production and commodities. This paper reports the results from survey data collected from the 593 students who reported participating in farm work at time of data collection. Passive consent was obtained from parents of the students after sending letters to the parents that explained the study. Only 10 students elected not to participate in the study.

Results

Baseline Characteristics. Demographic characteristics of the 593 children are given in Table 1. The mean age was 15.4 years (SD = 2.0 years). The majority (75%) were in the 9th or 10th grade. The children had a mean of 12 years of farm residence and 7.6 years of performing farm work. No differences were seen by gender for these variables. Males aged 14-15 years represented 46% of the sample, and 62% of the sample was composed of children from Kentucky. Most of the children (71%) who indicated that they currently worked on farms were living on a farm; consequently, 29% of those surveyed who were doing farm work at the time of the survey either did not live on the farm or did not indicate their place of residence. The majority of the children in the sample were white.

Gender-Specific Prevalence Analysis. Table 2 illustrates the exposure of the sample to risky farm work and the subsequent self-reported protective behaviors. Although a high prevalence of exposure to dusty farm jobs was reported for both males and females (91.4% for both), boys were at a significantly higher risk of exposure (OR = 2.72, 95% CI: 1.49-4.97) than girls. Respirators were used by slightly less than 1 in 5 children, and high-efficiency particulate air filter

Table 1. Demographic Characteristics of Children (Aged 14-19 Years) Currently Living in a Farm in Kentucky, Iowa, and Mississippi (N = 593)

Characteristic	Children in Sample	
	N _(s) [*]	Percent
Gender/age		
Male		
14-15 y	272	45.9
16-17 y	149	25.1
18-19 y	30	5.1
Missing	2	0.3
Female		
14-15 y	81	13.7
16-17 y	51	8.6
18-19 y	8	1.3
Missing	—	—
Race		
White	511	86.2
Black and other	5	0.8
Missing	77	13.0
State		
Kentucky	368	62.1
Iowa	198	33.4
Mississippi	27	4.6
Year in high school		
Freshman	288	48.6
Sophomore	154	26.0
Junior	78	13.2
Senior	71	12.0
Missing	2	0.3
Live on farm now		
Yes	421	71.0
No	75	12.6
Missing	97	16.4

*N_(s) is the number in the sample for the variable reported.

respirators were used by just 11.3%. Overall, boys were twice as likely to report using high-efficiency particulate air filter respirators when doing farm work than were girls. Over one fourth reported difficulty breathing after doing dusty farm work, with girls indicating a slight, but not statistically significant, elevated risk of breathing problems. Work in grain storage, hay, and in poultry facilities was cited as problematic for dust exposure.

The prevalence of exposure to noisy work was comparable with exposure to dusty work, with a slightly higher prevalence for males (94%) than for females (84%). Males were more likely to have experienced ringing in the ears (OR = 1.39, 95% CI: 0.90-2.15) than females, but this difference was not significant. Hearing protection was used by slightly more than one fourth of the children. Use of hearing protection was significantly more prevalent than use of

Table 2. Gender Differences in Exposure to Respiratory, Hearing, Tractor, and PTO Hazards for Children Who Currently Work on Farms*

Exposure Characteristic	N _(s)	Number of "Yes" Responses	Percent "Yes" Responses	OR, 95% CI
Respiratory				
Perform dusty job†				
Male	434	406	93.6	2.72, 1.49-4.97
Female	133	112	84.2	
Use respirator on farm				
Male	404	84	20.8	1.07, 0.62-1.88
Female	112	22	19.6	
Use high-efficiency particulate air filter doing farm work†				
Male	401	55	13.7	2.29, 1.00-6.15
Female	108	7	6.5	
Have difficulty breathing after dusty work				
Male	402	115	28.6	0.80, 0.50-1.29
Female	111	37	33.3	
Hearing				
Perform farm work with noisy equipment				
Male	421	379	90.0	1.38, 0.76-2.48
Female	136	118	86.8	
Use hearing protection while farming				
Male	379	110	29.0	1.01, 0.63-1.64
Female	118	34	28.8	
Have experienced ringing in the ears				
Male	378	232	61.4	1.39, 0.90-2.15
Female	118	63	53.4	
Tractor				
Ever drive a tractor with ROPS†				
Male	425	311	73.2	2.48, 1.65-3.73
Female	128	67	52.3	
Drive tractor with ROPS and seat belt				
Male	310	230	74.2	0.76, 0.40-1.44
Female	67	53	79.1	
Tractor used most has ROPS and seat belt				
Male	314	172	54.8	1.05, 0.63-1.76
Female	71	38	53.5	
Ever overturned tractor†				
Male	399	29	7.3	8.15, 1.10-60.55
Female	105	1	1.0	
Ever injured in a tractor overturn				
Male	423	12	2.8	—
Female	129	0	—	
PTO equipment				
Perform farm work using PTO equipment†				
Male	427	390	91.3	4.50, 2.74-7.40
Female	137	96	70.1	
Have ever stepped over rotating PTO†				
Male	389	168	43.2	2.52, 1.46-4.38
Female	95	22	23.2	
Used equipment with missing/damaged PTO shield†				
Male	390	253	64.9	2.89, 1.78-4.72
Female	95	37	39.0	
Ever injured from stepping over PTO shaft				
Male	390	8	2.0	—
Female	96	0	0	

*Overall analysis based on responses from 453 male and 140 female children who currently work on farms (n = 593). N_(s) is the number in the sample for the variable reported. Missing values constituted less than 8% of responses for any question. Analysis for the respiratory, hearing, and PTO exposure questions were restricted to the subset of responses that answered affirmatively to performing dusty jobs, performing farm work with noisy equipment, and performing farm work with PTO equipment, respectively, following the initial question in the category. The question concerning driving tractors with ROPS and seat belts and the question regarding whether the tractor used most often has an ROPS and seat belts were restricted to children who responded that they had ever driven a tractor. Ever injured in a tractor overturn is based on the total number of children reporting ever having driven a tractor.

†Statistically significant result at the *P* < .05 level.

respirators among children in the sample. Males reported using hearing protection most often while participating in shooting sports, including hunting on farm property. Females reported highest use while feeding pigs in confinement buildings.

Only half of the children who drove tractors on the farm most often used a tractor with an ROPS and a seat belt. Tractor-related “near misses” and injuries were almost exclusively reported by males, with 7% ($n = 29$) of the boys who drove tractors indicating that they had overturned the tractor. Of those who had overturned a tractor, 41% indicated they were injured in the incident. Overall, we estimate that about 3% of males aged 14-19 who drive tractors on the farm are injured in a tractor overturn. Over a third (39%) reported ever stepping over a rotating PTO shaft; however, 59.8% reported using equipment with missing or damaged shields. Boys were 4.5 times more likely to engage in farm work that included using PTO equipment ($OR = 4.50$, 95% CI: 2.74-7.40) and were more than 2.5 times as likely to step over a rotating PTO shaft ($OR = 2.52$, 95% CI: 1.46-4.38) than were girls. Eight children reported being injured by a PTO shaft, and 2 of these were hospitalized for their injuries.

Frequency of Use Analysis. We examined frequency of use patterns for the use of respirators, hearing protection, and seat belts on ROPS-equipped tractors by gender. These data revealed that when queried about use of a given type of PPE in the last 10 times it should have been used, the self-reported frequency of use tended to be very low (1-3 times) for respirators and hearing protection. Excluding those who reported never using respirators or hearing protection, the median frequency for either type of protection was 4 times in the last 10 times. There were no significant differences by gender for either type of protection.

Across all frequency categories for use of seat belts on ROPS-equipped tractors, girls were more likely than boys to wear seat belts when operating the tractor ($P = .0002$). Girls reported a median seat belt use of 6 out of every 10 times they drove an ROPS-equipped tractor, while the median reported seat belt use for boys was 4 out of every 10 times.

Logistic Regression Analysis: Predictors of Use of PPE. Logistic regression models were used to examine gender differences in the use of 2 types of PPE (ie, respirators and hearing protection, considered separately as dependent variables) while controlling for state of residence, child’s age, symptoms related to breathing difficulties, and noise exposure for each outcome, and physician-recommended use of the specific protective equipment.

Results from the logistic regression for use of respirators indicate that children from Iowa were more likely to wear respiratory protection ($OR_{adj} = 8.05$, 95% CI: 4.82-13.46) compared to children from Mississippi ($OR_{adj} = 2.60$, 95% CI: 0.81-8.37) or Kentucky (referent). Adolescents who reported breathing difficulties after exposure to dusty farm work were 1.5 times more likely to use a respirator than those not reporting breathing difficulties. This suggests that prevalence of breathing difficulties among children influenced their use of respirators. After controlling for these variables, the model indicated that males were slightly more likely to use a respirator than females ($OR_{adj} = 1.47$, 95% CI: 0.82-2.63) and that physician recommendations may have a modest influence on respirator use among children ($OR_{adj} = 1.50$, 95% CI: 0.81-2.76), but neither finding was statistically significant.

Results of the logistic regression for use of hearing protection indicated that boys were slightly more inclined to use hearing protection than girls ($OR_{adj} = 1.20$, 95% CI: 0.77-1.87), and those students reporting ringing in the ears were more likely to report using hearing protection than those who did not report ringing ($OR_{adj} = 1.18$, 95% CI: 0.79-1.74), but neither finding was statistically significant. Those children who reported that a doctor had recommended that hearing protection be used were 2.4 times more likely to use hearing protection ($OR_{adj} = 2.42$, 95% CI: 1.27-4.61), while children from Iowa were about twice as likely to use hearing protection ($OR_{adj} = 1.93$, 95% CI: 1.30-2.86) than children in Mississippi or Kentucky (referent).

Discussion

The results of the study confirm that a high proportion of boys and girls working on farms are exposed to dusty and noisy work environments. Among those children who have ever used a respirator, the majority reported infrequent use when undertaking dusty farm jobs but with no significant difference in the frequency of use of respirators by gender. Boys, however, were more likely to use a high-efficiency particulate air filter while doing farm work, which may be a function of the tasks performed and familiarity with the equipment. Children were more likely to use hearing protection than respirators, even though the prevalence of exposure to noisy jobs was comparable to that of the dusty ones. The low overall prevalence of PPE use in our study parallels the use of PPE among Midwestern adult farmers, although adolescents in Iowa were more likely than youth in Kentucky or Mississippi to use PPE.⁶ This regional variation could be due to cultural attitudes toward safety devices, more extensive farm safety education, or different agricultural practices.

Symptoms related to dust or noise exposures appear to have influenced children's use of respirators and hearing protection. Respirator use among children with breathing difficulties and use of hearing protection among children reporting ringing in the ears support the finding of Kidd et al that negative events influence behavior.¹³ Although a history of respiratory and hearing problems in child farm workers may have prompted their parents to encourage PPE use for their children, the adolescents in this study frequently worked unsupervised and independently and wore the protective devices when exposure to dust and noise was excessive. It may be that the use of these protective devices was less frequent when the youth did not perceive a high level of risk or if the youth had not experienced a health problem due to the exposure.

There has been no examination of the efficacy of providing agricultural health advice by health care providers. In this study, the advice of a health provider to use respiratory and hearing protection seemed to influence the use of these devices. Perhaps their symptoms prompted them to seek medical attention, so these adolescents took action to protect their health when advised to do so by their physicians. This possible effect from physician recommendation was mitigated by the infrequent use of the equipment.

The survey did not query about the fit of the PPE device or if the student had been instructed on its use. These issues are important when determining the use and effectiveness of PPE and should be explored more fully. Only a few reports have focused on PPE fit and availability for women.²⁰⁻²² These reports noted that very little has been done to ensure adequate access to or design of PPE to accommodate female workers in any industry.

In addition to the PPE discussed in this report, the use of other protective equipment, shoes, and clothing should be examined. The guidelines for determining children's and adolescents' farm work assignments and use of PPE provided by the North American Guidelines for Children's' Agricultural Tasks (www.nagcat.org) could also be offered by health providers when counseling parents and youth.

The literature shows that access to farm equipment and safety information varies by gender, with females historically not having equal access to farm safety information.^{23,24} In our analyses, except for seat belt use on tractors, girls were less likely to use PPE. Girls may be more familiar with seat belts than with other types of PPE and thus make the translation of seat belt use in a vehicle to that on a tractor. Tasks requiring respiratory or hearing protection would not have this ready translation. Perhaps females have less exposure to the need for PPE, or perhaps they do not have equal access to PPE. Disparities in PPE use may also result from the

fit of the PPE itself.²⁰⁻²² While seat belts are adjustable, respiratory and hearing protection is generally designed to fit adults. The PPE may not properly fit female adolescents or may be uncomfortable.

Despite years of educational efforts to promote use of roll bars on tractors and efforts to inform about the high risk of fatal outcomes from tractor overturns, only half of the participants in this study who operated tractors reported that the tractor they drive most often is equipped with a roll bar and seat belt. These easily adopted safety measures have been calculated to reduce fatalities and injuries from tractor overturns by as much as 98%.²⁵ Buckling the seat belt on a vehicle so equipped should be second nature; however, very few of the participants routinely used a seat belt when driving a tractor. Often, the tractor driven most often by the teens in the study was not even equipped with a seat belt.

This study found that boys who drive tractors on the farm were 8 times more likely to overturn them than girls. It is documented that males begin tractor driving at younger ages than females and have more tractor driving time;²⁶ thus, it would be expected that male overturn rates would surpass corresponding female rates. This risk should be countered with protective strategies beyond tractor driving instruction. Operation of tractors not equipped with ROPS or seat belts should be prohibited by law among all youth regardless of family status. Similar legislation could be effective in reducing PTO-induced injuries.

Limitations. The survey used a cross-sectional, self-report design. The use of the prevalence OR for the estimation of risk in this study may lead to overestimates of the risk for outcomes that are more prevalent than 10% in the population.²⁷⁻²⁹ However, the relative ranking of risk factors on the basis of adjusted ORs from the logistic regression analysis in this study still yields appropriate inferences from the data and is a commonly used approach for the adjustment of multiple confounders in cross-sectional studies.^{30,31} Work exposures may have been underreported or overreported because of the seasonality of agricultural production and the time limitations of farm work imposed by the child's attendance at school, with recall potentially biased toward more recent work. In addition, much of the data were collected during late fall and winter, a time when farm work is minimal, which could result in underreporting. The sample was located primarily in Kentucky, which could bias results toward work performed on smaller farms, where work and PPE use may differ from other regions where farms tend to be larger.

The schools were not randomly selected; thus, the external validity of the findings may not be generalizable

to the entire United States. However, the sample does represent a diversity of agricultural commodities and geographic locations, which tempers bias. The work practices examined focused on common agricultural tasks known to be high-risk activities in any farm setting.

While there are evident limitations to this cross-sectional study, it does provide evidence to support the need for randomized community trials of interventions to encourage the use of PPE among farm children.

Conclusion

Children and adolescents, especially adolescents aged 15-19, continue to be at high risk for acute injury and cumulative trauma when performing farm work. Teens in this study were able to identify hazardous conditions; yet, few took precautions that could prevent personal injury. Simple and inexpensive PPE is available, but use of these devices typically occurs among a small proportion of farm children and is inconsistent. When confronted by symptoms that might be averted by PPE, youths were more inclined to wear the devices. Health care providers may be instrumental in increasing PPE use and improving other protective strategies. Further work with health professionals that promotes the advantages of PPE may be beneficial.

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