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Compliance With the North American Guidelines for Children's Agricultural Tasks (NAGCAT) Work Practice Recommendations for Youth Working With Large Animals

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ABSTRACT. The North American Guidelines for Children's Agricultural Tasks (NAGCAT) were developed to reduce the risk of childhood agricultural injury. The purpose of this study was to evaluate compliance with NAGCAT-recommended work practices (WPs) when youth work with large animals. On a daily basis, over a period of 10 weeks, youth self-reported the number of minutes they worked with a large animal and whether they followed the associated NAGCAT WP guidelines. Statistical analyses were conducted to compare boys to girls and to consider the effect of factors such as youth age, farm residence status, and selected parental characteristics. A high proportion of youth exhibited relatively low compliance for most of the five WPs evaluated. Respirators were rarely worn, but checking for people and obstacles in the area while working with large animals was commonly reported. In general, boys, especially the older boys, exhibited higher compliance than did girls. The results of our

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study demonstrate, in general, that youth are not following recommended NAGCAT WPs when working with large animals, identifying an area in agricultural safety and health requiring focused attention.

KEYWORDS. Farm safety, personal protective equipment (PPE), children, youth, agricultural health hazards, occupational health, rural health, childhood agricultural injury

INTRODUCTION

Agriculture is known to be one of the most hazardous industries in the United States.¹ As an industry, the annual fatality rate is one of the highest in the United States, averaging 27.3 deaths per 100,000 agricultural workers.² A review by Hard et al.³ reported that fatal agricultural injuries are largely caused by machinery, especially tractors. Motor vehicles, animals, electrocutions, falls, and mechanical suffocations are also commonly implicated. Documentation of nonfatal agricultural injuries is much more challenging, because not every agriculture-related injury requires medical treatment, where a record of the visit and details of the injury would be documented and, hence, potentially accessible.⁴ Another review of agricultural injury reported that nonfatal injury rates among agricultural workers (or farm residents) range from a low in the vicinity of 3 to 4 per 100 person-years to a high of approximately 17 per 100 person-years.⁵ A recent Bureau of Labor Statistics publication indicated that the nonfatal agricultural injury (and illness) rate in 2008 was 5.3 per 100 full-time workers, corresponding to 2.9 cases with days away from work, job transfer, or restriction per 100 full time workers¹ (which is roughly 40% higher than all industries combined). The most important causes of nonfatal injuries include machinery, falls, animals, vehicles on public roads, and tractors.⁵

Employment in agriculture has remained fairly consistent since the 1970s, at about 3.3 million workers.⁴ In 2006, there were an estimated 1.1 million persons under 20 years old living and/or working on farms or ranches.⁶ Approximately 95% of farms have 10 or fewer workers, and therefore do not fall under federal Occupational Safety and Health Act (OSHA) regulations for agriculture-related operations.⁷

Such farms are not required to comply with safety standards or undergo safety inspections,⁶ which, in part, may explain the increased injury risk among adults (and youth) exposed to agricultural hazards.

In contrast to other industries/occupations, youth represent an important segment of the agricultural workforce. Children and adolescents who live on farms, whether they perform farm chores or not, are regularly exposed to a variety of chemical, physical, and biological hazards.⁶ In addition, visiting farms for recreation can also be perilous for youth.^{8,9} Youth are often assigned chores that require them to work with machinery and large animals, which are both associated with a relatively high injury risk.^{10,11} Consequently, youth who are exposed to agricultural hazards are more likely to experience premature mortality, morbidity, and disability.^{5,12} Youth working on family farms are largely exempt from child labor laws, which allows parents to assign almost any kind of chore to their children, and at young ages.¹³ In 2006, there were approximately 23,100 nonfatal injuries among farm youth, a 30% reduction from the estimated 33,000 in 1998.⁶ Studies of agriculture-related injury among children and adolescents have demonstrated that rate differences by age and sex do not manifest until school age, at which point, rates are generally higher among boys.^{14,15}

Parents and other caregivers are responsible for deciding whether or not their children can safely perform farm chores.^{7,16-19} Unfortunately, youth are often assigned chores that are normally performed by adults and which exceed their developmental capabilities.^{16,18} Some parents/caregivers consider it beneficial to have their children working on the farm, regardless of the associated injury risk.¹⁰ Some adults believe that having children work at a

younger age helps them learn chores faster, resulting in increased productivity, safety, and a reduced need for adult supervision, leading to independence and responsibility.¹⁰

The North American Guidelines for Children's Agricultural Tasks (NAGCAT) were developed as a response to the relatively large number of children and adolescents who work on farms and their relatively high injury rates.^{18,20} Published in 1999, the NAGCAT were designed for parents of youth aged 7 to 16 years. These guidelines were developed to help parents assign youth agriculture-related chores that are developmentally appropriate for their age, in an effort to reduce the risk of childhood agricultural injury (CAI).²⁰ For each of the 62 jobs/chores addressed, there are specifications of adult responsibilities, recommended levels of adult supervision, known hazards, work practice (WP) recommendations, a training checklist, and a developmental checklist to help parents or other caregivers determine each youth's level of development.¹⁸

The risk of CAI appears to vary by the type of farm chore performed. Working with animals has been found to be associated with a relatively high injury risk; about 20% of farm injuries among youth result from working with animals.⁹ In 2001, the injury rate for youth working on livestock farms was 19.2 injuries per 1000 youth, compared to 12.1 injuries per 1000 youth on crop farms.¹⁸ Hendricks and Adekoya⁹ found that the majority of CAIs occurred among youth living on livestock farms in the United States (2001 data). The results of this study also revealed injury rate differences by gender: animals were the primary cause of injury among females, whereas males were primarily injured by vehicles. In another relevant study, females experienced about 88% of all animal-related injuries.¹⁵ A study by Gerberich et al.¹¹ found animals to be the leading cause of injury and death among children on farms, accounting for 40.3% of all CAIs.

Many studies addressing agricultural hazards have been injury focused. However, there is a notable lack of research on compliance with recommended safe work practices, including the use of personal protective equipment (PPE). Carpenter et al.²¹ reported that the use

of certain safety measures on farms with 11 or more workers may have a positive effect on reducing agricultural injury risk. On smaller farms (those with 10 or fewer workers), it is arguably more difficult to determine the effectiveness of safety measures, because reliance on them is personally motivated and not enforceable, making relevant data difficult to collect. Children tend to mimic adults with regard to safety practices, with the focus usually on task completion instead of safety.^{18,22} The use of PPE and other safety measures by children on farms is often low. Reed et al.²² found that only about 20% of youth reported wearing a respirator, and about 29% reported using hearing protection. To our knowledge, previous studies of agricultural injury and WP compliance have not specifically considered children and adolescents working with large farm animals.

As noted above, NAGCAT recommendations include safety procedures and equipment, including PPE, which should be used when performing certain farm chores. If the guidelines are not being followed, then the reasons for not using them need to be identified, and alternative intervention methods should be developed. The purpose of the study reported here was to evaluate the extent to which youth were in compliance with NAGCAT when working with large animals. With respect to variation in compliance, we considered the influence of sex, youth age, and farm residence status. Although the overarching goal of the study was to evaluate the effectiveness of NAGCAT by delivering an in-home intervention,¹⁷ household status (i.e., intervention or control) was ignored for this article.

METHODS

Recruitment of Study Participants

Data for this study were collected as part of an investigation designed to evaluate the effectiveness of NAGCAT,¹⁷ which included, in part, assessing the extent of compliance with NAGCAT-specified WPs for working with large animals. Potentially eligible participants were members of 4-H clubs, 9 to 17 years old, who lived on farms in the 20-county central Ohio area, or who had undertaken a large animal 4-H

project in the previous year. During the data collection period (2004 to 2006), we attempted to contact all potentially eligible households in a sample of 9 of the 20 counties.

Recruitment was facilitated through The Ohio State University (OSU) Extension 4-H program office in each of the nine counties. Letters describing the study and inviting participation were mailed to each of the identified households. Following this, project staff attempted to make telephone contact with an adult resident in each household to determine both eligibility and interest in participation. Additional details regarding sample selection, recruitment methods, and incentives offered are described in Canan et al.²³

In addition, each child or adolescent 4-H member, referred to as a “Youth Partner” (YP) was paired with an adult caregiver (the “Parent Partner” [PP]), who was the adult primarily responsible for assigning chores. All study methods were approved by The Ohio State University institutional review board, which included having the PPs and YPs sign informed consent and assent forms, respectively.

Data Collection

Data were collected in three sequential phases: Phase 1, youth and adults were expected to separately complete self-administered questionnaires (SAQs); Phase 2, youth were expected to submit to a baseline testing protocol; and Phase 3, youth were expected to complete “Daily Record Books” (DRBs), essentially daily diaries based on participant event monitoring.^{24,25} In Phase 1, the youth SAQ ascertained, in part, information regarding demographics, risk perception, and attitudes toward agricultural work. The adult SAQ ascertained, in part, information regarding demographics, history of the youth’s unintentional injuries, and NAGCAT-related work experiences. Phase 2 included anthropometry and measurements of postural sway, neuropsychological functioning, hearing, IQ, and strength.^{17,25}

Completion of DRBs was the last phase of data collection (Phase 3), where youth were provided a closed-ended list of 31 chores from the

NAGCAT guidelines where they responded to questions pertaining to each one. The first chore-specific question was “Did you do this chore today?” If the respondent answered “yes” to performing a specific chore that day, they were instructed to report the total number of minutes they spent performing the chore. Youth were then directed to respond to questions regarding NAGCAT-recommended safety WPs, the extent of adult supervision, and the occurrence of any injuries, which were defined as events resulting in any pain, bleeding, bruising, or redness to the skin (or worse). If youth responded “yes” to performing a specific WP, it was assumed they performed that WP the entire time they were working the chore. If an injury occurred, youth were instructed to provide relevant details about the injury and the events surrounding the injury.²⁵

Data Analysis

The analysis focused on the NAGCAT chore “Worked with Large Animals.” For this chore, NAGCAT recommends five WPs: (1) wearing steel-toed, nonskid shoes; (2) wearing leather gloves; (3) using/wearing a respirator; (4) checking for people and obstacles in the work area; and (5) carrying a stick to guide the animals.

The primary outcome variable of interest in our study was the minute-based WP compliance expressed as a percentage (hereafter referred to as the WP-specific compliance “rate”). The total number of minutes each youth worked the chore while in the study was estimated by summing the duration of all reported work sessions. Table 1 describes the calculations for two hypothetical youth who worked with large animals on separate occasions over the course of the first week of the follow-up period. When youth indicated they performed the WP (e.g., Youth 1, Day 1), it was assumed they performed this WP the entire time they worked the chore, as previously noted. The minute-based WP compliance rate was then calculated for each youth by dividing the total number of reported minutes in compliance over the course of the 10-week follow-up period by the total number of minutes the chore was performed during follow-up.

TABLE 1. Calculations for Two Youth Who Worked with Large Animals and Wore Leather Gloves During Week 1 (Hypothetical)

	Minutes worked chore	Wore leather gloves (Yes/No)?	Assumed minutes in compliance*	Compliance rate, %**
Youth 1				
Day 1	30	Y	30	
Day 2	15	N	0	
Day 3	10	Y	10	
Day 4	10	Y	10	
Day 5	10	N	0	
Day 6	5	N	0	
Day 7	30	Y	30	
Total minutes	110		80	80/110 = 72.7%
Youth 2				
Day 1	0	Y	0	
Day 2	10	N	0	
Day 3	5	N	0	
Day 4	20	Y	20	
Day 5	5	N	0	
Day 6	0	N	0	
Day 7	15	Y	15	
Total minutes	55		35	35/55 = 63.6%
Grand totals	165		115	115/165 = 69.7% [†]
Unweighted mean [‡]				68.2%

*When youth responded "Yes" to performing the work practice, it was assumed the youth performed the work practice the entire time they worked the chore.

** Calculated by dividing the assumed total number of minutes in compliance by the total number of minutes youth reported working the chore while in the study.

[†]This is the weighted mean for the subgroup (Youth 1 and Youth 2).

[‡]Calculated by averaging the compliance rates for all youth.

Descriptive statistics included the number of YPs who worked with large animals as well as the mean, median, minimum, and maximum compliance rates for each WP among participants who worked with large animals at least once while they were in the study.

To better understand youth behavior with respect to NAGCAT-recommended WPs, cumulative frequency distributions ("ogives") of compliance rates for each WP were constructed. Two-sample Kolmogorov-Smirnov (K-S) tests were performed using the exact method to assess statistical significance of any differences between compared distributions.²⁶

Youth were stratified by age tertiles (<12.73 years, 12.73–14.74 years, and >14.74 years) and farm residency status. Ogives specific for residence status (farm, nonfarm) were constructed for each age tertile, comparing boys to girls. As noted above, exact K-S tests were performed to determine if the gender-

and age-specific ogives were statistically significantly different.

Statistical Software

Data were analyzed with SPSS version 17.0 and STATA release 8. All graphs and tables were created using Microsoft Excel 2003.

RESULTS

Overall

Among the 3141 households identified as potentially eligible, 601 (19.1%) refused participation, 267 (8.5%) were found to be ineligible, and 417 (13.3%) agreed to participate. The remaining 1856 (59.1%) could not be contacted after multiple attempts by mail and telephone. If the unreachable and ineligible households are excluded (because they could not enter the numerator of a response rate calculation),

the initial response rate can be estimated as $417/[3141 - (1,856 + 267)] \times 100 = 41.0\%$. A more conventional response rate would be calculated as $417/[3,141 - 267] \times 100 = 14.5\%$.

Considering the 417 above referred-to households referred to above, 347 YP-PP dyads completed the necessary consent/assent forms and participated in baseline testing. Although 347 dyads initially agreed to participate, missing data reduced the number of dyads with usable data to 330.^{27,28} Table 2 summarizes selected descriptive statistics for youth who worked with large animals at least one time during the

10-week follow-up period. There were 94 boys (65.3% of all boys in the study) and 152 girls (81.7% of all girls in the study) who worked with large animals at least one time during the data collection period. The results in Table 2 indicate that there were proportionately more girls who worked with large animals, and that they had more exposure to large animals than boys (girl:boy ratio of individual-level means range from 1.3 to 2.0).

Tables 3 and 4 summarize selected demographic characteristics of the YPs and the PPs included in the current analysis. The mean age of the YPs who worked with large animals was 13.6 years. As suggested by their mean ages, boys and girls were nearly identical with respect to age, but they differed significantly by farm residence status (Table 3), where 82% of boys lived on a farm compared to 62% of girls (p value: 0.053). Almost all youth in our study reported having received some kind of safety training on how to work with large animals (Table 3). On the other hand, relatively few reported ever having received training on the proper use of a respirator. As expected, girls reported significantly less risky activity compared to boys. As shown in Table 4, boys and girls were similar with respect to their PP's age, education, acreage of land rented, owned, and/or worked, and perceived level of adult supervision required.

Table 5 summarizes selected descriptive statistics for WP-specific compliance rates for the YPs who worked with large animals, along with the exact K-S p values comparing boys to girls. In general, boys, especially older boys, exhibited higher mean compliance rates for all WP compared to girls, although statistical significance (at the 0.05 level) was reached for only 4 of the 20 comparisons. Among boys, mean WP compliance rates tended to increase with age, although this pattern was not as evident among girls. Descriptive statistics for youth farm residents contrasted with non-farm residents are summarized in Tables 6 and 7.

Checking for People and Obstacles in the Area

Checking for people and obstacles (Figure 1) was the one work practice where youth exhibited

TABLE 2. Exposure-Related Descriptive Statistics for Youth Who Worked With Large Animals

Subgroup	All boys ($n = 144$)	All girls ($n = 186$)	Totals ($n = 330$)*
Number of youth who worked with large animals at least once	94	152	246
Percentage of youth who worked with large animals at least once	65.3	81.7	74.5
Cumulative totals			
Hours	1294.1	4623.8	5917.9
Days	53.9	192.7	246.6
Group means			
Hours/youth	13.8**	30.4	24.1
Days/youth	0.6	1.3	1.0
Youth-specific days /week			
Minimum	0.1	0.1	0.1
Median	0.8	2.4	1.8
Mean	1.7	2.6	2.3
Maximum	6.8	7.0	7.0
Youth-specific minutes /day			
Minimum	3.9	5.9	3.9
Median	50.2	60.5	53.3
Mean	54.1	69.5	63.6
Maximum	327.3	361.0	361.0
Youth-specific minutes /week			
Minimum	0.4	1.0	0.4
Median	41.0	129.3	72.4
Mean	101.5	202.5	163.7
Maximum	720.0	1189.9	1189.9

*330 is the total number of YP-PP dyads with usable data.

**1294.1/94 = 13.8.

TABLE 3. Selected Characteristics of Youth Partners Who Worked With Large Animals

Selected youth partner characteristics	Boys (n = 94)		Girls (n = 152)		All		Significance testing		
	Mean	SD*	Mean	SD	Mean	SD	t test p value**		
Age at time of entry into study	13.6	1.8	13.6	2.4	13.6	2.2			
Mean age first worked with large animals	8.0	3.0	8.0	3.0	8.0	3.0			
	N	%	N	%	N	%	χ^2	d.f.	p value
Farm residence									
Live on farm	76	81.7	91	61.5	167	69.3	5.88	1	.053
Do not live on a farm	17	18.3	57	38.5	74	30.7			
Totals	93	100	148	100	241	100			
Ever worked with large animals before?									
No	2	2.2	6	4.0	8	3.3	0.631	1	.427
Yes	91	97.8	143	96.0	234	96.7			
Totals	93	100	149	100	242	100			
Had training on how to use and fit a respirator properly?									
No	71	76.3	127	85.2	198	81.8	3.043	1	.081
Yes	22	23.7	22	14.8	44	18.2			
Totals	93	100	149	100	242	100			
Had training on how to work with animals safely?									
No	1	1.1	1	0.7	2	0.8	0.111	1	.739
Yes	92	98.9	147	99.3	239	99.2			
Totals	93	100	148	100	241	100			
Did dangerous/risky things for fun?									
Never	32	34.4	78	52.3	110	45.5	9.228	2	.010
Once or twice	45	48.4	59	39.6	104	43.0			
Several times	16	17.2	12	8.1	28	11.6			
Totals	93	100	149	100	242	100			

*SD is the standard deviation.

**Two-tailed Student's *t* test comparison of means, boys versus girls, assuming equal variances.

the best compliance, with the overall rate estimated of 80.4% (Table 5). Table 5 also shows that the mean compliance rate was 81.9% for boys and 79.5% for girls of all ages (*p* value: >.05). For this WP, girls tended to exhibit higher compliance as age increased. Age trends for boys were inconsistent. Based on the results summarized in Tables 6 and 7, farm residency had little to no impact on compliance for this WP.

Wearing Steel-Toed Nonskid Shoes

As visualized in Figure 2 (panels A and E), approximately 50% of boys and approximately 55% to 60% of girls never wore steel-toed nonskid shoes while working with large animals. For this WP, Table 5 shows that the difference between the distributions for boys and girls approached statistical significant (*p* value: .056, ignoring farm residency status). Here, the oldest

boys reported a significantly higher mean work practice compliance rate, 54.7% versus 21.9%, a ratio of about 2.5 compared to the girls (Table 5; *p* value: .004). The oldest farm- and non-farm-resident boys exhibited much better compliance than their female counterparts (Table 6, Figure 2).

Carrying a Stick to Guide Animals

We found a significant difference between boys and girls who reported carrying a stick to guide animals (Figure 3); on average, boys performed this work practice 25.6% of the time, whereas girls did this 16.6% of the time (Table 5; *p* value: .016). Table 5 also shows that boys in the oldest tertile were much more likely to carry a stick to guide animals than were girls (exact K-S *p* value: .017). As indicated in Tables 6 and 7 (and Figure 3), farm-resident

TABLE 4. Selected Characteristics of Parent Partners (PPs) in Study

Selected characteristics	Boys		Girls		All		Significance testing		
	Mean	SD*	Mean	SD	Mean	SD	<i>t</i> test <i>p</i> value**		
PP age in years	44.5	7.0	41.7	8.2	42.4	7.7	.902		
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	χ^2	<i>d.f.</i>	<i>p</i> value
PP education									
Less than high school (HS)	2	2.1	3	2.0	5	2.1	0.337	4	.953
HS diploma/GED	31	33.0	50	34.0	81	33.6			
Some college/technical school	33	35.1	55	37.4	88	36.5			
College Graduate or higher	28	29.8	39	26.5	67	27.8			
Other	0	0.0	0	0.0	0	0.0			
Total	94	100	147	100	241	100			
PP acreage of land (rent, own, work)									
1–9 acres	23	24.6	57	38.8	80	33.2	8.145	11	.615
10–49 acres	23	24.5	34	23.1	57	23.7			
50–99 acres	17	18.1	25	17.0	42	17.4			
100–149 acres	7	7.4	6	4.1	13	5.4			
150–199 acres	5	5.3	6	4.1	11	4.6			
200–249 acres	3	3.2	3	2.0	6	2.5			
250–299 acres	2	2.1	3	2.0	5	2.1			
300–349 acres	0	0.0	1	0.7	1	0.4			
350–399 acres	0	0.0	0	0.0	0	0.0			
400–499 acres	2	2.1	2	1.4	4	1.7			
500–999 acres	9	9.6	8	5.4	17	7.1			
1000 acres or more	3	3.2	2	1.4	5	2.1			
Total	94	100	147	100	241	100			
What level of supervision is required for the Youth Partner to work with large animals									
Youth Partner does not do	7	7.4	14	9.5	21	8.7	5.374	5	.497
Constant	26	27.7	38	25.9	64	26.6			
Nearly constant	21	22.3	41	27.2	61	25.3			
Intermittent	15	16.0	26	17.7	41	17.0			
Periodic	18	19.1	22	14.3	39	16.2			
No supervision	7	7.4	8	5.4	15	6.2			
Total	94	100	149	100	241	100			

*SD is the standard deviation.

**Two-tailed Student's *t* test comparison of means, boys versus girls, assuming equal variances.

boys exhibited lower compliance than non-farm-resident boys; for girl, this trend was reversed.

oldest farm-resident girls), compliance did not vary significantly by farm residency status.

Wearing Leather Gloves

The mean compliance rates for wearing leather gloves while working with large animals (Figure 4) were low among both boys and girls, 10.5% and 8.3% of the time, respectively (Table 5; exact K-S *p* value: .328). As visualized in Figure 4, approximately 70% to 80% of boys and girls never wore leather gloves when working with large animals. With one exception (the oldest farm-resident boys versus the

Using/Wearing a Respirator

Compared to the other work practices, using a respirator (Figure 5) had the lowest overall mean compliance rate among the youth in our study (Table 5). Less than 1% of all youth wore a respirator at least once during the 10-week follow-up period. As shown in Table 5, none of the participating youth reported 100% compliance for wearing a respirator when working with large animals. For girls as a group, the highest compliance rate reported was about 10%

TABLE 5. Minute-Based Work Practice Compliance Rates (%) for Youth Who Worked With Large Animals

Figure	NAGCAT work practice*	Age (years)**	Boys (n = 94, 65.3%) [‡]			Girls (n = 152, 81.7%) [§]			All (n = 246/330 = 74.5%)			p value ^{††}			
			Mean [†]	Med	Min	Max	Mean	Med	Min	Max	Mean		Med	Min	Max
1	Check for people or obstacles in the area	All	81.9	100	0	100	79.5	98.0	0	100	80.4	98.4	0	100	.492
		<12.73	81.9	98.1	0	100	68.4	91.4	0	100	73.0	93.7	0	100	.224
		12.73-14.74	80.0	98.0	0	100	84.5	100	0	100	82.2	100	0	100	.929
2	Wear steel-toed, nonskid shoes	>14.74	85.1	100	0	100	86.3	99.4	0	100	85.9	100	0	100	.517
		All	31.5	1.4	0	100	21.1	0	0	100	25.1	0	0	100	.056
		<12.73	22.1	0	0	97.2	16.4	0	0	100	18.3	0	0	100	.325
3	Carry a stick to guide animals	12.73-14.74	23.8	0	0	100	27.0	0	0	100	25.4	0	0	100	.951
		>14.74	54.7	44.1	0	100	21.9	0	0	100	32.3	5.1	0	100	.004
		All	25.6	0	0	100	16.6	0	0	100	20.0	0	0	100	.016
4	Wear leather gloves	<12.73	18.7	0	0	100	16.9	0	0	100	17.5	0	0	100	.641
		12.73-14.74	24.3	0	0	100	12.1	0	0	100	18.2	0	0	100	.224
		>14.74	35.5	36.9	0	100	19.9	0	0	100	24.9	1.6	0	100	.017
5	Use/wear respirator	All	10.5	0	0	100	8.3	0	0	100	9.1	0	0	100	.328
		<12.73	3.5	0	0	50	8.3	0	0	100	6.7	0	0	100	.25
		12.73-14.74	10.3	0	0	100	13.3	0	0	100	11.8	0	0	100	.79
5	Use/wear respirator	>14.74	18.6	0	0	100	4.5	0	0	98.5	9.0	0	0	100	.005
		All	0.8	0	0	35.7	0.2	0	0	9.6	0.4	0	0	35.7	.472
		<12.73	0	0	0	0	0.3	0	0	9.6	0.2	0	0	9.6	.179
5	Use/wear respirator	12.73-14.74	0.6	0	0	23.1	0.3	0	0	7.0	0.4	0	0	23.1	.744
		>14.74	2.0	0	0	35.7	0.2	0	0	6.0	0.8	0	0	35.7	.139

Note. Med = median; Min = minimum; Max = maximum.

*Rank-ordered by the overall mean compliance rates.

**Age groupings based on tertile splits.

[†]Weighted mean as described in Table 1.

[‡]The number and percent of boys who worked with large animals at least once during follow-up = 94/144 = 65.3%.

[§]The number and percent of girls who worked with large animals at least once during follow-up = 152/186 = 81.7%.

^{††} p value comparing boys to girls based on the exact Kolmogorov-Smirnov equality-of-distributions test.²⁶

TABLE 6. Minute-Based Work Practice Compliance Rates (%) among Participating Youth Who Worked With Large Animals, by Farm Residence Status

Figure	NAGCAT work practice*	Age** (years)	Farm-resident boys (n = 73 = 77.7%) [†]		Farm-resident girls (n = 97 = 63.8%)		Ratio of means	K-S p value [‡]	Non-farm-resident boys (n = 21 = 22.3%)		Non-farm-resident girls (n = 53 = 34.9%)		Ratio of means	K-S p value [‡]
			Mean; Med	Min; Max	Mean; Med	Min; Max			Mean; Med	Min; Max	Mean; Med	Min; Max		
1	Check for people or obstacles in the work area	All	82.8; 100	0, 100	81.8; 99.2	0, 100	1.01	.864	78.8; 100	0; 100	74.7; 97.1	0; 100	1.05	0.524
		<12.73	84.0; 98.9	3.8, 100	79.0; 95.2	2.9, 100	1.06	0.637	75.7; 96.2	0; 100	51.1; 38.3	0; 100	1.48	0.372
		12.73–14.74	81.5; 97.9	0, 100	82.3; 100	0, 100	0.99	0.385	75.8; 100	0; 100	90.0; 97.5	37.7; 100	0.84	0.816
2	Wear steel-toed, nonskid shoes	>14.74	83.5; 100	0, 100	83.9; 99.4	0, 100	1.00	0.558	97.1; 100	91.3; 100	90.4; 99.6	0; 100	1.07	0.868
		All	31.1; 0	0; 100	24.3; 0	0; 100	1.28	0.357	33.1; 2.7	0; 100	16.1; 0	0; 100	2.06	0.110
		<12.73	19.6; 0	0; 97.2	19.2; 0	0; 100	1.02	0.888	29.4; 0	0; 84.5	12.7; 0	0; 100	2.31	0.487
3	Carry a stick to guide animals	12.73–14.74	26.0; 0	0; 100	31.5; 0	0; 100	0.83	0.931	17.1; 0	0; 100	16.0; 0	0; 94.3	1.07	0.717
		>14.74	48.5; 37.3	0; 100	23.2; 2.2	0; 100	2.09	0.072	100; 100	100; 100	19.7; 0	0; 100	5.08	0.002
		All	24.1; 0	0; 100	19.5; 0	0; 100	1.24	0.206	30.9; 0	0; 100	11.9; 0	0; 100	2.60	0.040
4	Wear leather gloves	<12.73	15.4; 0	0; 93.7	21.2; 0	0; 100	0.73	0.737	28.6; 0	0; 100	11.1; 0	0; 89.9	2.58	0.487
		12.73–14.74	23.2; 0	0; 100	15.0; 0	0; 100	1.55	0.478	27.3; 0	0; 100	5.0; 0	0; 37.4	5.46	0.158
		>14.74	33.6; 28.5	0; 100	21.6; 0	0; 100	1.56	0.064	49.5; 50.0	0; 98.6	17.1; 0	0; 100	2.89	0.141
5	Use/wear a respirator	All	11.0; 0	0; 100	10.7; 0	0; 100	1.03	0.614	8.8; 0	0; 100	3.9; 0	0; 80.0	2.26	0.738
		<12.73	4.7; 0	0; 50.0	11.5; 0	0; 100	0.41	0.72	0; 0	0; 0	3.1; 0	0; 31.0	0	0.311
		12.73–14.74	9.6; 0	0; 94.4	15.0; 0	0; 100	0.64	0.452	12.2; 0	0; 100	9.3; 0	0; 80.0	1.31	0.981
5	Use/wear a respirator	>14.74	18.9; 0	0; 100	6.3; 0	0; 98.5	3	0.026	16.7; 0	0; 50.0	1.4; 0	0; 25.9	11.93	0.163
		All	0.8; 0	0; 35.7	0.3; 0	0; 9.6	2.67	0.545	0.7; 0	0; 15.0	0.2; 0	0; 7.0	3.50	0.786
		<12.73	0.0; 0	0; 0	0.4; 0	0; 9.6	0	0.367	0; 0	0; 0	0; 0	0; 0.8	—	1.000
5	Use/wear a respirator	12.73–14.74	0.8; 0	0; 23.1	0.1; 0	0; 1.8	8	1	0; 0	0; 0	0.8; 0	0; 7.0	0	0.478
		>14.74	1.6; 0	0; 35.7	0.3; 0	0; 6.0	5.33	0.852	5.0; 0	0; 15.0	0; 0	0; 0	—	0.13

Note. Med = median; Min = minimum; Max = maximum.

*Rank-ordered by the overall compliance rate (see Table 5).

**Age groupings based on fertile splits.

[†]The number and percent of farm resident boys who worked with large animals at least once during follow-up = 73/94 = 77.7%.

[‡]p value comparing girls to boys within each subgroup as estimated by the exact Kolmogorov-Smirnov equality-of-distributions test.²⁶

TABLE 7. Summary of Farm/NonFarm Comparisons*

NAGCAT work practice	Subgroup	Comparing farm-resident boys to non-farm-resident boys		Comparing farm-resident girls to non-farm-resident girls	
		Ratio of means	K-S <i>p</i> value**	Ratio of means	K-S <i>p</i> value**
Check for people or obstacles in the area	All	1.05	.836	1.10	.362
	<12.73 years	1.11	.789	1.55	.026
	12.73–14.74	1.08	.897	0.91	.271
	>14.74 years	0.86	.896	0.93	.713
Wear steel-toed, nonskid shoes	All	0.94	.770	1.51	.391
	<12.73 years	0.67	.516	1.51	.687
	12.73–14.74	1.52	.784	1.45	.236
	>14.74 years	0.49	.073	1.18	.547
Carry a stick to guide animals	All	0.78	.555	1.64	.318
	<12.73 years	0.54	.487	1.91	.747
	12.73–14.74	0.85	.817	3.00	.312
	>14.74 years	0.68	.896	1.26	.980
Wear leather gloves	All	1.25	.573	2.74	.274
	<12.73 years	—	.311	3.71	.778
	12.73–14.74	0.79	.781	1.61	.678
	>14.74 years	1.13	1.000	4.50	.281
Use/wear a respirator	All	1.14	1.000	1.50	.908
	<12.73 years	—	1.000	—	.436
	12.73–14.74	—	1.000	0.12	.080
	>14.74 years	0.32	.230	—	.525

*Based on results in Table 6.

***p* value comparing farm-resident youth to non-farm-resident youth was estimated by the exact Kolmogorov-Smirnov equality-of-distributions test.²⁶

(Table 5), with the overall mean estimated to be 0.2%. None of the youngest boys wore a respirator when working with large animals. The oldest boys exhibited the highest mean compliance rate (2.0%) for using a respirator compared to all other subgroups (Table 5). Considering farm residency status, there were no significant differences between boys and girls (Tables 6 and 7, Figure 5), except for the youngest girls when checking for obstacles in the area.

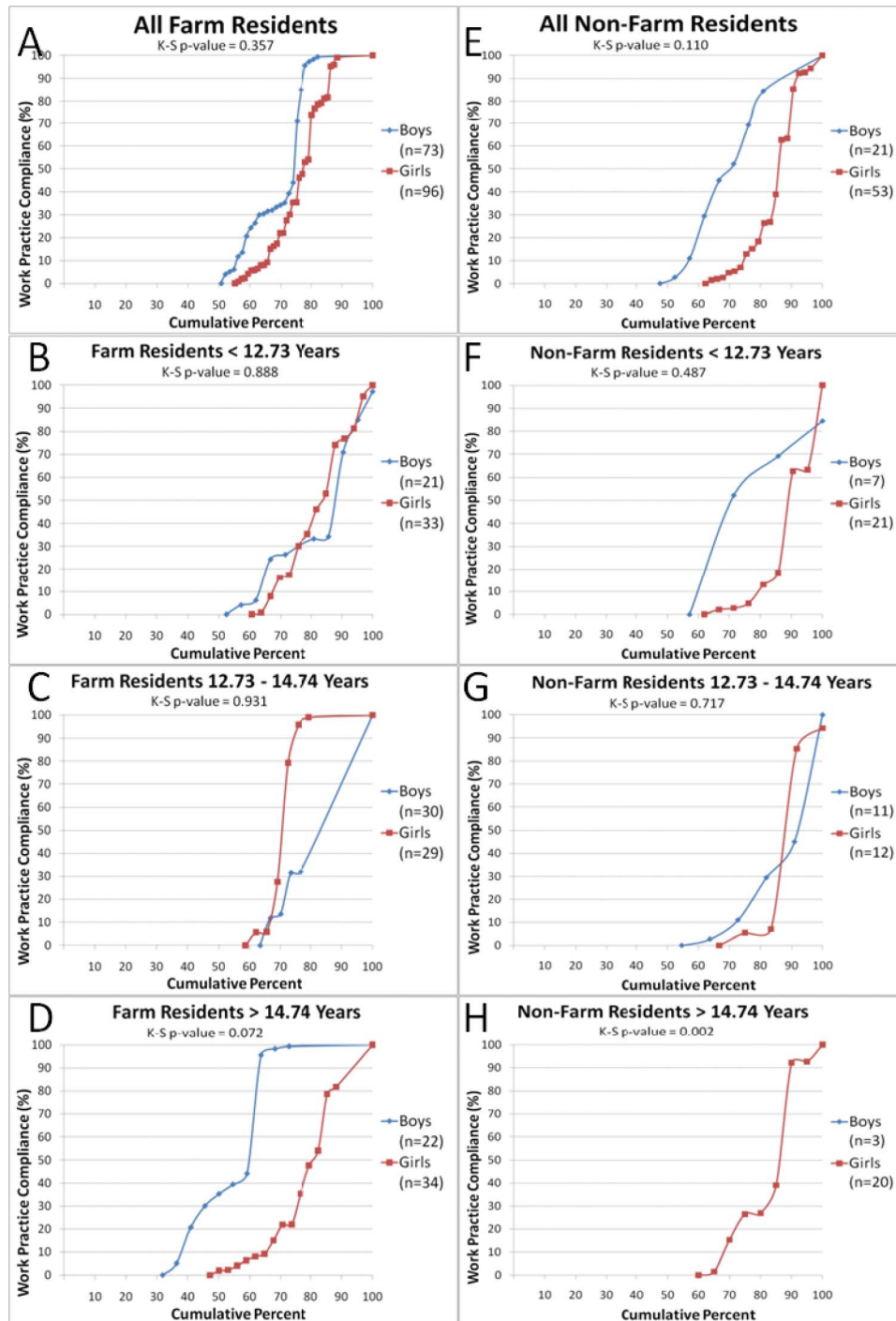
DISCUSSION

The major finding from our study is that most 4-H youth, when working with large animals, exhibited relatively low compliance with NAGCAT-recommended WPs, except checking for people and obstacles in the work area. Compared to the other WPs considered, a relatively low percentage of youth never checked

for people and obstacles. On the other hand, respirator use among the 4-H youth was found to be extremely low: greater than 90% reported never wearing a respirator when working with large animals, although it is acknowledged that we did not collect descriptive information on the working environment each time a chore was performed, except when a reportable injury occurred. Overall compliance with wearing leather gloves was found to be 9.1%, somewhat better than wearing a respirator. Carrying a stick to guide animals and wearing steel-toed nonskid shoes fell somewhere between these other WPs, although overall compliance was still found to be relatively low (mean rate 20.0% and 25.1%, respectively).

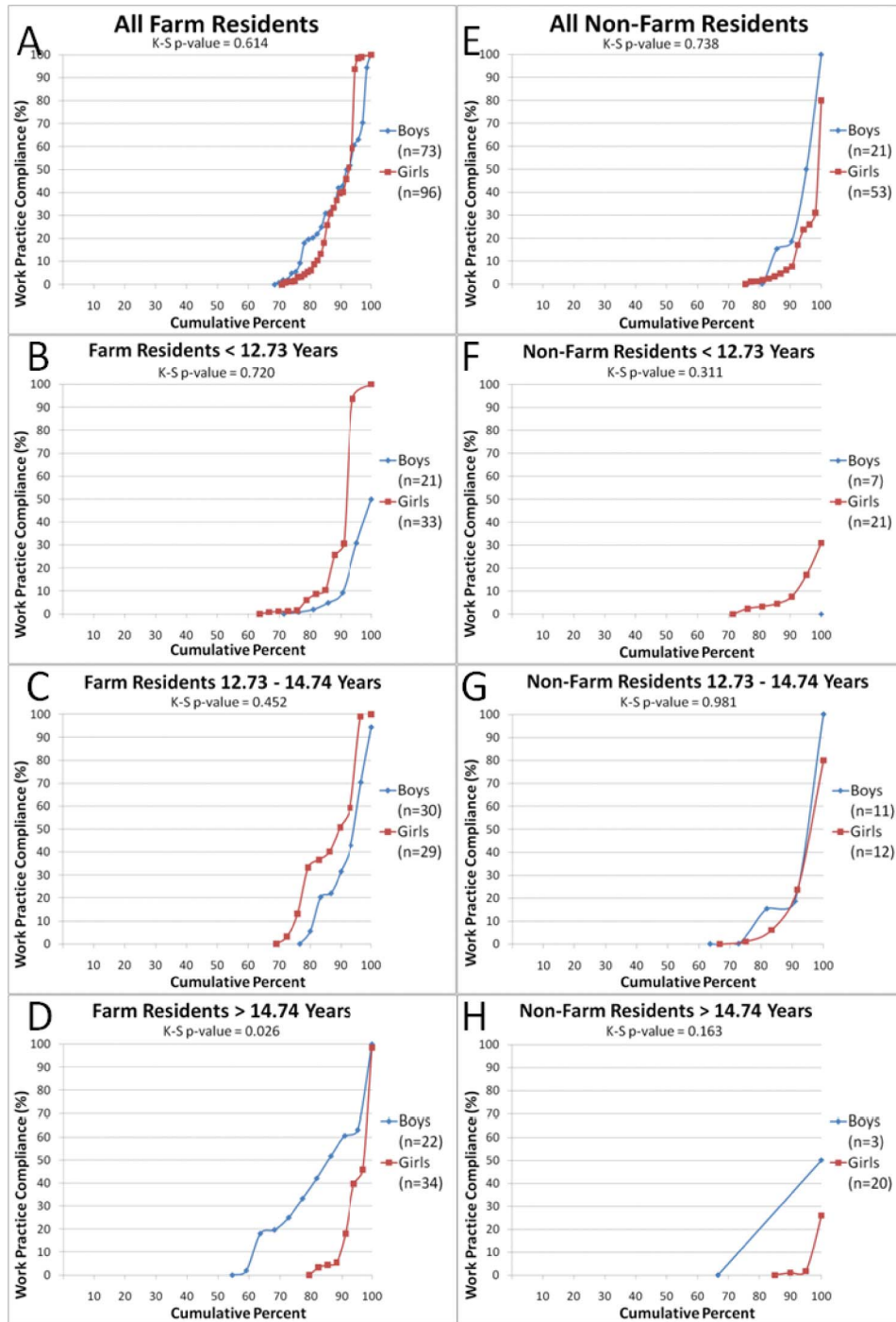
Among the oldest youth, differences between boys and girls for wearing steel-toed nonskid shoes, wearing leather gloves, and carrying a stick to guide animals were statistically significant, with boys performing these WPs more

FIGURE 1. Cumulative compliance distributions for youth who checked for people and obstacles in the area, by farm residence status. (*Girls have 3 missing values. KS = Kolmogorov-Smirnov test.) (color figure available online).



*Girls have 3 missing values
KS: Kolmogorov-Smirnov test

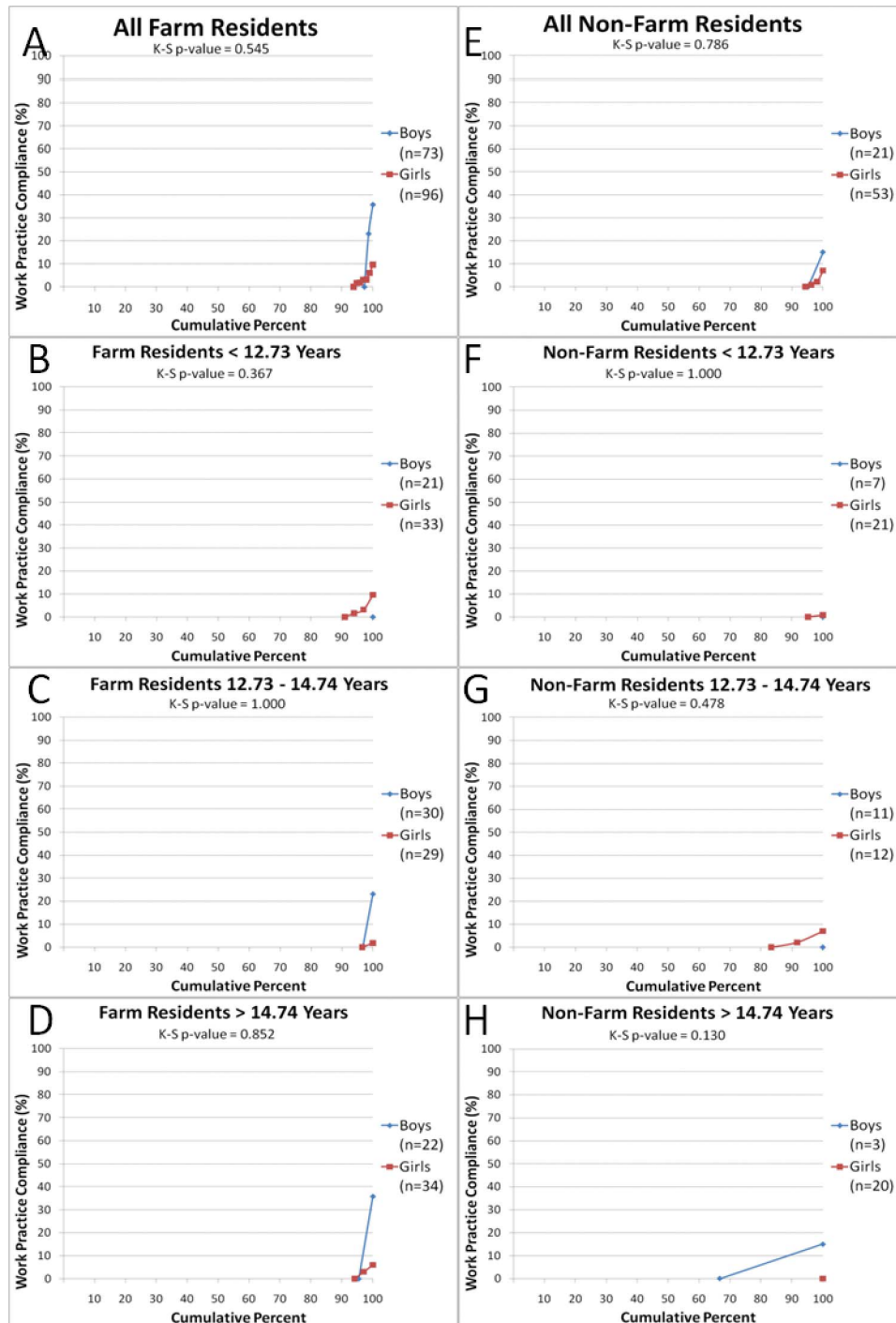
FIGURE 2. Cumulative compliance distributions for youth who wore steel-toed, nonskid shoes, by farm residence status. (*Girls have 3 missing values. KS = Kolmogorov-Smirnov test.) (color figure available online).



*Girls have 3 missing values

KS: Kolmogorov-Smirnov test

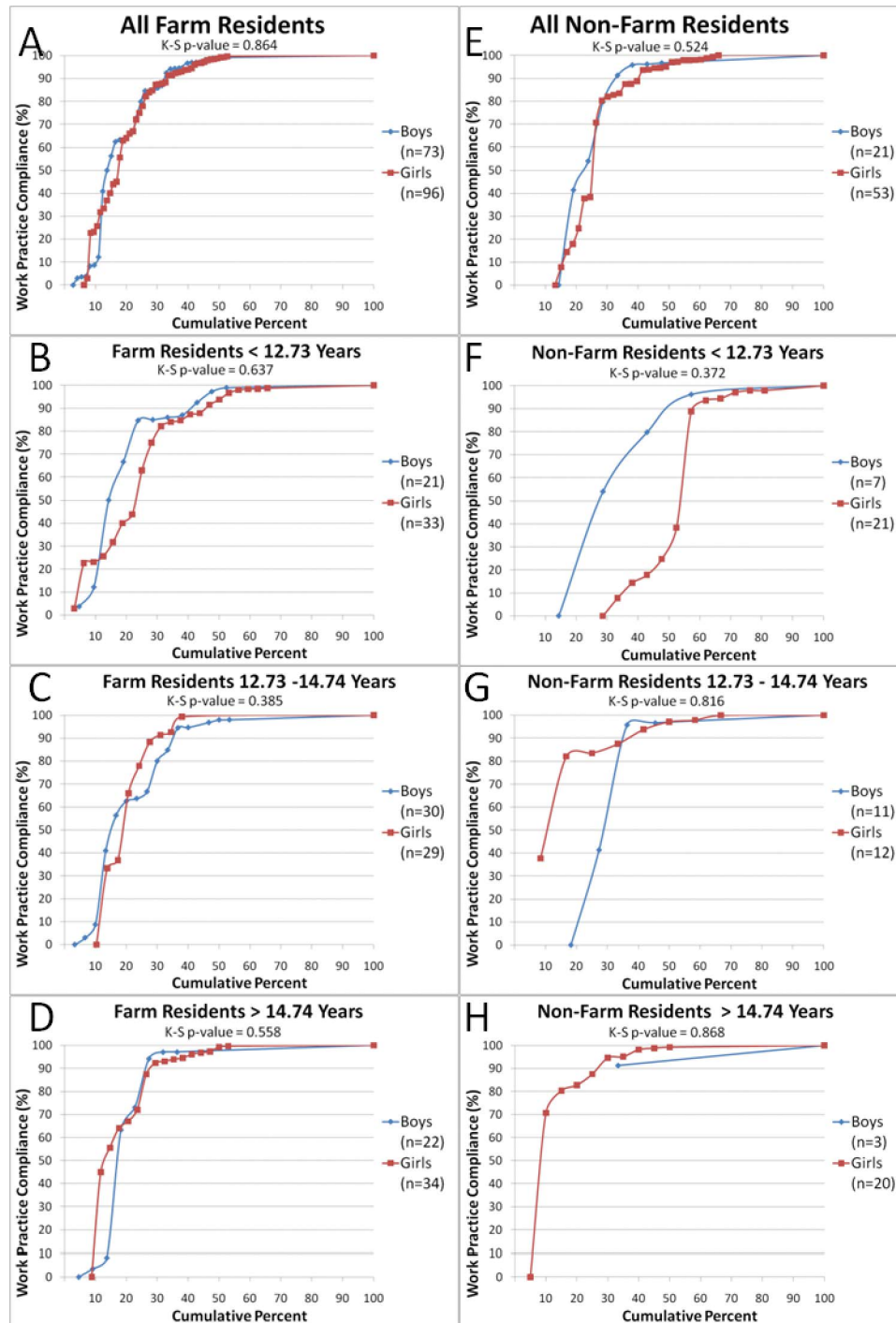
FIGURE 3. Cumulative compliance distributions for youth who carried a stick to guide animals, by farm residence status. (*Girls have 3 missing values. KS = Kolmogorov-Smirnov test.) (color figure available online).



*Girls have 3 missing values

KS: Kolmogorov-Smirnov test

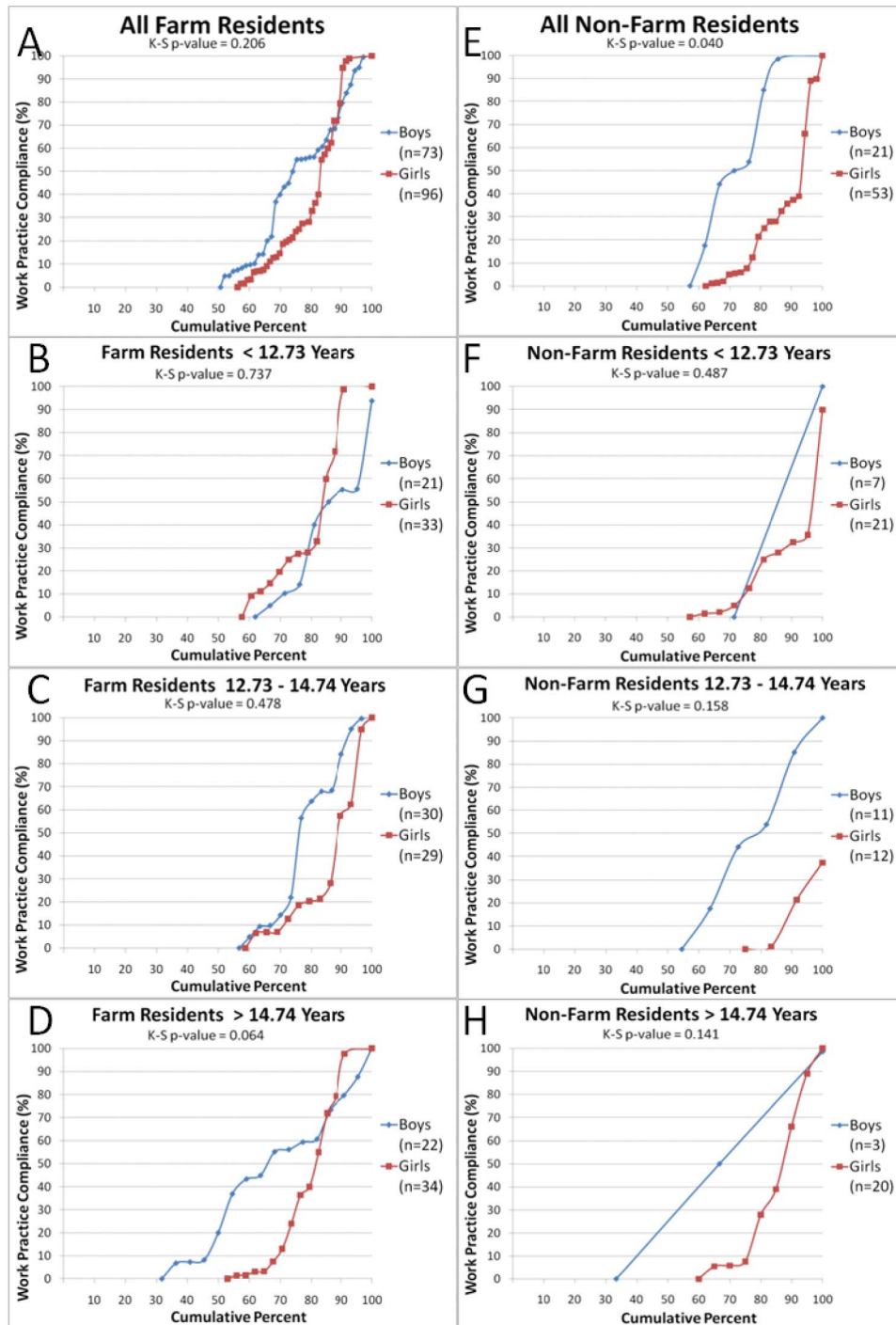
FIGURE 4. Cumulative compliance distributions for youth who wore leather gloves, by farm residence status. (*Girls have 3 missing values. KS = Kolmogorov-Smirnov test.) (color figure available online).



*Girls have 3 missing values

KS: Kolmogorov-Smirnov test

FIGURE 5. Cumulative compliance distributions for youth who used or wore a respirator, by farm residence status. (*Girls have 3 missing values. KS = Kolmogorov-Smirnov test.) (color figure available online).



*Girls have 3 missing values
KS: Kolmogorov-Smirnov test

often than girls (see Table 5). Older boys may exhibit higher compliance than girls for a number of reasons. First, boys in general, and perhaps older boys in particular, may be assigned and therefore work a different mix of chores than girls, as reported by Reed et al.²² and Buttel and Gillespie.²⁹ If one or more of the other chores requires, for example, wearing gloves or steel-toed nonskid shoes, there may be some carry-over effect from one chore to another, driven in part by differences in knowledge, attitudes, and perception between boys and girls. Further, boys in our study may have been assigned more hazardous chores than girls, a phenomenon reported by Schulman et al.,³⁰ Cohen et al.,³¹ and Marlenga et al.,³² among others. The fact that boys consistently exhibit higher rates of CAI compared to girls⁵—a phenomenon consistent with the gender-specific division of farm labor discussed by Buttel and Gillespie²⁹—may reflect lower self-protection motivation among boys, although boys in general (and older boys in particular) exhibited higher safety compliance suggesting just the opposite. It should be noted that girls experienced more exposure to large animals on average (Table 2), indicating that it may be easier to comply with recommended WPs when exposure time (i.e., chore duration) is relatively low.

When we considered farm/nonfarm residency status, we found one statistically significant difference comparing farm-resident boys and girls: wearing leather gloves among the oldest youth (exact K-S *p* value: .026 [Figure 4, panel D]). Additionally, two comparisons approached significance: carrying a stick to guide animals among the oldest youth (K-S *p* value: .064 [Figure 3, panel D]), and wearing steel-toed nonskid shoes among the oldest youth (K-S *p* value: .072 [Figure 2, panel D2]). For non-farm-resident youth, we found one statistically significant difference comparing boys to girls: wearing steel-toed nonskid shoes among the oldest youth (K-S *p* value: .002 [Figure 2, panel H]). In comparing farm residents to non-farm residents, youth who lived on farms tended to have higher compliance rates for each WP, especially among girls (Table 7).

Our WP-specific results should be interpreted with caution. First, if youth indicated

they performed a particular WP, it was assumed they engaged in the WP the entire time they were working the chore. With certain WPs, such as wearing steel-toed nonskid shoes or leather gloves, this is a reasonable assumption. However, checking for people and obstacles in the area, carrying a stick to guide animals, or using/wearing a respirator might not have been done during the entire work session or may have been done intermittently. In addition, the type of large animals youth worked with should be taken into account. Unfortunately, NAGCAT guidelines do not specify WPs based on specific species of large animals. For example, carrying a stick to guide horses is an uncommon practice. Youth who primarily work with horses will predictably exhibit lower WP compliance as a result. Girls tend to work with horses more often than boys, which could explain their relatively low compliance with respect to carrying a stick to guide animals.

Although few studies of persons exposed to agricultural hazards that focus on WP compliance or the use of personal protective equipment (PPE) have been conducted, our results are consistent with previous investigations. Carpenter et al.²¹ reported the use of safety glasses and a respirator to be rare among adult farmers working with large animals. In the same study, males were more likely than females to wear a respirator. Reed et al.²² found that males were more likely than females to use a respirator, which is consistent with our findings. Schenker et al.³³ found that when working in dusty conditions, only 24.4% of adult farmers wore a respirator for more than half the time. This study also found that men were more likely than women to wear a respirator.

Carpenter et al.²¹ also reported that steel-toed shoes and heavy gloves were used more often among Midwestern farmers than dust masks and safety glasses (the use of which was described as “rare”). Further, most of the farm workers in this study reported never wearing PPE when interacting with large animals. Based on this study, it appears that the use of PPE by adult farm workers could be characterized as low, which in general agrees with our findings.

The reasons for engaging (or not engaging) in safety practices vary widely. In our study, it is

unclear why certain subgroups of youth always performed one or more WPs whereas others never did. According to Carpenter et al.,²¹ farmers tend to base their decisions regarding use of PPE on wanting to avoid injury, health problems, and hazardous exposures. Reed et al.²² argued that children, like adults, are more likely to use PPE if they have experienced adverse health outcomes in the past, such as a traumatic injury. This assumption was partly supported by our observation that boys engaged in safety practices more often than girls, a fact consistent with the higher injury rates usually seen among boys compared to girls in most studies.

Another factor affecting the likelihood of engaging in appropriate safety behaviors is access to the appropriate PPE, which is usually determined by parents and/or other caregivers. Checking for people and obstacles in the area when working with large animals does not require much effort, and this is probably at least a partial explanation for the relatively high WP compliance rate we observed. Compared to other chores, youth might feel more strongly that this is expected for any number of reasons, which might have influenced their DRB responses.

We can point out several strengths to our study. First, there was good participation among those who agreed to participate, although the overall response rate was poor. Additionally, the study was longitudinal in nature: participants were expected to provide daily data for 10 weeks. As shown in Table 2, our results are based on more than 5900 cumulative hours of exposure to large animals. These data include potentially important control variables and detailed information on injuries, chores, and work practices.

Limitations of our study should also be acknowledged. First, in some instances, the chore-specific sample size yielded sparse data, possibly limiting the informativeness of the results. Another potential limitation is the assumption of performing a WP the entire time youth were working with large animals. The impact of this assumption is likely the overstatement of the magnitude of the compliance rate numerator, resulting in overestimation of the rate itself. Arguably, this may have had the

greatest impact on the results regarding checking for people and obstacles in the area. It may have been more informative to ask participating youth to report how long they performed each WP during each chore session, but this was not reasonable due to respondent burden issues. Third, the response rates, however calculated, are admittedly low. However, sample youth were similar to all (presumably eligible) 4-H youth in the nine study counties with respect to sex, ethnicity, race, and age (although sample youth were approximately 12 months older, on average). Finally, the definition of "large animal" in NAGCAT is somewhat ambiguous (horses, cattle, emu, llama, ostrich, etc.), raising concern about the exact distribution of "large animals" worked by girls compared to boys, or by younger youth compared to older youth. For example, as previously noted, girls are more likely to work with horses than boys.

Our study raises questions worthy of future investigation. Future research should include an in-depth assessment of the reasons why certain youth were in compliance with some of the WPs all of the time, whereas others were never in compliance. Understanding the characteristics associated with compliance beyond sex and age could potentially inform future interventions. Investigating the role of adult supervision among youth working on farms is another area of interest. It is known that adult supervision occurs at varying levels of intensity based on the age of the child. How this level of supervision explains WP compliance needs to be studied. Youth who are supervised at any level might exhibit different WP compliance compared to those who are not supervised at all. Again, understanding this relationship may help tailor interventions so they are more effective. Access to PPE and other safety measures should also be investigated. If youth are not performing recommended work practices simply because they do not have access to the appropriate PPE, then this would affect the intervention approach. Determining if there are differences between boys and girls regarding access to safety equipment/PPE also needs to be addressed. Because boys perform certain chores more often than do girls, they might have more access to the appropriate PPE. Additionally,

compliance with the relevant WPs and their relation to injury rates should be investigated to determine if compliance reduces the risk of injury among youth living and/or working in agricultural environments.

Our study adds to the current knowledge about safety behaviors among youth exposed to agricultural hazards. Our study indicates that, in general, youth are not in compliance with WPs recommended by NAGCAT when working with large animals. In addition, we found gender differences in WP compliance rates, especially among older youth. It could be argued that girls in this subgroup need to be made more aware of the appropriate safety behaviors when working with large animals. The results from this study can hopefully be used to help tailor future interventions to increase WP compliance among youth living and/or working on farms, which, ultimately can reduce the risk of CAI.

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