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Assignment of Work Involving Farm Tractors to Children on North American Farms

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Background *Children are at high risk for tractor-related injury. The North American Guidelines for Children's Agricultural Tasks (NAGCAT) provide recommendations for the assignment of tractor work. This analysis describes tractor-related jobs assigned to farm children and compares them to NAGCAT.*
Methods *A descriptive analysis was conducted of baseline data collected by telephone interview during a randomized, controlled trial.*
Results *The study population consisted of 1,138 children who worked on 498 North American farms. A total of 2,389 farm jobs were reported and 456 (19.1%) involved operation of farm tractors. Leading types of tractor jobs were identified. Modest, yet important, percentages of children were assigned tractor work before the minimum ages recommended by NAGCAT.*
Conclusions *Children on farms are involved in tractor work at a young age and some are involved in jobs that they are unlikely to have the developmental abilities to perform. NAGCAT is a new parental resource that can be applied to these work situations.* Am. J. Ind. Med. 40:15–22, 2001. *© 2001 Wiley-Liss, Inc.*

KEY WORDS: agriculture; farm; children; injury; tractor; guidelines; work

INTRODUCTION

Farm injuries are an important source of death and morbidity among North American children [Rivara, 1997; Canadian Agricultural Injury Surveillance Program, 1999; Castillo et al., 1999; Hard et al., 1999; Pickett et al., 1999]. In order to develop effective approaches to the prevention of these injuries, it is helpful to understand common occupational exposures experienced by children within the farm work environment. Efforts have taken place to develop systems for the surveillance of farm injuries and their sequelae, and descriptive studies of childhood farm injury have been performed. However, less attention has been paid to the work exposures that may lead to trauma on farms.

During the past several years, there has been a rising interest in issues pertaining to the health of agricultural populations. With respect to injury, a fundamental question is whether farm parents assign jobs that are appropriate for the ages and levels of development of children. In response to this issue, Lee and Marlenga [1999] embarked on a multistage project to develop work guidelines for children who are involved in farm work. The first edition of the *North American Guidelines for Children's Agricultural Tasks* (NAGCAT) was released in June 1999 and is currently undergoing field testing and formal evaluation. The safe operation of farm tractors in different work situations is heavily emphasized in NAGCAT because of the high frequency of tractor involvement in fatal and other traumatic farm injuries [Lee and Marlenga, 1999].

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If appropriately disseminated, NAGCAT may become an important new resource to be used in the prevention of traumatic farm injuries. In light of this, our research group had the opportunity to evaluate an enhanced approach to their dissemination. This involved the conduct of a multi-site randomized, controlled trial with a diverse sample of North American farms. During the baseline interviews of this trial, parents were surveyed about children 7–16 years who worked on their farm and were asked to list the two most common jobs performed by each child between May and August. Many jobs reported as being common involved the operation of farm tractors.

The tractor exposure data were analyzed with the objectives of (1) specifying the tractor jobs to which these children are assigned and (2) comparing this job assignment to the recommendations contained in NAGCAT. Our hope was that this information would contribute to the prevention of farm injuries by providing empirical data about the ages at which children are commonly involved in farm tractor work, the nature of these jobs, and the extent to which farm parents are making choices that are consistent with NAGCAT.

METHODS

Sampling Frame

The farms and children under study were from the United States and Canada. Representatives from these farms had volunteered to participate in the randomized, controlled trial, and data for the present analysis came from its baseline interview. Eligibility criteria were as follows: (1) the farm had at least one child aged 7–16 years (age span covered by NAGCAT) working on the farm, (2) a parent who makes decisions about work assignments for children had agreed to be interviewed by telephone, (3) this person was conversant in English, and (4) he/she provided informed consent according to institutional requirements. The trial itself was designed to test the efficacy of an enhanced dissemination strategy to increase the likelihood of adoption of NAGCAT.

In the United States, samples of farms were selected from the roster of the United States Department of Agriculture's master sampling frame. These farms were limited to those that had participated in a 1998 national agricultural injury survey [United States Department of Agriculture, 1999] and had children in the eligible age range at that time. A total of 1,873 farms from mid-western states and 1,689 western states were potentially eligible, and farm representatives from all 3,562 farms were sent a letter of invitation. Those who returned a signed letter indicating willingness to participate and found to have eligible children were enrolled in the study. Participants from the US included farm representatives from 11 western ($n = 115$ farms) and 12 mid-western states ($n = 169$). Participating farms could be compared to the overall sample frame with respect to location, acreage, and primary commodity, and were found to be quite representative (data not shown), although dairy operations were somewhat over-represented in the mid-western sample (23% vs. 13%).

In Ontario, Canada, farms were identified from two sources: the Central Farm Registrar maintained by Statistics Canada [Statistics Canada, 1997] and a commercially available farm mailing list [The APC Farming Database, 1999]. A total of 2,500 farms from the Central Farm Registrar and 1,275 farms from the APC Farming Database were sent a letter of invitation. Representatives from 214 Ontario farms responded to our invitation to participate by signing and returning a postcard to the investigators and were enrolled in the study. Participating farms were compared to the Census of Agriculture and were found to be representative geographically by region; however, dairy operations and larger farms were over-represented (data not shown). The total study enrollment included 498 farms, 284 (57%) from the US and 214 (43%) from Ontario, with geographic distribution as shown in Figure 1.

All farmers received a telephone call at which time eligibility was confirmed, verbal consent was sought, and the baseline interview was conducted. Data collected included characteristics of the farm and children who worked there. Farm-related variables included the primary commodity produced, the working status of the farm (full-time, part-time, hobby), and the geographic location. Characteristics of farm children included the age and gender of each working child in the 7–16 year age range. In addition, respondents were asked to name up to two jobs that each child "most commonly performed between May and August." The latter were collected using an open-ended format that allowed subsequent division of these farm jobs into specific categories of farm work.

The NAGCAT Tractor Matrix

Members of the NAGCAT project team developed a matrix that summarized minimum ages recommended for the involvement of children in farm tractor work (Table I). The ages were arrived at by consensus and were specific to different tractor jobs. A variety of issues were considered during this process including: developmental characteristics of children in different age groups, patterns of childhood farm injury in the United States and Canada, and the relative level of hazards associated with various farm tractor operations [Lee and Marlenga, 1999].

Classification of Work Involving Farm Tractors

A composite list of jobs that were assigned to farm children was developed. These jobs were classified

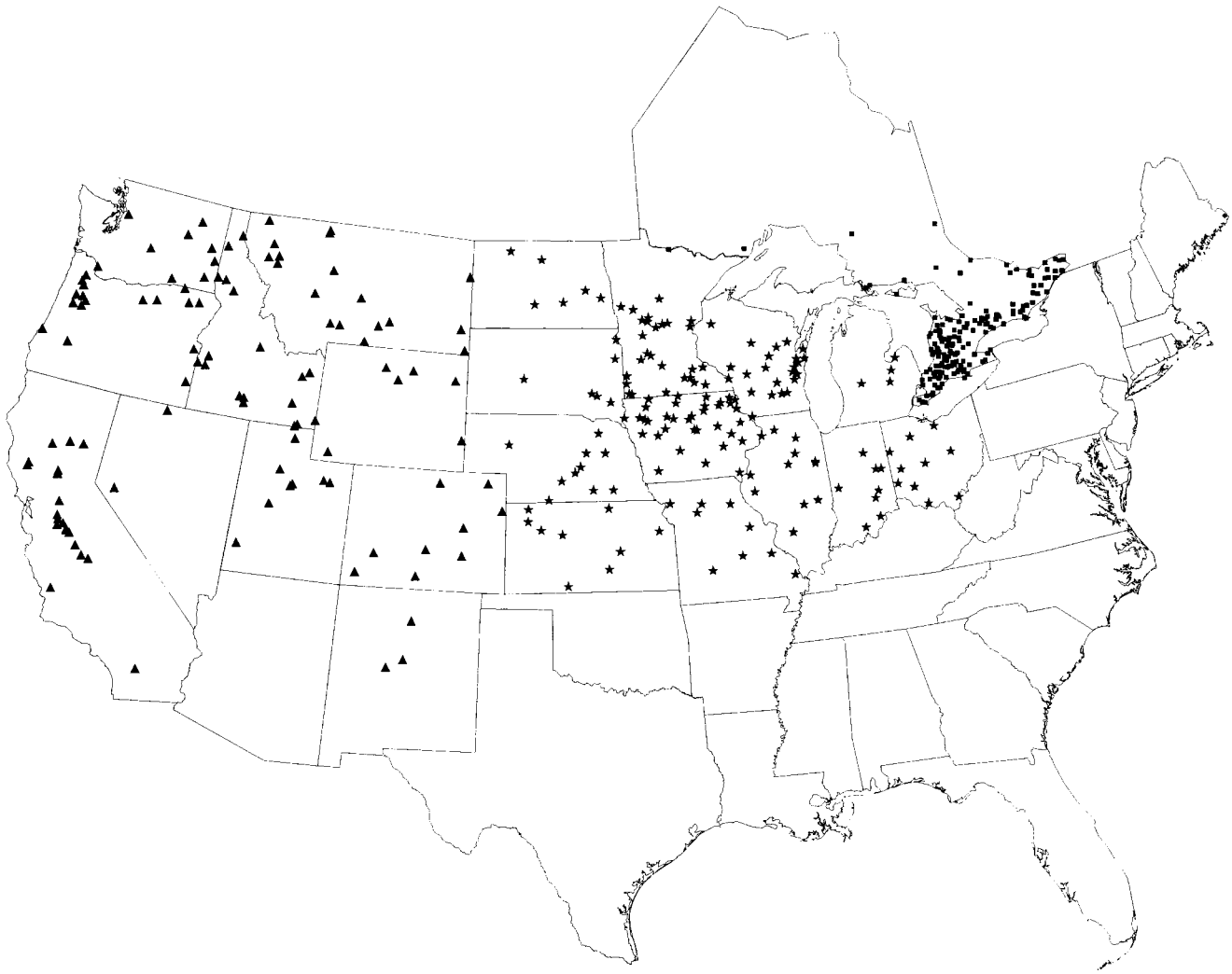

FIGURE 1. Geographic distribution of study farms by region. ▲ – Western U.S., ★ – Mid-Western U.S., ■ – Ontario. One farm from Hawaii not shown.

according to a new coding system for children's agricultural jobs (the Marshfield classification [Marlenga et al., unpublished]). Records of jobs that involved use of a farm tractor were compiled into a separate list. These included jobs associated with conventional farm tractors and lawn/garden tractors (note: many of the latter involved work that was clearly related to the farm operation [e.g. cutting around fences, farm buildings], and was reported as such by the farm representatives). Eight categories of tractor work were established ranging in complexity from simple tractor operations (e.g. no implements attached) to more complex applications and fieldwork (e.g. fieldwork with power takeoff-driven implements).

Analysis

Descriptive analyses were employed to characterize the study farms by commodity, self-reported working status of the farm operation, and North American region. The distribution of eligible children on these farms was described by age group and gender. Rates of performance of the farm tractor jobs by children were summarized for each of the three study regions by gender and within each age group. Multiple logistic regression models were used to examine the potential association of gender with the performance of the most commonly reported farm tractor jobs (i.e. those with sufficient numbers of observations from which to develop a stable model) with adjustment for age, commodity, and region. These models used generalized estimating equations [Liang and Zeger, 1986] to allow for correlation among children from the same farm. Finally, percentages of children performing farm tractor jobs at ages lower than the most conservative ages recommended by NAGCAT were calculated, as were percentages performing farm jobs among all children less than the recommended ages. Associated 95% confidence intervals were computed

TABLE I. Chart Describing Recommended Ages (in Years) for Involvement of Farm Children in the Operation of Farm Tractors[a]

	Size of tractor			
Farm tractor jobs (in order by increasing level of complexity)	**Lawn/garden ≤20 hp**	**Small > 20 hp < 70 hp**	**Medium/large > 70 hp**	**Articulated**
Operating a farm tractor (no implements attached)	12–13	12–13	14–15	16+
Fieldwork with trailed implements[b]	12–13	12–13	14–15	16+
Fieldwork with 3-point implements[c]	12–13	14–15	14–15	16+
Fieldwork with remote hydraulics	14–15	14–15	14–15	16+
Fieldwork with PTO-powered implements[d]	14–15	14–15	14–15	16+
Using a tractor-mounted front-end loader	14–15	16+	16+	16+
Working in an orchard	14–15	16+	16+	16+
Working inside buildings	14–15	16+	16+	16+
Driving on public roads	Local law	16+	16+	16+
Pulling oversize or overweight load	Due to increased hazard and complexity, these jobs should not be assigned to children			
Hitching tractor to move stuck/immovable objects				
Simultaneous use of multiple vehicles				
Additional persons working on a trailing implement				
Pesticide or anhydrous ammonia application				

[a]Source: North American Guidelines for Children's Agricultural Tasks [Lee and Marlenga, 1999]; reproduced with permission. This guideline also recommends the following: children should only operate wide-front tractors equipped with ROPS and seatbelts. An adult should ensure that the child can reach all controls while wearing a seatbelt, that a pre-operations service check has been completed, and that no extra riders are allowed on the tractor. This guideline assumes that the child will be operating the tractor in daylight, under dry conditions, not on a steep slope and with reasonable distance from ditches, trees, and fences.

[b]Trailed implement: implement that attaches to the rear of a tractor by means of a drawbar and is usually equipped with wheels for transport.

[c]3-point implement: implement that attaches to the rear of a tractor by means of a three point hook-up system which functions by hydraulic lift.

[d]PTO-powered implement: implement that attaches to the external shaft on the rear of the tractor by means of a driveline and receives rotational power directly from the tractor.

with robust standard errors from logistic regression models using generalized estimating equations. All analyses were conducted in SAS® [SAS Institute Inc., 1997].

RESULTS

Table II provides a description of the study sample. Four hundred and ninety-eight farms participated in the study and a total of 1,138 children (aged 7–16 years) worked on these farms. The primary commodities produced on these farms were grain, dairy, and ''other livestock.'' The majority of these farms were operated on a full-time basis. Table II also provides the distribution of the farm children by age group, gender, and resident status. The median acreage of the farms was 300 (range 2–30,000) acres.

A total of 2,389 jobs were reported for the 1,138 children (note: more than two jobs were reported for some children). Of these, 1,059 (44.3%) involved animal care, 598 (25.0%) were crop management activities, 456 (19.1%) involved the operation of farm tractors (including lawn/garden tractor operation), 94 (3.9%) involved other equipment operation, 112 (4.7%) were farm maintenance activities, and 70 (2.9%) were other farm jobs.

A total of 360 children worked at least one farm tractor job. Table III describes the jobs performed by these children in the different North American study regions. Leading types of farm tractor work included fieldwork with trailed implements, operation of lawn/garden tractors, and fieldwork with implements powered by power takeoff (PTO) devices. It was not possible to do regional comparisons due to apparent differences in interviewer probing at the data collection sites.

The distribution of farm tractor work is further described in Table IV by age group and gender. This shows that some children operate tractors in field settings by 12–13 years of age. It also provides some indication of the differential assignment of work to males and females on farms. Males were more likely than females to be assigned to fieldwork with PTO-powered implements ($P < 0.001$), 3-point implements ($P = 0.007$), trailed implements ($P < 0.001$), and similarly likely to be assigned to the operation of riding lawn tractors ($P = 0.23$).

Table V compares the observed ages of children involved in different farm tractor operations with the most conservative age range recommended by NAGCAT. Among the sub-population of children performing tractor farm jobs,

TABLE II. Description of Study Sample

	Total	
Factor	**n**	**%**
Farms	498	100
Primary commodity group		
Dairy	119	23.9
Hogs	31	6.2
Other livestock	115	23.1
Poultry	10	2.0
Grain	121	24.3
Other field crops	39	7.8
Fruit	21	4.2
Vegetables	9	1.8
Other	33	6.6
Working status of farm operation		
Full-time	382	76.7
Part-time	93	18.7
Hobby	23	4.6
Region of North America		
Ontario	214	43.0
Western USA	115	23.1
Mid-Western USA	169	33.9
Farm children (7–16 years)	1138	100
Resident status		
Resident	1004	88.2
Non-resident	134	11.8
Age (years)		
7–9	234	20.6
10–11	222	19.5
12–13	247	21.7
14–15	292	25.7
16	143	12.6
Gender		
Male	670	58.9
Female	468	41.1

modest to high percentages (8.5–37.0%) of these children are below the recommended age levels (Table V, center column). Among all children who are less than the recommended age ranges (which varies by tractor task), relatively low percentages (0.1–8.5%) of children are commonly assigned to tractor work (Table V, right most column).

DISCUSSION

This study involved a secondary analysis of data compiled during a study of North American farmers with children. Its objectives were to identify common tractor work to which these children are assigned and to compare these to recommendations contained in NAGCAT. The percentages of children reported to work with farm tractors before the age of 12 and the number of children who were involved in tractor work at ages earlier than the recommendations of NAGCAT were modest, but represent an important exposure given the potential for serious injury and death. Also notable were the differences in tractor work assigned to boys and girls on farms.

Common patterns of childhood injury associated with the operation of farm tractors have been documented. Clearly, the male domination of trauma statistics is in part attributable to the differential involvement of boys and girls in farm tractor work. Our data confirm the anecdotal observation that important proportions of young male farm children are assigned tractor-related work. This work is not limited to simple tractor operations under controlled conditions, but involves farm jobs that require the use of PTO devices, 3-point, and other trailed implements. Female children are sometimes assigned to similar jobs, however, their use of tractors is relatively infrequent when compared with their male counterparts.

When the recommendations contained in NAGCAT [Lee and Marlenga, 1999] are applied to the present work descriptions, it is also evident that farm children are sometimes engaged in tractor work that is beyond their developmental abilities. These abilities may include the physical (e.g. strength, reach), cognitive (e.g. hazard recognition, problem solving skills), and psychosocial attributes (e.g. minimization of impulsive or risk-taking behavior) requisite for job performance [Clark, 1994].

There are a variety of reasons why farm children are involved in tractor work at an early stage in life. Farm families generally value the role of work as a fundamental means of character development including the development of responsible work habits [White and Brinkerhoff, 1981; Lee et al., 1997]. Psychologists have described these types of cultures as being ''individualistic'' as opposed to ''collective'' in that members of the farming community are almost universally expected to look after themselves and their immediate family. They also place strong value on individual action, verbal assertion, and standing up for rights [White and Brinkerhoff, 1981; Kelsey, 1994]. On farms, this is reflected in the inherent value placed upon a strong work ethic, the development of responsibility at an early age, and the assertion of family independence in making choices about childhood involvement in work.

Other reasons why farm parents assign tractor work to children include the economic requirement or perceived requirement for all family members to become involved in sustaining the farm operation. Family farms throughout the world have traditionally relied on the availability of people of all ages to perform work, and there is a common

TABLE III. Common Farm Tractor Work Performed by Children 7–16 Years by North American Study Region[a]

Description	Number (percentage of children in region)			
	Ontario, Canada (n = 541)	Mid-Western USA (n = 354)	Western USA (n = 243)	Total (n = 1138)
Tractor operation				
No implement attached	2 (0.4)	0 (0.0)	0 (0.0)	2 (0.2)
Lawn mower operation: riding	83 (15.3)	9 (2.5)	10 (4.1)	102 (9.0)
Fieldwork with trailed implements	82 (15.2)	35 (9.9)	22 (9.1)	139 (12.2)
Fieldwork with 3-point implements	28 (5.2)	14 (4.0)	5 (2.1)	47 (4.1)
Fieldwork with remote hydraulics	5 (0.9)	7 (2.0)	9 (3.7)	21 (1.8)
Fieldwork with PTO-powered implements	42 (7.8)	20 (5.6)	13 (5.3)	75 (6.6)
Using a tractor-mounted front-end loader	3 (0.6)	5 (1.4)	1 (0.4)	9 (0.8)
Tractor operation with unspecified implements	5 (0.9)	43 (12.1)	13 (5.3)	61 (5.4)

[a]Multiple tractor jobs were reported for individual children in some circumstances.

expectation that children will play an occupational role. This becomes more and more apparent as children grow and enter their teenage years [White and Brinkerhoff, 1981], a finding that was reinforced by our age-related analyses. It is also common for young people to have earlier expectations than their parents with respect to when they are ready to perform different jobs and work roles [Dekovic et al., 1997]. By their very nature, children are experimentalists who seek new experiences in order to grow. In addition, a child's attitude [Dekovic et al., 1997] and appearance [Zebrowitz et al., 1991] may have a profound impact on how others view the child and their level of maturity. Farm children and their parents may consequently overestimate what jobs can be safely performed, especially in work situations where the child has no experience.

While the present analysis was based on a large and geographically diverse sample of farms, limitations of this analysis must be recognized. First, the farm sample consisted of voluntary participants in a randomized trial and their reported experience may not represent that of the general farm population. Because these farmers agreed to participate in this safety research, they may be more conscious of safety issues than others and the reported involvement of their children in the operation of tractors may be lower than societal norms. Second, the reports lacked detail about the exact circumstances under which

TABLE IV. Common Farm Tractor Work Performed by Children Aged 7–16 Years by Age and Gender[a]

Description	Number (percentage of children in age/gender group)									
	7–9		10–11		12–13		14–15		16	
	M (n = 133)	F (n = 101)	M (n = 123)	F (n = 99)	M (n = 142)	F (n = 105)	M (n = 178)	F (n = 114)	M (n = 94)	F (n = 49)
Tractor operation										
No implements attached	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.0)	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)
Lawn mower operation: riding	6 (4.5)	2 (2.0)	17 (13.8)	14 (14.1)	15 (10.6)	11 (10.5)	11 (6.2)	11 (9.6)	8 (8.5)	7 (14.3)
Fieldwork with trailed implements	5 (3.8)	1 (1.0)	5 (4.1)	5 (5.1)	25 (17.6)	4 (3.8)	47 (26.4)	12 (10.5)	26 (27.7)	9 (18.4)
Fieldwork with 3-point implements	1 (0.8)	0 (0.0)	1 (0.8)	3 (3.0)	9 (6.3)	0 (0.0)	14 (7.9)	4 (3.5)	14 (14.9)	1 (2.0)
Fieldwork with remote hydraulics	0 (0.0)	0 (0.0)	2 (1.6)	0 (0.0)	1 (0.7)	0 (0.0)	7 (3.9)	3 (2.6)	6 (6.4)	2 (4.1)
Fieldwork with PTO-powered implements	0 (0.0)	0 (0.0)	2 (1.6)	1 (1.0)	12 (8.5)	3 (2.9)	26 (14.6)	7 (6.1)	20 (21.3)	4 (8.2)
Using a tractor-mounted front-end loader	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.7)	0 (0.0)	5 (2.8)	1 (0.9)	2 (2.1)	0 (0.0)
Tractor operation with unspecified implements	2 (1.5)	1 (1.0)	5 (4.1)	0 (0.0)	12 (8.5)	1 (1.0)	22 (12.4)	4 (3.5)	13 (13.8)	1 (2.0)

[a]Multiple tractor jobs were reported for individual children in some circumstances.

TABLE V. Comparison of NAGCAT Age Recommendations for Various Tractor Operations With Ages Reported in a Voluntary Sample of North American Farms

Farm tractor jobs (in order by increasing level of complexity)	Most conservative age range recommended by NAGCAT	Total children performing task	% of total children performing task < recommended age % (95% CI)	Total children < recommended age	% performing task among all children < recommended age % (95% CI)
Tractor operation	12–13	104	37.0 (27.6–47.6)	456	8.5 (6.0–12.0)
No implements attached					
Lawn mower operation: riding					
Fieldwork with trailed implements	12–13	139	11.2 (6.8–17.8)	456	3.6 (2.1–5.9)
Fieldwork with 3-point implements	12–13	47	8.5 (3.2–21.1)	456	1.0 (0.4–2.7)
Fieldwork with remote hydraulics	14–15	21	14.7 (4.8–37.2)	703	0.4 (0.1–1.3)
Fieldwork with PTO-powered implements	14–15	75	24.0 (15.7–34.9)	703	2.6 (1.6–4.2)
Using a tractor-mounted front-end loader	14–15	9	11.1 (1.5–50.0)	703	0.1 (0.0–1.0)

tractor operation took place and the degree of hazard imposed on the child. Third, these data do not provide a complete inventory of childhood exposures to farm tractor work. Participating farmers were asked to report up to two jobs that each child ''most commonly performed between May and August.'' The list was not exhaustive, was based upon self-reports, and was undoubtedly affected by the time of recall of work exposures, which may be differential by site (interviews were conducted between April and December 1999, depending upon study site). Further, even though children may be engaged in tractor operations, tractor operation may not be reported as a common farm job by parents. Therefore, our data may under-represent the number of children who are actually operating tractors, thus under-representing important exposures. Finally, the study was conducted in the geographic regions described in Figure 1 and the findings may not apply to other regions.

Implications

The analyses presented here provide clear evidence that children on farms are involved in tractor work at a young age and that many are involved in jobs that they are unlikely to have the developmental abilities to perform. The work exposures observed are consistent with the types of activity that are commonly associated with traumatic injury on farms. The prevention of these injuries will ultimately require that these hazardous exposures are minimized. Potential solutions include the introduction of minimum age requirements for farm tractor use, manufacturing and engineering changes implemented to make farm tractors safer, and education aimed at minimizing unsafe work practices. Past attempts to introduce agricultural health and safety legislation in North America have, however, been actively opposed by the industry [Kelsey, 1994], leaving the latter two options as the more viable solutions.

The NAGCAT guideline for tractor operation (Table I) provides one alternative to enforced regulation on farms. When applied in a systematic manner, NAGCAT has the potential to help farmers and other responsible adults to minimize risks to working farm children. Adult responsibilities, requisite precautions for a safe work environment, and developmental requirements for task completion are provided within NAGCAT. Finally, the philosophy that underpins the NAGCAT initiative, given that children are going to work on farms, is that those responsible for work assignments must have a knowledge base from which they can make informed decisions. This philosophy is consistent with that espoused by the agricultural industry. If appropriately disseminated, NAGCAT may become an important new resource to be used in the prevention of traumatic farm injuries.

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