

Parental Knowledge of Child Development and the Assignment of Tractor Work to Children

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ABSTRACT. *Objectives.* Many childhood farm tractor injuries occur during the performance of work that was assigned by parents, and some tractor work is beyond the developmental capabilities of children. This has been highlighted recently by a policy statement authored by the American Academy of Pediatrics. The objective of this study was 1) to assess child development knowledge of farm parents who received a new resource, the North American Guidelines for Children's Agricultural Tasks (NAGCAT), and 2) to determine whether this knowledge was associated with use of NAGCAT in the assignment of tractor jobs and with compliance with 2 aspects of the NAGCAT tractor guideline.

Methods. Secondary analysis of data collected during a randomized controlled trial that involved 450 farms in the United States and Canada was conducted. Variables assessed included 1) parental knowledge of child development across several age groups and 3 domains of child development (physical, cognitive, and psychosocial), 2) documentation of the most common tractor jobs assigned to each child, and 3) a report of whether NAGCAT was used in assigning these tractor jobs.

Results. High parental knowledge of child development was associated with enhanced use of NAGCAT and fewer violations when assigning tractor work to children. However, even in the presence of high knowledge, some farm parents still assigned to their children work that was in violation of NAGCAT.

Conclusions. Educational interventions by themselves are not sufficient to remove many farm children from known occupational hazards. These findings are discussed in light of the recent policy statement on agricultural injuries from the American Academy of Pediatrics. *Pediatrics* 2003;112:e11–e16. URL: <http://www.pediatrics.org/cgi/content/full/112/1/e11>; *child development, child, agriculture, wounds and injuries, rural population, knowledge, attitudes, practice, parenting, safety.*

ABBREVIATIONS. AAP, American Academy of Pediatrics; NAGCAT, North American Guidelines for Children's Agricultural Tasks; PTO, power take-off; ROPS, rollover protection structure.

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Childhood farm injuries are an important injury control problem and remain a priority for prevention. The recent policy statement by the American Academy of Pediatrics (AAP), Prevention of Agricultural Injuries Among Children and Adolescents, summarizes the scope of the pediatric farm injury problem, identifies the need for continuing and improved injury control strategies on farms, and provides recommendations for pediatricians. The recommendations for pediatricians address the need for patient and community education as well as public advocacy related to agricultural injury prevention in childhood and adolescence.¹ Specific injury prevention strategies that are proposed include the need for physicians to educate parents about normal growth and development of children and to encourage them to consider this information when making decisions about a child's readiness for work. The statement also describes legislative alternatives surrounding the operation of farm tractors.¹

Although developed for pediatricians, issues covered by the AAP policy statement are important for farm parents. When assigning farm work to children, parents are responsible for making informed choices about many hazards to which their children are exposed. To make sensible decisions, parents may rely solely on their intuition,^{2,3} they may look to their own childhood experiences or standards of practice in their local community,^{2,3} or they may base decisions on something more formal. Optimally, the last would include knowledge obtained from empirical research evidence or the recommendations of those with child development expertise.

When the physical environment is inherently dangerous, an error in adult judgment can lead to serious injuries to children; thus, these decisions become more consequential. Children on farms experience especially high rates of death,^{4,5} morbidity,^{6,7} and disability⁸ as a result of injury. Many pediatric farm injuries occur because children are exposed to occupational hazards such as tractors, unguarded machinery, large animals, drowning and suffocation hazards, and unguarded heights. However, some of these injuries are also attributable to farm parents assigning work that is beyond the developmental capabilities of the child.⁹

Because the farm is both an occupational work site and a home environment, the decisions that parents need to make regarding the safety of their children are more complex. Parents may struggle with judgments about whether the work environment is pre-

senting undue risk to the child or whether the work assignments are appropriate and safe. The difficulties inherent in making such decisions may be reflected in assignment of work that is clearly beyond the developmental abilities of the child.

Even when parents have a good understanding about what children are capable of doing at different developmental stages, this may not always be reflected in actual behavior. For example, children may be exposed to adult work activities for them to develop skills, a reasonable work ethic, or the judgment necessary to manage complicated situations.³ These work assignments may be made deliberately for the long-term benefit of the child but may not be developmentally appropriate for the child.^{3,10}

Although there are many possible reasons why farm parents allow themselves to make inappropriate work assignments to children, there is little published evidence about how farm parents' knowledge of child development principles influences their decision making. In a previous series of analyses that focused on the nature of farm work assignments¹¹ and tractor work assignments¹² to children, we observed that children on farms begin to work and are often assigned adult work responsibilities at an early age. The present analysis examined whether these work assignments could, in part, be attributed to a lack of parental knowledge about child development. If so, then this would inform the content and delivery of health and safety interventions aimed at farm parents.

The purpose of this study was to assess the level of relevant child development knowledge that farm parents possessed and evaluate whether this knowledge related to work assignments. Specifically, we determined whether knowledge was associated with 1) their use of a new parent resource (the North American Guidelines for Children's Agricultural Tasks [NAGCAT])⁹ when assigning farm work to their children and 2) their appropriate assignment of tractor work to their children based on the NAGCAT recommendations. Findings are discussed in light of the recommendations contained in the AAP policy statement.

The NAGCAT are a set of consensus guidelines developed to assist farm parents in assigning appropriate and safe work to their children aged 7 to 16 years. Child development principles provided the scientific basis for this assessment tool, which covered 62 common agricultural jobs. Each job is depicted in a poster that includes a job illustration and lists of adult responsibilities, hazards, safety reminders, recommended levels of supervision, and a developmental checklist. The posters are grouped into booklets based on job type and include the categories of animal care, general activities, haying operations, implement operations, manual labor, specialty production, and tractor fundamentals (go to www.nagcat.org).

The NAGCAT tractor fundamentals booklet contains a tractor matrix that summarizes the minimum ages for children to be involved in farm tractor work. The tractor matrix is the only place within the NAGCAT parent resource where ages are directly linked

to a farm job. All other NAGCAT guidelines contain a checklist to be used by parents to make developmentally appropriate work assignments. Age recommendations for tractor work were based on typical developmental abilities of children at different ages (based on expert opinion and normative data) while considering the complexity and relative level of hazard of the tractor jobs. Thus, by limiting our study only to tractor jobs, we were able to use the reported age of the child as a proxy for child development. Tractor work assignments were also selected for focused study because tractors are a leading cause of fatal traumatic injuries in the pediatric farm population.⁵

METHODS

Overview

The study involved a cross-sectional analysis of data collected by telephone survey. Participants were volunteer farm parents who agreed to participate in a randomized controlled trial, described elsewhere.¹³ In short, the randomized trial itself was designed to test the efficacy of an enhanced dissemination strategy to increase the likelihood of adoption of NAGCAT. This trial showed that the provision of information contained in a safety video, child development fact sheets, and supportive telephone calls improved rates of adoption of NAGCAT but did not lead to improved parental knowledge about child development.¹³ As part of that trial, each parent completed interviews about themselves and their farm operation and job assignments to children who worked on the farm. Interviews with parents took place on recruitment and during follow-up interviews. The current analysis was based on follow-up at 15 months with 450 (90%) of the 498 farm parents originally recruited for study. The ethics committees of the Marshfield Clinic Research, University of California-Davis, and Queen's University at Kingston, Canada, each approved the original study protocol.

Farm Sample

The sample of farms and associated parents was selected from the United States Department of Agriculture's master sampling frame for the 1998 national childhood agricultural injury survey and in Canada from the Canadian Farm Register and the Agricultural Publishing Company farm database. The available sample of farms was large and covered a range of North American regions (western United States; midwestern United States; and Ontario, Canada) and types of production agriculture. Eligibility criteria were as follows: 1) the farm had at least 1 child aged 7 to 16 years (age range covered by NAGCAT) working on the farm, 2) a parent who makes decisions about work assignments for children was willing to participate, 3) this person was conversant in English, and 4) he or she provided informed consent according to institutional requirements. In addition, parents had to participate in the 15-month follow-up interview to be included in analyses presented here.

The full trial protocol is described elsewhere.¹³ As part of the trial, all farm parents received copies of guideline booklets from the NAGCAT Parent Resource. Each individual work guideline contained a child development checklist specific to that job. Furthermore, if they had been randomized to receive the enhanced dissemination strategy, then they received additional training materials about child development, including a video about age-appropriate farm tasks from the National Safety Council and fact sheets developed from principles and prose contained in the NAGCAT parent resource.

Assessment of Parental Knowledge

Parental knowledge about child development principles was assessed via 13 questions from the follow-up interview. These questions addressed a range of developmental attributes used in the construction of the NAGCAT parent resource.⁹ The attributes covered 3 standard domains of development—physical, cognitive, and psychosocial (Table 1)—and were selected deliberately to cover a range of ages. The questions were taken directly from

TABLE 1. Child Development Questions Forming the Basis for the Parental Knowledge Score

Domain	True/False
Physical	
Balance/coordination/strength	Children 11 to 14 years of age are at increased risk for work-related injuries.
Balance/coordination/strength	Children 11 to 14 years of age need to be checked at least every 6 mo for ability to perform a task.
Balance/coordination	During periods of rapid growth, children have an increased chance of falling.
Musculoskeletal	It is safe for most 14- to 15-year-olds to lift 25 lb (or 10 kg) over and over for up to 1 h.
Reach	Children need to be tall enough to reach all controls before operating tractors or machinery.
Cognitive	
Reaction times	Children 7 to 9 years old have quick enough reaction times to begin working around large animals.
Attention span	A 10- to 11-year-old can safely be assigned manual field chores for 2 h.
Attention span	A child should have at least a 15- to 20-min attention span to do simple, manual tasks on the farm.
Abstract thinking	A 10- to 11-year-old who has been taught to do a farm task at home needs to be retaught the same task when doing it at a friend's farm.
Abstract thinking	A 12- to 13-year-old child is physically and mentally ready to drive a tractor of any size as long as all safety features are in place.
Problem-solving skills	Even if a child demonstrates good problem-solving skills, he or she should not operate a tractor or machinery on steep slopes.
Psychosocial	
Emotional maturity	A child's eagerness to work indicates that he or she is ready to perform a task.
Risk-taking	A child who demonstrates risk-taking behavior can drive tractors as long as an adult is nearby.

concepts and associated prose contained in NAGCAT. When the NAGCAT parent resource was being developed, it was pilot-tested iteratively with review teams that consisted of farm parents, the agricultural media, agricultural health and safety professionals, and researchers. The specific questions used in the scale were also pilot-tested iteratively with samples of farm parents in both countries, and, where necessary, wording was clarified to improve understanding. Cronbach's α was used to assess the internal consistency reliability of the scale. Questions contained in the scale were asked on multiple occasions during the trial to monitor change, if any, in levels of parental knowledge. In the present analysis, parents were rated according to their level of knowledge at the 15-month follow-up interview.

Tractor Work Assessment

Parents were asked to identify every child aged 7 to 16 years who worked on the farm. For each, they were asked to name the 2 tractor jobs that the child did most often during the previous July and August and whether the NAGCAT parent resource was referred to in the assignment of these jobs. When tractor jobs were named, the parent was also asked whether a power take-off (PTO) device was used, the age and horsepower of the tractor involved, and whether the tractor was equipped with a rollover protection structure (ROPS). All tractor jobs were then classified according to the following binary (yes or no) self-reported outcomes:

1. Was the NAGCAT parent resource used during the assignment of the tractor jobs?
2. Was the tractor the child operated equipped with ROPS?
3. Was any tractor job assignment in violation of at least one of the following NAGCAT age restrictions: tractor work assigned to a child younger than 12 years and/or assignment to a large tractor (>70 hp) when a child was 12 to 13 years of age and/or assignment to PTO-related tractor work before the age of 14?

Parents were instructed to consider that "use of NAGCAT" meant that they had read NAGCAT and 1) changed the job, 2) changed the working environment, or 3) simply confirmed that the work was appropriate.

Assessment of Additional Variables

Additional variables assessed during the interview and considered in the analysis included study group, study region, and parental demographics (age, gender, highest level of education).

Analysis

Descriptive analyses were used to characterize the child development knowledge levels of farm parents by randomized group, region, gender, age group, and education. The knowledge score

calculated for each parent was assigned to his or her children. A logistic regression model was used to examine the potential association between use of NAGCAT (first binary outcome) and levels of parental knowledge in the assignment of tractor work to children. Additional logistic models examined potential associations of the assignment of work on tractors without ROPS (second binary outcome) and violations to the age restrictions advocated by NAGCAT (third binary outcome) with parental knowledge. The last analysis was restricted to children younger than 14 years, as these are the ages for which clear age restrictions apply. All of the logistic models used generalized estimating equations to allow for correlation among children from the same farm and these were adjusted for region as per the stratified study design.¹⁴

Parental age, gender, and the study intervention were evaluated as potential confounders but were found to have little impact on the model results (generally <1% change in the knowledge score estimate) and were not included in the final models. Parental education was recorded in the study but was not included as a covariate in the statistical models; formal education is seen as one factor that leads to knowledge, and including such a factor in a model with the knowledge score would likely reduce the precision of the analysis.¹⁵

Statistical tests for association were based on the full knowledge score, but for presentation purposes, the lowest scores (8 or less) were pooled to avoid small response frequencies. Estimates of prevalence rates, odds ratios, and associated 95% confidence intervals were computed from the logistic models. The analyses were conducted in SAS.¹⁶

RESULTS

Parental Knowledge of Child Development

Levels of parental knowledge were summarized according to the score developed from questions contained in Table 1. Raw scores ranged from 5 (38% correct) to 13 (100%) with a median score of 11 (85%). Scores of 12 or more were observed in 215 (47.8%) farm parents, scores of 11 were observed in 100 (22.2%) farm parents, and lower knowledge scores (5–10) were observed in 135 (30.0%) farm parents. Scores were observed to be higher among younger and better-educated parents and for female parents (Table 2). These knowledge scores did not vary substantially between experimental and control groups.

TABLE 2. Description of Parental Knowledge by Parental and Farm Characteristics

Responding Parents	n	Knowledge Score					
		High (12 and Above)		Medium (11)		Low (10 and Below)	
		n	%	n	%	n	%
Total	450	215	47.8	100	22.2	135	30.0
Control	227	101	44.5	53	23.3	73	32.2
Experimental	223	114	51.1	47	21.1	62	27.8
Region							
Western United States	94	36	38.3	14	14.9	44	46.8
Midwestern United States	146	69	47.3	33	22.6	44	30.1
Ontario, Canada	210	110	52.4	53	25.2	47	22.4
Gender							
Male	174	72	41.4	44	25.3	58	33.3
Female	276	143	51.8	56	20.3	77	27.9
Age (y)							
<40	156	76	48.7	36	23.1	44	28.2
40–44	149	73	49.0	33	22.2	43	28.9
45+	144	66	45.8	31	21.5	47	32.6
Highest level of education							
High school or less	145	55	37.9	36	24.8	54	37.2
Some college/university	105	46	43.8	24	22.9	35	33.3
Complete college/university	193	111	57.5	39	20.2	43	22.3
Other (eg, training school)	7	3	42.9	1	14.3	3	42.9

Parental Knowledge and Use of NAGCAT

Table 3 summarizes the relationship between the parental knowledge score and use of NAGCAT in the assignment of tractor work to children. There was a strong relationship between lower parental knowledge and lower use of NAGCAT. Parents with the lowest level of knowledge most often failed to use NAGCAT, with a relative odds of nonuse that was 8.0-fold higher (95% confidence interval: 3.6–17.7) than parents in the highest knowledge group.

Although the specifics of how NAGCAT were used were not recorded for individual jobs, the most common changes made as a result of study participation by parents that reported NAGCAT use on tractor jobs were 1) preventing the child from doing a job (67.7% of these farms), 2) providing more supervision (65.5%), and 3) setting a limit on the amount of time worked (49.6%).

Parental Knowledge and Violations of NAGCAT

Clear violations of NAGCAT for farm tractor jobs were associated with lower levels of parental knowledge of child development. The prevalence of ROPS

violations (Table 4) decreased from 36.8% among parents with the lowest knowledge scores to 19.5% among parents with the highest scores, although this trend was not statistically significant ($P = .076$). Knowledge scores were significantly associated with age violations (Table 5). Age violations were higher among parents with the lowest knowledge scores (odds ratio: 3.0; 95% confidence interval: 1.4–6.5 for parents who scored 8 and below). Although the highest rate of violations was among parents with low levels of child development knowledge, ROPS and age violations were present even among the most knowledgeable parent group.

DISCUSSION

A major finding of the present analysis was that, on testing, farm parents had a relatively high level of knowledge about child development. Lower levels of parental knowledge were associated with decreased use of NAGCAT in the assignment of farm work to children. Furthermore, higher rates of violation to the NAGCAT tractor guidelines were observed

TABLE 3. Association Between Parental Knowledge and Use of NAGCAT in the Assignment of Tractor Jobs to Children Ages 7 to 16*

Parental Knowledge Score	No. of Children	Percentage of NAGCAT Not Used	OR† of Nonuse of NAGCAT	P Value
13 (all correct)	221	7.5	1.0	<.001
12	310	13.6	1.9 (1.0–3.9)	
11	252	9.3	1.3 (0.6–2.7)	
10	155	17.7	2.7 (1.2–6.0)	
9	91	28.9	5.0 (2.3–11.1)	
8 and below	87	39.3	8.0 (3.6–17.7)	
Combined	1116	16.2		

* Estimates from logistic regression using generalized estimating equations with adjustment for region (95% confidence interval).
 † Odds ratio of negative outcome relative to highest knowledge category (95% confidence interval).

TABLE 4. Association Between Parental Knowledge and ROPS Violations of NAGCAT for Farm Tractor Jobs Among Working Children Ages 7 to 16*

Parental Knowledge Score	No. of Children	Percentage of NAGCAT Clearly Violated	OR† of ROPS Violation	P Value
13 (all correct)	221	19.5	1.0	.076
12	310	21.5	1.1 (0.6–2.0)	
11	252	21.9	1.2 (0.7–2.0)	
10	155	17.2	0.9 (0.4–1.8)	
9	91	23.7	1.3 (0.6–2.7)	
8 and below	87	36.8	2.4 (1.2–4.7)	
Combined	1116	22.4		

* Estimates from logistic regression using generalized estimating equations with adjustment for region (95% confidence interval).
 † Odds ratio of negative outcome relative to highest knowledge category (95% confidence interval).

TABLE 5. Association Between Parental Knowledge and Age Violations of NAGCAT for Farm Tractor Jobs Among Working Children Ages 7 to 13*

Parental Knowledge Score	No. of Children	Percentage of NAGCAT Clearly Violated	OR† of Any Age Violation	P Value
13 (all correct)	121	17.6	1.0	.019
12	169	26.4	1.7 (0.9–3.1)	
11	135	22.0	1.3 (0.7–2.6)	
10	73	24.0	1.5 (0.7–3.3)	
9	49	34.3	2.4 (1.0–6.0)	
8 and below	54	39.3	3.0 (1.4–6.5)	
Combined	601	25.8		

* Estimates from logistic regression using generalized estimating equations with adjustment for region (95% confidence interval).

† Odds ratio of negative outcome relative to highest knowledge category (95% confidence interval).

among parents who scored lower on the knowledge test.

The strong associations between parental knowledge and childhood farm work assignments were not unexpected. What was revealing was the extent to which the influence of this knowledge seemed to be mitigated by other factors. Even among parents who scored highest on knowledge of child development, some parents still assigned dangerous tractor work to their children. This was demonstrated in a motivated group of farm parents who had volunteered for our randomized trial. The “real world” assignments of dangerous tractor work to farm children may be somewhat higher, and this in turn would contribute to the high rates of childhood farm trauma observed in North America.

Agrarian societies historically have placed a high value on independence, self-sufficiency, and a strong work ethic, and farm children are often taught these values from an early age.^{17,18} Children may be exposed to challenges for them to develop the skills necessary to make independent decisions and to allow them to assume adult work responsibilities. On farms, work assignments that are developmentally inappropriate for children seem to be common. In addition, childhood work assignments are further influenced by economic considerations.¹⁹ Even parents who are well informed about child development issues sometimes subject their children to risks to make productivity gains.¹⁹ When the risks imposed by farm hazards are weighed against the farm’s economic well-being or a child’s potential future in agriculture, the hazards may be overlooked.^{19,20} The constant need to keep the farm enterprise on solid financial ground is a recurrent theme in the agricultural health literature. Although not assessed directly by the present study, on the basis of this cited evidence, we expect that agrarian values and productivity considerations both played roles in the observed tractor work assignments to children.

Established approaches to the prevention of workplace injuries include education to raise awareness about known hazards, modifications to the work environment to protect the worker from undue risks, and enforcement of established occupational health

and safety regulations. Children on North American farms are generally not subject to these regulations^{21,22} or analogous child labor laws²³ because the agricultural industry has historically opposed legislated safety standards. The need for safe working conditions for farm children has been well recognized for decades,²⁴ but there is still a reliance on voluntary occupational safety standards within this industrial sector, and educational solutions to health and safety problems are preferred over regulations. Our analyses suggest that high parental knowledge acquired through education seems to have some influence on the appropriateness of tractor work assignments. However, knowledge by itself is not sufficient to remove all children from obvious and known hazards, as even parents with perfect knowledge scores showed clear violations in nearly 20% of tractor jobs (Table 4).

The approach to the current study was analytical in nature, and common forms of bias that typically threaten the internal validity of such analyses should be considered. The analysis was based on a voluntary sample of farm parents who had participated in a randomized controlled trial. Selection bias is possible in this situation, and the strengths of associations between parental knowledge and pediatric work practices may be different (inflated or diminished) relative to general farm population norms. Similarly, some misclassification of the study outcomes (self-reported use/violations of the NAGCAT tractor guidelines) is likely, and if the degree of misclassification varied with parental knowledge, then this could also lead to bias in estimates of association. Hence, caution is warranted in the interpretation of the exact magnitude of the estimated rates.

The lag period between the times of parental knowledge assessment and tractor job assignments also warrants discussion, as the 15-month follow-up knowledge score may not have reflected levels of parental knowledge at the times of job assignments. However, on average, this lag period was relatively short (median: 60 days; range: 29–102). In addition, the knowledge score had been assessed in the months leading up to the work assignments. After a median of 7 months between assessments, the mean knowledge score had increased by only 0.36 (median change: 0) on the 13-point scale, and the 2 knowledge score assessments were strongly correlated (intra-class correlation coefficient: 0.54; $P < .001$). We expect that the lag period therefore would have a minimal impact, if any, on the observed associations.

The reliability of the new instrument used to evaluate parental knowledge also requires comment. Although based on 13 questions that cover 3 standard domains of child development, the internal consistency reliability of this instrument was found to be moderate (Cronbach’s α : 0.53), and additional refinement would be desirable.

A major strength of the analysis was that it was based on a robust and diverse sample of farm parents. A high level of follow-up was achieved among the study recruits, and efforts were made to collect information in a standardized and structured manner according to modern survey principles.

AAP Policy Statement

The results of this study have a number of implications for pediatricians in light of the recent policy statement by the AAP.¹ First, the AAP recommends that ROPS and seatbelts be present on tractors that are operated by children. This is a sensible recommendation, and pediatricians can be strong advocates for children in this regard. However, there is a definite need to evaluate the efficacy of physician advice in terms of whether it influences farm safety behaviors. Our results suggest that knowledge produced by specific educational efforts may not be enough to change farm parents' practices.

Second, the AAP recommends educating parents about normal growth and development and about NAGCAT, in particular. This, too, is a sensible recommendation. However, our findings indicate that many farm parents, although informed about the child development principles, still assigned work to children that was developmentally inappropriate. Educational efforts may have some impact on farm safety practices, but knowledge imparted by safety resources such as NAGCAT, by themselves, are insufficient to remove many farm children from known occupational hazards.

Third, the AAP recommends that pediatricians ensure that the community is educated about agricultural health and safety issues as they affect children. Again, this recommendation is sensible, as increased knowledge is necessary to affect behavior change; however, it may not be sufficient to change the practices of some farm parents.

Finally, the AAP recommends promotion of voluntary or legislated safety standards. Our data suggest that even with an educated population of farm parents who have voluntary standards in hand (NAGCAT), many children still will be assigned developmentally inappropriate work. Perhaps the time indeed has come to examine and put to the test the legislated alternatives for tractor operation suggested by the AAP. The latter include safety standards that would 1) restrict individuals younger than 18 from operating any tractor that was not equipped with a ROPS and seatbelt, 2) restrict individuals younger than 16 from operating any farm vehicles, and 3) require children aged 16 and older to have a valid driver's license before they could operate a tractor on a public roadway.¹ Our findings suggest that the voluntary approach to safety standards currently in use is insufficient to remove many farm children from known tractor hazards.

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Parental Knowledge of Child Development and the Assignment of Tractor Work to Children

William Pickett, Barbara Marlenga and Richard L. Berg

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