

CHAPTER 18

PREVENTING WORK-RELATED MUSCULOSKELETAL DISORDERS FOR YOUTH WORKING ON FARMS

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Chapter In.

INTRODUCTION

Children and adolescents are essential to the farming workforce. Children begin helping at very young ages, performing physically demanding jobs designed for adults that may exceed their capabilities.

Children often lift and move materials, operate farm equipment, and perform other tasks that require considerable strength and coordination (Figure 18.1 and Figure 18.2). Nearly 2 million American youth, younger than age 20, lived or worked on a US farm in 1998 (Table 18.1).



Figure 18.1 (NIOSH)

Children who work on farms perform physically demanding tasks that place them at risk of developing musculoskeletal disorders. The above tasks require the youth to perform heavy lifting and forceful muscle exertions while working in awkward overhead postures. The physical demands are significantly increased if the work is highly repetitive.



Figure 18.2 (Ursy Potter Photography)

Farms are one of the most hazardous places for anyone to work. In the United States, about 8% of adult farm workers sustain injuries involving lost work-time each year (OSHA, 2001). Though we know less about injuries among farm children, they are clearly at considerable risk (Xiang et al., 1999; Allread et al., 2004).

Table 18.1 Ages of Children Working on US Farms		
Age (Years)	Percent (%)	Number
<10	9	130,000
10–15	47	650,000
16–19	53	745,000

Source: Meyers and Hendricks (2001).

INJURIES AMONG CHILDREN

Farm children may sustain musculoskeletal injuries from acute events such as traumatic injuries or by repeated or sustained physical exertions.

TRAUMATIC INJURIES

Traumatic injuries typically result from sudden events. These include motor-vehicle accidents; slips, trips, or falls; and being struck or hit by animals or objects. Traumatic injuries may include lacerations, contusions, broken bones, or extremities caught in machinery.

MANY CHILD INJURIES ON FARMS ARE PREVENTABLE

One study concluded that half the injuries among farm children could have been avoided by following currently existing guidelines. Although most studies focus on farming, many youth also work in commercial or production agriculture, where serious injuries also occur. Unfortunately, there is a lack of formal reporting systems to capture information on the types and causes of injuries children incur while working on farms or in commercial enterprises.

MUSCULOSKELETAL DISORDERS RELATED TO WORK

Musculoskeletal disorders (MSDs) are caused by excessive physical demands or repetitive exertions (Table 18.2). These MSDs can affect the upper and lower back, upper extremities (hands, wrists, and elbows), shoulder, neck, and lower extremities (legs, ankles, and feet).

Table 18.2 Description of Musculoskeletal Disorders and Their Causes

What Are Musculoskeletal Disorders?	
Definition	Health conditions or disorders, which involve the muscles, nerves, ligaments, tendons, joints, cartilage, spinal discs, and other supporting structures of the body that are caused or exacerbated by a person's tasks and activities (NIOSH, 1997).
Risk Factors	<ul style="list-style-type: none"> • High repetition • Extended use of awkward postures • Long-duration static hold • Direct pressure on soft tissues of the body • Heavy loads • Exposure to vibration
Symptoms	Tingling, numbness, pain
Synonyms	Overuse injuries, repetitive motion injuries, repetitive strain injuries, cumulative trauma disorders

Farm workers are at risk of developing MSDs, particularly of the low back. In fact, farming ranks fifth among jobs at high risk of developing back pain. About 19% of farm workers experience work-related back pain that lasts a week or more.* This is more than double the rate among the general working population (9% for males) (Guo et al., 1995).

Characteristics of industrial work that contribute to injuries[†] (particularly back injuries) are similar to those often found in farming (Allread et al., 2004). Youth working on farms face these very same risks (Ehrmann-Feldman et al., 2002). Many farming jobs are physically demanding, often requiring lifting, pushing, pulling, and carrying of heavy bags, buckets, and other objects. Examples of farm jobs performed by youth that may lead to MSDs are listed in Table 18.3 (Bartels et al., 2000). Other examples of tasks performed by youth on farms are shown in Figures 18.5 through 18.8.



Figure 18.3 (NIOSH)
Physically demanding tasks on farms include pushing, pulling, lifting, and carrying heavy objects. Most children who work on farms develop strong muscles and bones through the continued use of their bodies over time, yet there can also be a tendency for them to push themselves to do as much as an adult without asking for assistance.





Teaching children to recognize signs and signals of overuse, as well as when and how to push their own physical limitations safely, can help prevent injuries. Supervisors must take children's reports of pain or other signs of overuse seriously, so appropriate rest or treatment can occur.

Children who work on farms care for large and small animals; clean animal stalls, pens, and corrals; load, unload, and stack hay; and drive tractors with trailers. Aside from the tractor-driving task, these activities are physically demanding. They involve heavy force exertions, as well as repetition and awkward movements, all of which are risk factors in the development of MSDs among adults (NIOSH, 1997).

* This does not include horticulture workers.

[†] These task requirements include the weight of objects lifted, frequency of lift, postures, and other aspects of work that are known to increase risk of injury.

Table 18.3 Jobs Performed by Youth on Farms that May Lead to MSDs

Work with Animals	<ul style="list-style-type: none"> • Feed and water livestock daily • Milk cows • Spread straw in animal pens • Bottle or bucket feed milk to calves or lambs • Move sows and pigs from pen to pen • Sort animals 	
Operating Equipment	<ul style="list-style-type: none"> • Drive tractor with no specific implement attached • Operate a lawn mower • Drive tractor to plant or drill crops • Drive a tractor raking hay • Drive tractor to till the soil • Operate combine to harvest corn, soybeans, or wheat • Operate a skid loader to clean pens • Drive tractor and grain wagon to barn, and then unload grain into bin • Drive tractor to pull wagons of hay to barn • Drive tractor to hay baler • Drive truck around the farm 	
Moving Materials (Manual Material Handling)	<ul style="list-style-type: none"> • Stacking bales of hay or straw on wagon • Place bales on an elevator off the wagon • Stack bales in the barn • Shovel, fork, or scrape manure to clean barn • Shovel grain or silage 	
Tasks that Require Awkward Postures	<ul style="list-style-type: none"> • Pull and sort sweet corn • Weed vegetables with hand hoe • Pick up rocks 	

Of course, not all physically demanding work is harmful. Physical activity builds bones and muscles and improves physical endurance. Parents and caregivers of children who do not live on farms encourage them to engage in gym and sports activities to develop similar levels of fitness! However, the way a child accomplishes a task and the matching of a child's capabilities with the demands of the task are important to avoid injury and possible permanent damage.

Children of different ages have specific developmental abilities that allow them to perform certain jobs with less risk of injury (Murphy and Hackett, 1997). Table 18.4 lists the various growth stages of children, their ages, developmental characteristics, types of injuries or fatalities that occur at each stage, prevention suggestions, and developmentally appropriate work tasks for each age group.

According to the report by Murphy and Hackett (1997):

The developmental characteristics, types of injuries or fatalities and preventive strategies for each age group are more scientifically grounded or experienced based than are the developmentally appropriate work tasks suggested. Task suggestions for the age groups may not exactly describe tasks or be suitable for all children: Each child is a unique individual and may not perfectly fit within any grouped criteria or classification.

On the other hand, it is normal for parents to overestimate the skills and abilities of their own children. The developmentally appropriate work task suggestions for each age group represent the best opinions of several child development and farm safety experts.

Parents and supervisors of youth working on farms need nonthreatening information on MSDs, risk factors and methods to decrease their children's exposure to risk factors. This will help them make wise decisions about the tasks their children perform that they may not have considered previously.

Excessive physically demanding work as a child may also increase the risk of latent, chronic musculoskeletal disorders, such as osteoarthritis, in adulthood. Although adults experience these disorders more often than children, the initial insult can occur during childhood. Figure 18.4 illustrates one theoretical model of this potential chronic injury pathway.

According to the theoretical model, repetitive exposure to large muscle exertions likely leads to significant increases in bone mineral density and bone stiffness. Mechanically,

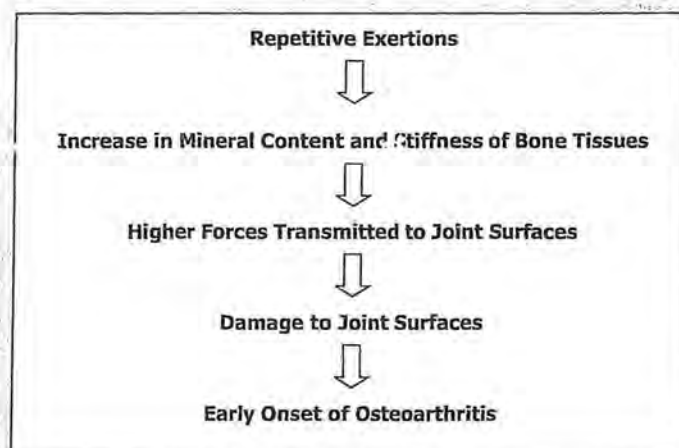


Figure 18.4 Theoretical Model of the Development of Early Onset Osteoarthritis.

stiffer bones likely would lead to increased transmission of forces through the bone to the joints. Over many years, these increased loadings may cause wear and tear or micotrauma to the musculoskeletal system, resulting in chronic early onset of chronic MSD symptoms such as osteoarthritis (Thelin et al., 2004).



Figure 18.5 (Ursy Potter Photography)

Farm work involves many chores: planting, growing, harvesting, transporting, and often selling. Children in farming families help where and when they can, often with each part of the process. In the photo on the left, two young boys sort produce to sell at the market.



Figure 18.6 (Ursy Potter Photography)

Although the work is not a physically heavy task, it requires repetitive motions of the small muscles of the fingers and hands (which fatigue quicker than larger muscle groups) and, in this case, the boys' posture during the process can be fatiguing. The photo on the right shows that even the youngest children are involved in the family business of farming and selling.



Figure 18.7 (Ursy Potter Photography)

This father has placed his little girl on the hood of his vehicle, so she is not "underfoot" of the llamas he has taken to a market. Even when the children are not actively engaged in the care of the animals, children in farming families are around the animals and daily work activities. Many parents cannot imagine doing their job and keeping an eye on their children at the same time, but farming families do so every day.



Figure 18.8 (Ursy Potter Photography)

Transporting animals to market can be dangerous work. Getting the animals from the pen or barn to the vehicle and then into the vehicles takes careful planning and firm, even handling of these large, sometimes resistant animals. It can be difficult for an adult, as well as a child.

This boy is handling nine pigs at once. Although it may work out just fine, if one or several of them move in an unanticipated direction, he could have difficulties. In fact, two pigs are moving in a different direction than the rest.

What types of farms are children injured on?

Livestock (2.17 per 100)

Crop operations (1.59 per 100)

Who is injured?

Children younger than 10 years of age are injured most frequently.

Boys are injured more often than girls.

The most common type of injury among youth is a sprain or strain.

<http://www.fs4jk.org/>

Table 18.4 Child Development and Appropriate Work Tasks from the Penn State Report**Child Development and Appropriate Work Tasks**

Growth Stage (in Years)	Developmental Characteristics	Causes of Deaths or Injuries	Preventive Strategies	Developmentally Appropriate Work Tasks
Birth–4 (Infant/ Toddler/ Preschooler)	<ul style="list-style-type: none"> • Rapid growth, beginning motor skills development • Has balance problems, slow reaction time • Is curious, exploring • Is fascinated by movement • Has illogical or “magic” thinking • Is very energetic, releases tension by playing, even when exhausted • Is self-centered but interested in group activities 	<ul style="list-style-type: none"> • Falling from tractors or heights, such as ladders • Ingesting poisons • Being kicked or trampled by animals • Being run over by a tractor • Drowning in ponds or manure pits 	<ul style="list-style-type: none"> • Never have a child as an extra rider. • Use strong physical barriers such as locks and fences around ponds and manure pits. Lock up chemicals. • Store ladders out of sight and reach. • Provide a fenced-in play area away from farming activities. • Provide maximum supervision at all times because of small children’s poor coordination, high energy, and lack of fear. 	<ul style="list-style-type: none"> • None, children this age should not be exposed to work hazards
5–9 (Preschooler/ Early Elementary School Age)	<ul style="list-style-type: none"> • Is learning to use small and large muscles—slow, steady growth stage • Has poor hand–eye coordination • Tries to master more complex skills • Operates with concrete facts, not capable of abstract ideas or thinking • Wishes to appear competent; seeks parental approval • Wishes to take on tasks without adult supervision • Is discovering that parents make mistakes, are human • Rarely follows through on a task—not yet ready for responsibility 	<ul style="list-style-type: none"> • Slipping and falling from tractors, trucks, or heights • Entangling in augers, other machines • Suffocating in grain • Being kicked or trampled by animals 	<ul style="list-style-type: none"> • Set rules. • Discuss safe behavior with children. • Assign and closely supervise chores. • Talk openly about types of injuries and consequences. • Never assign intense, physical chores—they can lead to exhaustion. • Play games (with adult supervision) that focus on farm safety issues. • Use Job Safety Analysis (JSA) tools. 	<ul style="list-style-type: none"> • Tasks of short duration that do not require excellent hand–eye coordination • Projects with hand tools, not power tools • Help with watering plants and feeding small animals, such as pets or orphaned baby animals • Collect eggs

(continued)

Table 18.4 Child Development and Appropriate Work Tasks from the Penn State Report (Continued)

Child Development and Appropriate Work Tasks				
Growth Stage (in Years)	Developmental Characteristics	Causes of Deaths or Injuries	Preventive Strategies	Developmentally Appropriate Work Tasks
10–13 (Middle School Age/ Early Teen)	<ul style="list-style-type: none"> • Is growing at a steady rate—approaching puberty; boys grow more quickly than girls • Small muscles are developing rapidly • Has same coordination as adults but lapses of awkwardness are common • Has greater physical and mental skills • Desires peer and social acceptance • Wishes to try new skills without constant adult supervision • Signs of independence emerging • Success important for self-concept 	<ul style="list-style-type: none"> • Becoming entangled with machinery • Hearing loss from exposure to noisy machinery • Injuring head or spine in motorcycle and all-terrain vehicle accidents • Extra rider falling from tractor or other equipment 	<ul style="list-style-type: none"> • Potentially the most dangerous age because of constant risk taking and ease of distraction and clumsiness—never mistake a child's size for ability to do work! • Enroll child in bike safety classes; always require helmets. • Set clear and consistent rules; discuss consequences and rewards. • Provide specific education on farm hazard prevention. • Plan increases in chores and responsibilities. • Start with low-risk tasks; give more responsibility for follow-through with less supervision. • Use JSA. 	<ul style="list-style-type: none"> • Hand raking, digging • Limited power tool use (with supervision); hand tools better • Operating lawn mower (push mower, flat surface, under supervision) or garden tractor • Handling and assisting with animals

Table 18.4 Child Development and Appropriate Work Tasks from the Penn State Report (Continued)**Child Development and Appropriate Work Tasks**

Growth Stage (in Years)	Developmental Characteristics	Causes of Deaths or Injuries	Preventive Strategies	Developmentally Appropriate Work Tasks
13–16 Adolescent/ Young Teenagers)	<ul style="list-style-type: none"> • Is growing rapidly and changing physically; can be an uneasy time • Girls growing faster than boys • Has moved from concrete thinking to abstract; enjoys mental activity • Can find solutions to own problems but still needs adult guidance • Feels need to be accepted by peers • Resists adult authority • Feels immortal 	<ul style="list-style-type: none"> • Hearing loss from exposure to loud machinery • Head and spine injuries from motorcycle or all-terrain vehicle accidents • Machinery rollover or roadway accident • Amputation due to power take-off (PTO) entanglement 	<ul style="list-style-type: none"> • Judge size, age, cognition, and judgment to assess maturity for tasks. • Be consistent with rules. • Provide education from peers with farm injuries. • Provide all-terrain vehicle training, protective gear. • Become involved in 4-H and FFA safety projects. • Use JSA. 	<ul style="list-style-type: none"> • Still needs adult supervision but ready for more adult jobs such as equipment operation and maintenance • Gradually increase tasks as experience is gained • Manual handling of feed and feeding animals • Can operate a tractor over 20 PTO horsepower or connect and disconnect parts to or from tractor at ages 14 and 15 after the completion of a 10 hour training program • Can assist with and operate (including stopping, adjusting, and feeding) the following after completing a 10 hour training program: corn picker, cotton picker, grain combine, hay mower, forage harvester, hay baler, potato digger, mobile pea viner, feed grinder, crop dryer, forage blower, auger conveyor, the unloading mechanism of a nongravity-type self-unloading wagon or trailer, power post-hole digger, power post driver or nonwalking rotary tiller

(continued)

Table 18.4 Child Development and Appropriate Work Tasks from the Penn State Report (Continued)

Child Development and Appropriate Work Tasks				
Growth Stage (in Years)	Developmental Characteristics	Causes of Deaths or Injuries	Preventive Strategies	Developmentally Appropriate Work Tasks
16–18 (Middle/Older Teenage)	<ul style="list-style-type: none"> • Awkwardness overcome, mastery of small and large muscles basically complete • Knows abilities, moving further away from family and into community as an independent person • Feels immortal • May act like child one day, adult the next • Rebellion, risk-taking, and aggressiveness are typical behaviors • Consistent treatment from adults important • Needs independence and identity • Has increased sense of adult responsibilities, thinking of future • May experiment with drugs or alcohol 	<ul style="list-style-type: none"> • Same as adult risks: respiratory illness, hearing loss, muscle and bone injuries, rollover from tractor, machinery entanglements • Additional risk if experimenting with or under the influence of drugs or alcohol 	<ul style="list-style-type: none"> • Provide rules regarding drugs and alcohol; open communication. • Reward for accepting adult responsibilities. • Serve as role model—teach younger children farm safety. • Parents may still have cause for concern with recklessness and risk-taking and may work side-by-side with young adult until they are absolutely ready to work independently. • Use JSA. 	<ul style="list-style-type: none"> • May be ready to work with tractors, self-propelled machinery, augers, elevators, and other farm equipment, but must earn this responsibility. Should be trained, educated and supervised at regular intervals

Source: Murphy, D. and Hackett, K. Children and Safety on the Farm. Ps6361, U.Ed.AGR97-25, 1997.
Reprinted with permission.

Farmers and farm supervisors need to understand that MSDs are real and not “just part of doing business.” They also need to learn how to recognize and avoid risk factors. Doing so would enable them to more safely structure tasks and assign jobs to children (Bartels et al., 2000).

NONWORK INJURIES



Figure 18.9 (Ursy Potter Photography) **Figure 18.10** (Ursy Potter Photography)

Figure 18.11 (Ursy Potter Photography)

Injury and death occur even when farm children are not working. Although little is known about nonwork injuries among children on farms, it is a serious problem in farming populations.

Accidental injuries occur to children who are not actively working on the farm. Often, they are merely playing near their working parents when the injury occurs.

Nonwork injuries, such as those listed in Table 18.5, occur more often among children from 1 to 6 years old and the victims tend to be relatives of the farm owners (Pickett et al., 2005). Hartling et al. (2004) reviewed the effectiveness of recommendations for preventing nonwork injuries to youth.

Table 18.5 Types of Nonwork Injuries, Accidents, and Deaths, along with Potential Solutions

Causes	Activities	Potential Solutions
<ul style="list-style-type: none"> • Bystander and passenger runovers • Drowning • Machinery entanglements • Falls from heights (often from haylofts) • Animal trauma 	<ul style="list-style-type: none"> • Playing at the worksite • Being an extra rider on farm machinery or being a bystander • Recreational horseback riding 	<ol style="list-style-type: none"> 1. Keep children away from the worksite while adults work. 2. Provide alternate childcare so adults do not need to divide their attention between supervising children and doing their work. 3. Install passive physical barriers such as fencing such as around animals or in haylofts (Figure 18.14). 4. Store materials carefully, such as large items that might fall. 5. Institute guidelines for recreational riding of horses and all terrain vehicles.

Source: From Pickett, W., Brison, R.J., Berg, R.L., Zentner, J., Linneman, J., and Marlenga, B. (2005). *Inj. Prev.*, 11, 6–11, 2005.



Figure 18.12 (Ursy Potter Photography)
Many farming families do not have the luxury of daycare or hiring babysitters for their children while they work. Instead, their children accompany them. This means potential exposure to safety hazards associated with farm machinery or toxic chemicals such as pesticides.



Figure 18.13 (Ursy Potter Photography)

Careful instruction of how to interact with animals and emphasizing that animals can be unpredictable in their behavior can help prevent accidental injuries. However, young children are distractible and do not fully understand the consequences of their actions (see chapters in Section B of this book). When possible, it is best to place barriers such as fences around livestock to prevent accidental injuries among younger children. This separates the child from the hazardous situation.



Figure 18.14 (Ursy Potter Photography)

PERCEPTIONS DRIVE ACTIONS

Our perceptions drive our actions. Adults hire, supervise, and assign youth working on farms to jobs according to their perceived maturity, rather than their chronological age (Bartels et al., 2000). The young workers believe adults base their assignments on need (i.e., the task must be completed, and they are the only ones available to do it), rather than their capability or readiness to perform the task.

It is likely that adults consider both perceived maturity and need when making task assignments. However, parents and supervisors may not consider a young person's stature, strength, and stage of bone and muscular development when assigning their work. The adults may not have the knowledge or the background to understand why such considerations are important.

Table 18.6 lists the activities thought to cause the most serious MSDs in children during farm work.* Children and adolescents rarely report musculoskeletal disorders. However, they describe muscle aches and strains of the legs, arms, shoulder, back, or neck as everyday occurrences. Young workers often believe that "if it is not broken, you are fine."

Table 18.6 Causes of Serious Musculoskeletal Disorders in Children as Reported by Parents and Supervisors of Children Working on Farms	
Causes of Serious Child Musculoskeletal Disorders	
Primary	<ul style="list-style-type: none"> • Lifting objects • Forking • Shoveling
Secondary	<ul style="list-style-type: none"> • Bending over while working • Sitting in an awkward position looking back at equipment from a tractor • Sitting in a cramped position, looking down at a combine header • Long hours of work

Source: From Bartels, S., Niederman, B., and Waters, T. J. *Agric. Saf. Health*, 6, 191, 2000.

Parents and supervisors generally do not believe special training is necessary for youth working on a farm; they believe youth learn best by observing. They also believe that parents and supervisors would ignore guidelines for assigning youth to work tasks, unless required by law, even if physicians made the recommendations (Bartels et al., 2000).

Such perceptions suggest parents do not understand:

- the nature of MSDs
- the potential long-term consequences of MSDs that begin in childhood
- the importance of training (for themselves and for their children)
- the benefits of eliminating or reducing risk factors for MSDs for their children

Most parents and supervisors would not intentionally put young workers at risk. Instead, they lack information about the injuries and prevention strategies that apply to their children's lives. They may also be like many people and simply believe the injury reports are "exaggerated" or "do not apply to me and my family."

IDENTIFYING HIGH-RISK JOBS

Identify associations between tasks and injuries

One way to recognize high-risk jobs is to identify the various physical exertions and tasks within a job that are associated with MSDs. This is difficult when dealing with children because most information on children's performance is on standardized physical education tests (e.g., chin-ups, sit-ups, and push-ups) rather than work-related tasks.

* As reported by parents and supervisors.

To identify high-risk jobs and evaluate the child's capabilities to perform these demands, a specialized ergonomic tool developed by NIOSH researchers allows users to determine whether a specified work task is likely to exceed the strength capabilities of a youth.

Match task demands with child capabilities

In order to best match specific task demands with the personal capabilities of children a task-related assessment method is needed, such as a strength prediction program for children.

Performance information for some age categories is also lacking. For example, US strength data is available for 3–10 year olds, but not for 11–20 year olds (Owings et al., 1975).

Matching children's capabilities with the demands of their tasks requires an understanding of the "fit" between the child and equipment they use. The two data sets used in the United States to identify size characteristics of children are anthropometric data (infant–20 years, Snyder et al., 1977) and clinical growth charts (NCHS, 2003). Clinical growth charts include age-related percentiles for stature, weight, and body mass for boys and girls.

Table 18.7 Output Screen from NIOSH Static 2-D Biomechanical Model for Children

Researchers at the National Institute for Occupational Safety and Health (NIOSH) and the University of Wisconsin-Milwaukee used the available strength and anthropometric data to develop the NIOSH 2D Child Strength Program, a computerized two-dimensional strength prediction program^a for use with young workers (Waters, 2003).^b

This NIOSH computer program calculates the percent of young persons who will be sufficiently strong to perform a specific pushing, pulling, or lifting task by age and gender.

This Child Strength Prediction Program also estimates loads on the spine based on the administrators' responses regarding the child's age, gender, necessary body posture, weight, and direction of force (i.e., push, pull, or lift).

CHILDREN STATIC 2-D BIOMECHANICAL MODEL	
Task:	Lift
Sex:	Male
Age:	12
Weight / Force:	50
Hand Location:	
Horizontal:	14.5
Vertical:	18.4
L5/S1 to Hands:	16.0
Percent Capable	
ELBOW:	70
SHOULDER:	89
TRUNK:	2
HIP:	76
KNEE:	99
ANKLE:	99
Compressive Force = 909	
Shear Force = 53	
Back Exit	

An example of this tool is on the right. In this example, between 70% and 99% of 12-year-old males have the knee, ankle, hip, shoulder, and elbow strength to lift 22.7 kg (50 lb) in the posture shown, but only 2% have the necessary trunk strength.

This program estimates that the task involves a compression of the spine and shear force of 412 kg (909 lb). The acceptable compression force for adult males is 350 kg (770 lb), so this is obviously far above an acceptable level for a child (Waters et al., 1993).

This software program is still under development and has not yet been validated against alternate strength norms for children. Unfortunately, we have not been able to identify any alternate strength norms for comparison. Even so, it is an excellent tool to evaluate the fit between a child's strength and the demands of tasks. The results tell you when to reengineer a task or when someone with greater strength or a team of workers may be required.

^a Further information about the NIOSH 2D Child Strength Program is available at www.childergo.com/farmchildinjuries.htm

^b Gaps in the data among older youth were extrapolated to estimate the continued increases in strength.

CURRENT GUIDELINES FOR CHILDREN WORKING IN AGRICULTURE

Guidelines provide information about ways to reduce risks for children working on farms. Agriculture safety and health experts from the National Children's Center in Marshfield, Wisconsin, published the North American Guidelines for Children's Agricultural Tasks (NAGCAT) (NCCRHS, 1999).^{*} NAGCAT guidelines cover 62 jobs in seven major work areas, including animal care, general activities, haying operations, implement operations, manual labor, specialty production, and tractor fundamentals. Table 18.9 (A, B, and C), Table 18.10 (A, B, and C), and Figure 18.15 show three sample NAGCAT Guidelines. These provide guidance on tasks that involve manual lifting, hand picking vegetables, and operating a tractor.

NAGCAT Guidelines are easy to use. First, it provides information on the task. Then, it poses a series of questions about a child's ability to perform that specific task and suggests training needs and level of adult supervision needed for the task. Each "No" response triggers an explanation as to why that job may be hazardous. The guideline also includes specific age-based recommendations regarding supervision for children for each of the 62 farm tasks.

The guidelines are important and helpful for parents and supervisors. Adding data on the physical demands of farm work (as they become available) will make it even more so.

Table 18.8 Checklist Developed from the North American Guidelines for Children's Agricultural Tasks	
Sample Checklist (NAGCAT)	
<input type="checkbox"/> Yes <input type="checkbox"/> No	1. Can the child lift safely?
<input type="checkbox"/> Yes <input type="checkbox"/> No	2. Has the child been trained to lift safely?
<input type="checkbox"/> Yes <input type="checkbox"/> No	3. Can the child easily push up to 10% to 15% of his or her body weight?
<input type="checkbox"/> Yes <input type="checkbox"/> No	4. Does the amount of material to be lifted weigh less than 10% to 15% of the child's body weight?
<input type="checkbox"/> Yes <input type="checkbox"/> No	5. Does the child have to carry the object less than 10–15 yards?
<input type="checkbox"/> Yes <input type="checkbox"/> No	6. Are the tools the right size for the child?
<input type="checkbox"/> Yes <input type="checkbox"/> No	7. Has the child shown they can do the job safely 4–5 times under close supervision?
<input type="checkbox"/> Yes <input type="checkbox"/> No	8. Can an adult supervise as recommended?

^{*} North American Guidelines for Children's Agricultural Tasks can be downloaded at www.nagcat.org

Table 18.9A NAGCAT Guideline: Manual Labor Lifting

Lifting

Adult responsibilities

ADULTS NEED TO MAKE SURE:

- Work area has no hazards
- Object to be lifted weighs less than 10-15% of child's body weight
- Child carries object less than 10-15 yards

The important steps for safe lifting are followed:

1. Stand close to object to be lifted
2. Spread feet wide to straddle the object
3. Squat, bending knees and hips
4. Keep head up and back straight
5. Hold in stomach muscles
6. Lift using leg muscles
7. Keep the load close to body with a good grip
8. Turn feet, not back, in the direction you are going
9. Follow the above tips when putting the object down

Young people should be reminded:

- Improper lifting can lead to long-term back pain
- Ask for help when the load is too heavy or you don't know how heavy it is
- "Hug the load"
- Use mechanical devices such as carts and levers whenever possible
- Don't lift objects above chest height
- Bulky objects are more difficult to balance and carry
- Avoid twisting while lifting
- Take frequent stretch breaks to avoid overuse of muscles



Can your child do this job?

Main Hazards



Slippery/uneven surface can lead to slips, trips and falls



Weight of objects can strain muscles



Repetitive motion can strain muscles and injure back and joints

ABILITY

Can the child bend safely? (See "Bending")

- ☐ Yes.
- ☐ No. **STOP!** Children must be able to bend correctly to do this job safely.

Is the child going through a growth spurt? For example, is he or she clumsy or frequently changing clothing size?

- ☐ Yes. **STOP!** Children in periods of rapid growth become less flexible, increasing the chance of muscle strains and injury to back and joints.
- ☐ No.

Do the objects to be lifted weigh less than 10-15% of the child's body weight?

- ☐ Yes.
- ☐ No. **STOP!** Children lifting more than 15% of their body weight are more likely to injure their backs.

Does the child have to carry the load less than 10-15 yards?

- ☐ Yes.
- ☐ No. **STOP!** Children carrying a load more than 10-15 yards are more likely to injure their backs.

Supervision

What's the right amount? Here are suggestions—but remember, it depends on the child.

Age 7-9: LIMIT job to 15 minutes. WATCH constantly.

Age 10-11: LIMIT job to 20 minutes. CHECK every few minutes.

Age 12-13: CHECK every few minutes.

Age 14-15: CHECK every few minutes at first. When the child shows he or she can do the job, LEAVE for 15 to 30 minutes, then make sure the child is lifting correctly and not showing signs of fatigue.

TRAINING

Has the child been trained on lifting techniques?

- ☐ Yes.
- ☐ No. **STOP!** Lifting incorrectly can cause back injury.

Has an adult demonstrated lifting on site?

- ☐ Yes.
- ☐ No. **STOP!** Children learn best when shown how to do the job at the work site.

Has the child shown he or she can do the job safely 4 to 5 times under close supervision?

- ☐ Yes.
- ☐ No. **CAUTION!** An adult must watch constantly until the child shows he or she can do the job.

SUPERVISION

Can an adult supervise as recommended?

- ☐ Yes.
- ☐ No. **STOP!** The right level of supervision is key to preventing injuries.

Remember



Non-slip shoes

Table 18.9B Can Your Child Do this Job?













Main Hazards	ABILITY		Remember
 Slippery/uneven surface can lead to slips, trips and falls	1. Can the child bend safely? (See "Bending") ___ Yes. ___ No.  STOP! Children must be able to bend correctly to do this job safely.	2. Is the child going through a growth spurt? For example, is he or she clumsy or frequently changing clothing size? ___ Yes.  STOP! Children in periods of rapid growth become less flexible, increasing the chance of muscle strain and injury to back and joints. ___ No.	 Non-skid shoes
 Weight can strain muscles	3. Do the objects to be lifted weight less than 10-15% of his or her body weight? ___ Yes. ___ No.  STOP! Children lifting more than 15% of their body weight are more likely to injure their backs.	4. Does the child have to carry the load less than 10-15 yards? ___ Yes. ___ No.  STOP! Children carrying a load more than 10-15 yards are more likely to injure their backs.	
 Repetitive motion can strain muscles and injure back and joints	5. Has the child been trained on lifting techniques? ___ Yes. ___ No.  STOP! Lifting incorrectly can cause back injury.	6. Has an adult demonstrated lifting on site? ___ Yes. ___ No.  STOP! Children learn best when shown how to do the job at the work site.	
	7. Has the child shown he or she can do the job safely 4 to 5 times under close supervision? ___ Yes. ___ No.  CAUTION! An adult must watch constantly until the child	SUPERVISION 7. Can an adult supervise as recommended? ___ Yes. ___ No.  STOP! The right level of supervision is key to preventing injuries.	

Table 18.9C What's the Right Amount of Supervision?

Supervision	
What's the right amount? Here are suggestions—but remember, it depends on the child	
Age 7–9:	LIMIT job to 15 minutes. WATCH constantly.
Age 10–11:	LIMIT job to 20 minutes. CHECK every few minutes.
Age 12–13:	CHECK every few minutes.
Age 14–15:	CHECK every few minutes at first. When the child shows he or she can do the job, LEAVE for 15–30 minutes, then make sure the child is lifting correctly and not showing signs of fatigue.

Table 18.10A NAGCAT Guideline: Hand Harvesting Vegetables

Hand-harvesting vegetables

Adult responsibilities

ADULTS NEED TO MAKE SURE

- Child has safe transport to the field
- Re-entry standards are followed
- Work area has no hazards
- Child has no insect allergies
- Child wears long sleeved shirt, long pants, wide brimmed hat, sunglasses and sunscreen
- Break areas are provided away from the work site with lockers and water for drinking and washing hands
- Child has at least one ten-minute break every hour
- Child drinks a quart of fluids every hour



Can your child do this job?

ABILITY

Can the child bend and lift safely?
(See "Bending/Lifting")

- ☐ Yes
☐ No **STOP!** Children must be able to bend and lift correctly in order to do this job safely.

Are cutting tools the right size for the child?

- ☐ Yes
☐ No **STOP!** The wrong size tools can cause injury.

Does the filled container the child will carry weigh less than 10–15% of his or her body weight?

- ☐ Yes
☐ No **CAUTION!** An adult should carry the filled container.

Does the child have to carry the filled container less than 10–15 yards?

- ☐ Yes
☐ No **CAUTION!** An adult should keep the collection point close by or carry the filled container to the collection point.

If the child is 12 or older, can he or she repeat a manual procedure for 50 minutes without becoming exhausted?

- ☐ Yes
☐ No **STOP!** Children working beyond their endurance are more likely to be injured.

Does the child have at least a 15–20 minute attention span? For example, can the child play a board game for 20 minutes?

- ☐ Yes
☐ No **STOP!** Children working beyond their attention span are easily distracted and more likely to be injured.

Does the child have good eye-hand coordination? For example, can the child place a key in a lock?

- ☐ Yes
☐ No **STOP!** Good eye-hand coordination is needed to prevent injury.

Does the child do things that seem dangerous for the thrill of it?

- ☐ Yes **CAUTION!** Children who take risks or behave dangerously need close supervision. Limit cutting with a knife.
☐ No

TRAINING

Has the child been trained to use cutting tools safely?

- ☐ Yes
☐ No **STOP!** Training is needed to prevent injury.

Has an adult demonstrated hand-harvesting vegetables on site?

- ☐ Yes
☐ No **STOP!** Children learn best when shown how to do the job at the work site.

Has the child shown he or she can do the job safely 4 to 5 times under close supervision?

- ☐ Yes
☐ No **CAUTION!** An adult must watch constantly until the child shows he or she can do the job.

SUPERVISION

Can an adult supervise as recommended?

- ☐ Yes
☐ No **STOP!** The right level of supervision is key to preventing injuries.

Main Hazards



Sun can cause heat exhaustion



Contact with chemicals can cause disease, rashes or burns



Repetitive motion can strain muscles and injure back and joints

Remember



Non-slip shoes



Good handwashing



Gloves (may be better or machine protection)

Supervision

What's the right amount? Here are suggestions—but remember, it depends on the child.

Age 7–9:
LIMIT job to 15 minutes.
NO cutting tools. WATCH constantly.

Age 10–11:
LIMIT job to 20 minutes.
NO cutting tools. WATCH nearly constantly.

Age 12–13: WATCH constantly at first if the child uses cutting tools. When the child shows he or she can do the job, CHECK every few minutes.

Age 14–15: CHECK every few minutes at first. When the child shows he or she can do the job, LEAVE for 15 to 30 minutes, then make sure the child is bending and lifting correctly and not showing signs of fatigue.

Table 18.10B Can Your Child Do this Job?































Main Hazards	ABILITY		Remember
 <p>Sun can cause heat exhaustion</p>	<p>1. Can the child bend and lift safely? (See "Bending/Lifting")</p> <p>Yes. </p> <p>No.  STOP! Children must be able to bend and lift correctly to do this job safely.</p>	<p>2. Are cutting tools the right size for the child?</p> <p>Yes. </p> <p>No.  STOP! The wrong size tools can cause injury.</p>	 <p>Non-skid shoes</p>
 <p>Contact with chemicals can cause disease, now or later</p>	<p>3. Does the filled container the child will carry weigh less than 10-15% of the child's body weight?</p> <p>Yes. </p> <p>No.  CAUTION! An adult should carry the filled container.</p>	<p>4. Does the child have to carry the filled container less than 10-15 yards?</p> <p>Yes. </p> <p>No.  CAUTION! An adult should keep the collection point close by or carry the filled container to the collection point.</p>	 <p>Good hand washing</p>
 <p>Repetitive motion can strain muscles and injure back and joints</p>	<p>5. If the child is 12 or older, can he or she repeat a manual task for 50 minutes without becoming exhausted?</p> <p>Yes. </p> <p>No.  STOP! Children working beyond their endurance are more likely to be injured.</p>	<p>6. Does the child have at least a 15-20 minute attention span? For example, can the child play a board game for 20 minutes?</p> <p>Yes. </p> <p>No.  STOP! Children working beyond their attention span are easily distracted and more likely to be injured.</p>	 <p>Gloves (may be leather or moisture resistant)</p>
	<p>7. Does the child have good eye-hand coordination? For example, can the child place a key in a lock?</p> <p>Yes. </p> <p>No.  STOP! Good eye-hand coordination is needed to prevent injury.</p>	<p>8. Does the child do things that seem dangerous for the thrill of it?</p> <p>Yes.  CAUTION! Children who take risks or behave dangerously need close supervision. Limit cutting with a knife.</p> <p>No. </p>	
	TRAINING		
	<p>9. Has the child been trained to use cutting tools safely?</p> <p>Yes. </p> <p>No.  STOP! Training is needed to prevent injury.</p>	<p>10. Has an adult demonstrated hand-harvesting vegetables on site?</p> <p>Yes. </p> <p>No.  STOP! Children learn best when shown how to do the job at the work site.</p>	
	<p>11. Has the child shown he or she can do the job safely 4 to 5 times under close supervision?</p> <p>Yes. </p> <p>No.  CAUTION! An adult must watch constantly until child shows he or she can do the job.</p>	<p>SUPERVISION</p> <p>12. Can an adult supervise as recommended?</p> <p>Yes. </p> <p>No.  STOP! The right level of supervision is key to preventing injuries.</p>	

Table 18.10C What's the Right Amount of Supervision?	
Supervision	
What's the right amount? Here are suggestions—but remember, it depends on the child	
Age 7–9:	LIMIT job to 15 minutes. NO cutting tools. WATCH constantly.
Age 10–11:	LIMIT job to 20 minutes. NO cutting tools. WATCH nearly constantly.
Age 12–13:	WATCH constantly at first if the child uses cutting tools. When the child shows he or she can do the job, CHECK every few minutes.
Age 14–15:	CHECK every few minutes at first. When the child shows he or she can do the job, LEAVE for 15 to 30 minutes, then make sure the child is bending, lifting correctly and not showing signs of fatigue.

Tractor operation

chart

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, while not on a steep slope and with reasonable distance from ditches, trees and fences.



Refer to the specific guideline for recommended supervision

Size of tractor

Increased complexity of job

OPERATING A FARM TRACTOR (no equipment attached)

TRAILED IMPLEMENTS fieldwork

3-POINT IMPLEMENTS fieldwork

REMOTE HYDRAULICS fieldwork

PTO-POWERED IMPLEMENTS fieldwork

TRACTOR-MOUNTED FRONT-END LOADER

WORKING IN AN ORCHARD

WORKING INSIDE BUILDINGS

DRIVING ON PUBLIC ROADS*

PULLING OVERSIZE OR OVERWEIGHT LOAD

HITCHING TRACTOR TO MOVE STUCK OR IMMOVABLE OBJECTS

SIMULTANEOUS USE OF MULTIPLE VEHICLES

ADDITIONAL PERSONS WORKING ON A TRAILING IMPLEMENT

PESTICIDE OR ANHYDROUS AMMONIA APPLICATION*

LAWN & GARDEN less than 20hp

SMALL 20hp to 70hp

MEDIUM/LARGE more than 70hp

ARTICULATED

12-13 years

12-13 years

14-15 years

16+ years

12-13 years

12-13 years

14-15 years

16+ years

12-13 years

14-15 years

14-15 years

16+ years

14-15 years

14-15 years

14-15 years

16+ years

14-15 years

14-15 years

14-15 years

16+ years

14-15 years

16+ years

16+ years

16+ years

14-15 years

16+ years

16+ years

16+ years

14-15 years

16+ years

16+ years

16+ years

N/A

16+ years

16+ years

16+ years

Due to increased hazard and complexity, these jobs should not be assigned to children.

* follow state/province laws

Figure 18.15 NAGCAT Guideline: Tractor Operation.

The most important question is whether using the NAGCAT helps to prevent injuries. So far, the evidence is weak, but positive (Pickett et al., 2003). The effort is strongest if three things happen in conjunction: (1) a safety specialist visits the farm; (2) the safety specialist gives the parents or supervisors the NAGCAT guides; and (3) the safety specialist provides information on basic child development. Most studies evaluate training and behavior modification rather than actual changes in the workplace itself. Stopping the injury prevention effort at parental and supervisor education may not be sufficient to attain behavioral and design changes on farms. Safety standard regulations may be necessary.

FUTURE RESEARCH

In 2002, NIOSH and the Great Lakes Center for Agricultural Safety and Health at The Ohio State University cosponsored a meeting to discuss research gaps and risk factors for MSDs among children and adolescents working in agriculture.*

Experts at the meeting made the following suggestions:

1. Evaluate jobs performed by youth to identify high-risk jobs and objectively determine appropriate job assignments for youth.
2. Develop and implement health and hazard surveillance systems for measuring and tracking the magnitude of risk for children and adolescents working in agriculture.
3. Develop and evaluate ergonomic interventions for reducing risk or MSDs for children and adolescents working in agriculture.

Table 18.11 summarizes important research gaps identified at the meeting.

Table 18.11 Important Gaps in Research on Children and Youth in Farms	
<i>Issues Related to Assessing High Risk Jobs</i>	<ol style="list-style-type: none"> 1. Develop an "Enterprise Classification" system and evaluate risk of MSD based on this classification (e.g., determine risk by region, agriculture sector, or size of enterprise). 2. Determine the number of exposed youth and what jobs they are doing in each commodity area. 3. Identify the hazards or physical work factors in each job or task and determine the number of hours worked per year. 4. Evaluate the effectiveness of different methods of risk assessment, including self-assessment, professional judgment, and objective quantitative methods. Use "health outcome" or "level of exposure" as a measure of risk. 5. Evaluate risk in unmechanized production (e.g., tool usage in manual labor).
<i>Surveillance Issues</i>	<ol style="list-style-type: none"> 1. Develop a National Registry of musculoskeletal hazards and health outcomes (e.g., National Health and Hazard Exam). 2. Supplement existing surveillance systems (e.g., National Health Interview Survey, National Health and Nutrition Examination Survey, Behavioral Risk Factor Surveillance System, and prospective community-based surveys such as the Keokuk and Iowa Safe Farm surveys). 3. Conduct ad-hoc population-based health and hazard surveys, such as clinic- or school-based methods or face-to-face interviews. 4. Develop partnerships with those who know and are known by the population under study. 5. Conduct quality cross-sectional and longitudinal studies. 6. Develop and validate a consensus list of jobs and health outcomes.

* The proceedings from this meeting are available in a special NIOSH report (Waters and Wilkins, 2004).

Table 18.11 Important Gaps in Research on Children and Youth in Farms (Continued)

<i>Intervention Issues</i>	<ol style="list-style-type: none"> 1. Develop more solutions. Local and federal government agencies should encourage private industry and academic-industry partnerships and develop vocational agriculture awards program for interventions at the high school or college level. 2. Develop improved methods of disseminating information. 3. Conduct studies that address liability, cultural, ethical, and economic barriers. 4. Encourage more intervention evaluations using randomized trials and quasiexperimental and blended evaluations. 5. Adopt successful models for implementation of solutions, such as the tobacco model for increasing awareness of interventions.
<i>Etiological Issues</i>	<ol style="list-style-type: none"> 1. Conduct studies to assess physical, cognitive, and developmental capabilities. 2. Encourage development of studies to examine the dose-response relationships for MSDs to determine the magnitude of exposures and symptoms, including examination of multiple exposures (e.g., sports, 2nd job). 3. Increase development of instrument-based and laboratory-based work assessment systems to improve measurement of exposure and health outcomes. 4. Conduct population, clinical, and laboratory studies to evaluate the short-term impact of risk factors on MSDs, such as effects of different types of exposures on MSD risk and early indicators, such as bone density, stiffness, and pain. 5. Conduct population, clinical, and laboratory studies to evaluate the long-term impact of repeated exposure (e.g., study to compare health status of retired farmers compared with nonfarm workers, evaluation of the permanent effects of physical loading and include groups with maximal exposures, etc.).

Source: Waters, T.R. and Wilkins J.R., Conference Proceedings: Prevention of Musculoskeletal Disorders Among Youth and Adolescents Working in Agriculture, NIOSH, Cincinnati, OH. DHHS(NIOSH) Publication No. 2004-119, 2004.

CONCLUSIONS

Farming is physically demanding. The strength and endurance training that children get while working on farms can contribute to their overall health and fitness. However, excessive physical demands may lead to acute or chronic injuries and illnesses to the musculoskeletal system. The risk is especially great for the lower back, shoulders, and upper extremities.

Table 18.12 Ergonomic Interventions for Youth Working in Agriculture

<ol style="list-style-type: none"> 1. Design equipment so workers with smaller body sizes can adjust controls. 2. Use backpacks, knapsacks, or straps to support equipment, such as sprayers and weed eaters. 3. Improve design of existing mechanical equipment and develop new equipment to eliminate bending and twisting during physically demanding farm work. 4. Use lightweight bags and wheeled carts for picking and transporting ground crops. 5. Use small tubs and baskets for carrying fruit and produce. The full tubs will weigh less. 6. Buy feed and other materials in smaller, lighter bags. 7. Match the task requirements with the child's physical and mental capabilities. Alter the task design or the number of individuals assigned to the task or develop alternate means of completing the task if the demands exceed the child's abilities. 8. Design work tools to fit the body dimensions of children.

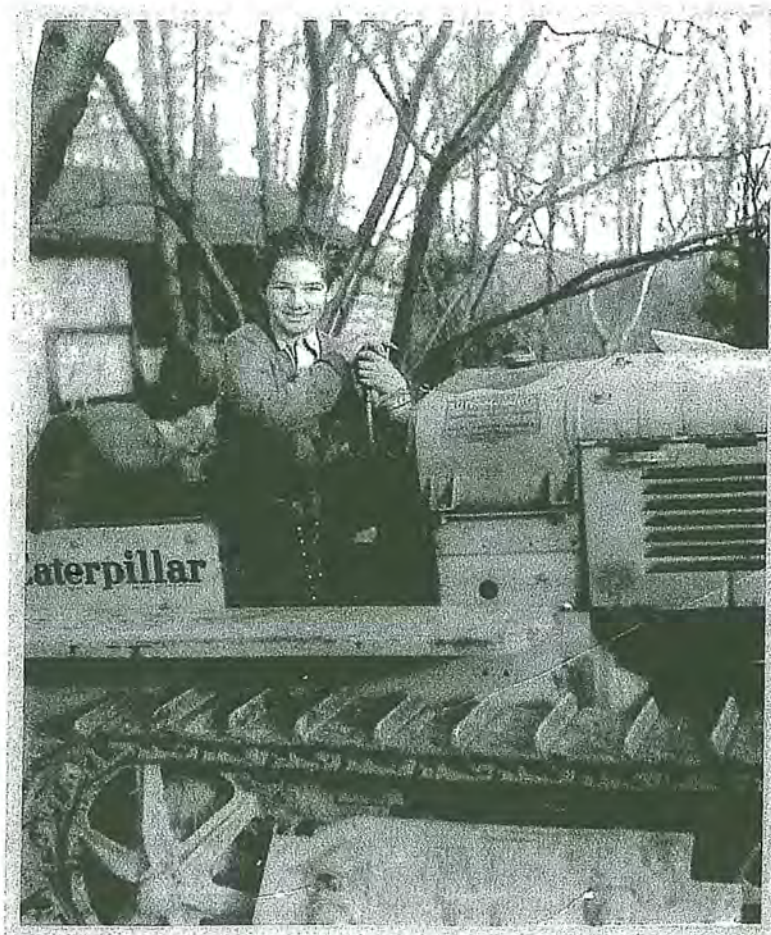
The demands of the job must match the child's abilities. Parents, supervisors, and children need to understand the hazards and know how to minimize risks. Children themselves will benefit from information that teaches them to recognize "normal" soreness versus soreness that indicates a need to rest or recover.

Table 18.12 provides additional suggestions for youth working in agriculture. More specific examples of successful ergonomic interventions are listed in "Simple Solutions: Ergonomics for Farm Workers" (NIOSH, 2001).

Since perceptions drive action, the first target for intervention is the perceptions of farm workers and supervisors. They need information on the problems in order to understand and make conscientious decisions on assigning farm tasks to children. The most effective ergonomic interventions involve a collective effort that includes children, parents, supervisors, and safety experts.

Children, parents, and supervisors will have ideas about task design and safety that fit their surroundings and lifestyle. They are also more likely to use the information if they are active participants in their own health and welfare, rather than recipients of programs designed by "outsiders."

Regardless of the risk of MSDs, children and adolescents will work in agriculture and on farms with their families to gain extra income. However, they should be able to do so without exposing themselves to significant risk. Every effort should be made to assign children to jobs appropriately, according to their capabilities and to identify and eliminate jobs with high risk of injury.



ACKNOWLEDGMENTS

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Ergonomics for Children: Designing products and places for toddlers to teens

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Humanics ErgoSystems, Inc., Encino, California

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- Focuses on design implications for products and environments for children
- Provides easy-to-find guidelines on children and health, products, home, schools, and public places
- Explores book bags, high-tech toys and other products, warnings, handwriting, and even the design of schools and neighborhoods

Providing guidance on a broad range of issues for young children and adolescents, *Ergonomics for Children: Designing Products and Places for Toddlers to Teens* give you a deep understanding of how children develop and how these developmental changes can influence the design of products and places for children. Copiously illustrated with photos and other images, the book helps you quickly find answers to your questions, grasp concepts, and apply them.

Its subsections are organized to help you locate and understand the content you need. Edited by experts with contributions from an international panel, the book is both broad in coverage and international in perspective. The contributors review the ways in which children develop physically, perceptually, cognitively, and socially and then use this information to provide practical guidelines for the design of places and products for children.

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There is considerable interest in and growing recognition of the emotional domain in product development. The relationship between the user and the product is

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