Extract from the book "Ergonomics for Children: Designing Products & Places for Toddlers to Teens" (2008) R. Lueder & V. Berg Rice (Eds). Taylor & Francis.

Chapter 18. "Preventing Work-Related Musculoskeletal Disorders for Youth Working on Farms" Written by Thomas R. Waters, Ph.D.

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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.

They often lift and move materials, operate farm equipment and perform other tasks that require considerable strength and coordination (Figures 1a and 1b). Nearly two million American youth, younger than age 20, lived or worked on a US farm in 1998 (Table 1).

Figure 1 *Image by Tom Waters*

Figure 2 *Image ©Ursy Potter Photography*

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.

Farms are one of the most hazardous places for anyone to work. In the US, about eight percent 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.

Table 1 Ages of children working on US farms
(Meyers & Hendricks 2001 from 1998 data)

Age	Percent	Number
< 10 yrs	9%	130,000
10-15 yrs	47%	650,000
16-19 yrs	53%	745,000

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 (Marlenga et al., 2003). Although most studies focus on farming, many youth also work in commercial or production agriculture, where serious injuries also occur. Unfortunately, we lack formal reporting systems to capture information on the types and causes of injuries children incur while working on farms or in commercial enterprises.

Farm workers are at risk of developing MSDs, particularly of the low back. In fact, farming ranks fifth among jobs at high risk of develop back pain. About 19% of farm workers experience work-related back pain that lasts a week or more[1]. This is more than double the rate among the general working population (9% for males) (Guo et al, 1995).

Image by Tom Waters

Figure 3 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 and/or treatment can occur.

[1] This does not include horticulture workers.

Characteristics of industrial work that contribute to injuries[2] (particularly back injuries) are similar to those often found in farming (Allread et al., 2004). Many farming jobs are physically demanding, often requiring lifting, pushing, pulling and carrying of heavy bags, buckets and other objects (Figure 2).

Musculoskeletal Disorders (MSDs) related to work

Musculoskeletal disorders are caused by excessive physical demands or repetitive exertions (Table 2). These MSDs can affect the upper and lower back, upper extremities (hands, wrists and elbow), shoulder, neck and lower extremities (legs, ankles and feet).

What are Musculoskeletal Disorders (MSDs)?	
Definition	Health conditions or disorders that 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	○ 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	Over use injuries, repetitive motion injuries, repetitive strain injuries, cumulative trauma disorders

Table 2 Description of musculoskeletal disorders (MSDs) and their causes.

[2] 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 3 Jobs performed by youth on farms that likely		
Work with Animals	• 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.	 *©Ursy Potter Photography*
Operating Equipment	• 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, 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)	• 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.	 *Tom Waters*
Tasks that require Awkward Postures	• Pull and sort sweet corn. • Weed vegetables with hand hoe. • Pick up rocks.	 *Tom Waters*
Table 2 lists jobs that farm workers identify as causing their injuries (Bartels et al., 2000). Youth working on farms face these very same risks (Ehrmann-Feldman et al., 2002).		

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 (Marlenga et al., 2001). 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).

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 3 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 (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 non-threatening 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. While adults experience these disorders more often than children, the initial insult can occur during childhood. Figure 3 illustrates one theoretical model of this potential chronic injury pathway.

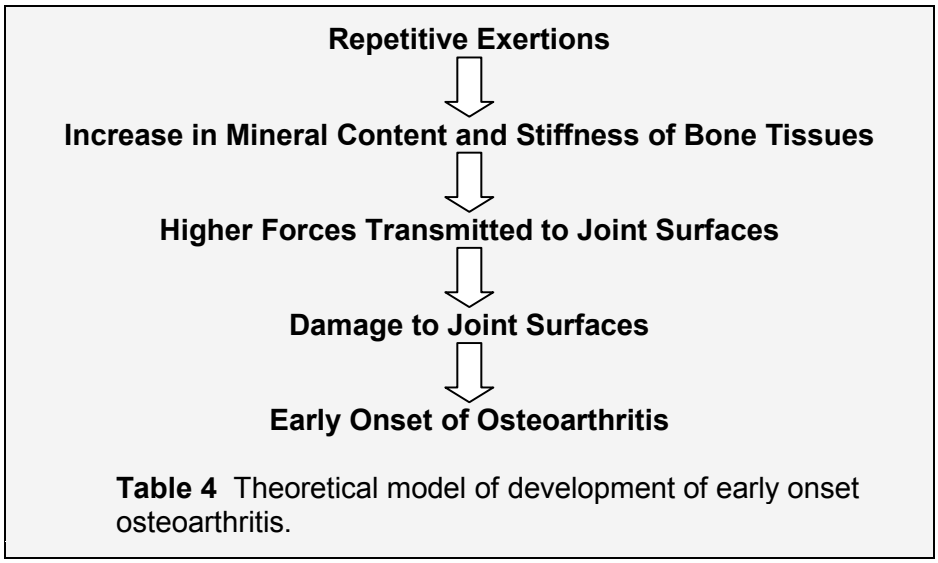

Table 4 Theoretical model of development of early onset osteoarthritis.

According to the theoretical model, repetitive exposure to large muscle exertions likely leads to significant increases in bone mineral density and bone stiffness. Mechanically, 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 4 *Image ©Ursy Potter Photography*

Figure 5 *Image ©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.

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.

Image ©Ursy Potter Photography

Figure 6 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.

Image ©Ursy Potter Photography

Figure 7 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 time. While 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.

Table 5 Child Development and Appropriate Work Tasks from the Penn State Report

(reprinted with permission, Murphy and Hackett, 1997)

Child development and appropriate work tasks				
Growth stage	**Developmental characteristics**	**Causes of deaths/injuries**	**Preventive strategies**	**Developmentally appropriate work tasks**
Birth–4 (infant/ toddler/ preschooler)	• 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	• Falling from tractors or heights, such as ladders • Ingesting poisons • Being kicked or trampled by animals • Being run over by tractor • Drowning in ponds or manure pits	• 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 super- vision at all times because of small children's poor coordination, high energy and lack of fear.	• None. Children this age should not be exposed to work hazards.
5–9 (preschooler/ early elementary school age)	• 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/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	• Slipping and falling from tractors, trucks or heights • Entangling in augers, other machines • Suffocating in grain • Being kicked or trampled by animals	• 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 JSA.	• Tasks of short duration that do not require 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

10-13 (middle school age/ early teen)	• 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	• 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	• 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.	• Hand raking, digging • Limited power tool use (supervision); hand tools better • Operating lawn mower (push mower, flat surface, under supervision) or garden tractor • Handling and assisting with animals
13–16 adolescent/ young teenagers)	• 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 need adult guidance • Feels need to be accepted by peers • Resists adult authority • Feels immortal	• Hearing loss from expo- sure to loud machinery • Head and spine injuries from motorcycle or all-terrain vehicle accidents • Machinery rollover/ roadway accident • Amputation due to power take-off (PTO) entanglement	• Judge size and age to measure 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.	• Still needs adult super- vision 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/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 non-walking rotary tiller.
16–18 (middle/ older teenage)	• Awkwardness overcome, mastery of small and large muscles basically complete. • Knows abilities, moving further away from family and into community as independent person • Feels immortal • May act like child one day, adult the next • Rebellion, risk-taking, aggressiveness 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	• Same as adult risks: respiratory illness, hearing loss, muscle/bone injuries, rollover from tractor, machinery entanglements • Additional risk if experimenting with or under the influence of drugs and / or alcohol.	• 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 absolutely ready. • Use JSA.	• 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.

Farmers and farm supervisors need to understand that musculoskeletal disorders 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).

Non-work Injuries

Figure 8 @Ursy Potter Photography

Figure 9 @Ursy Potter Photography

Figure 10 @Ursy Potter Photography

Injury and death occur even when farm children are not working. Although little is known about non-work 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.

Non-work injuries occur more often among children from one to six 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 some of these recommendations.

Table 6 Types of non-work injuries, accidents and deaths, along with potential solutions (Pickett, et al., 2005)

Causes	Activities	Potential Solutions
• Bystander and passenger runovers • Drowning • Machinery entanglements • Falls from heights (often from haylofts) • Animal trauma	• Playing at the worksite • Being an extra rider on farm machinery or being a bystander • Recreational horseback riding	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 (Figures 5a and 5b) 4. Store materials carefully, such as large items that might fall. 5. Institute guidelines for recreational riding of horses and all terrain vehicles.

Image @Ursy Potter Photography

Figure 11 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.

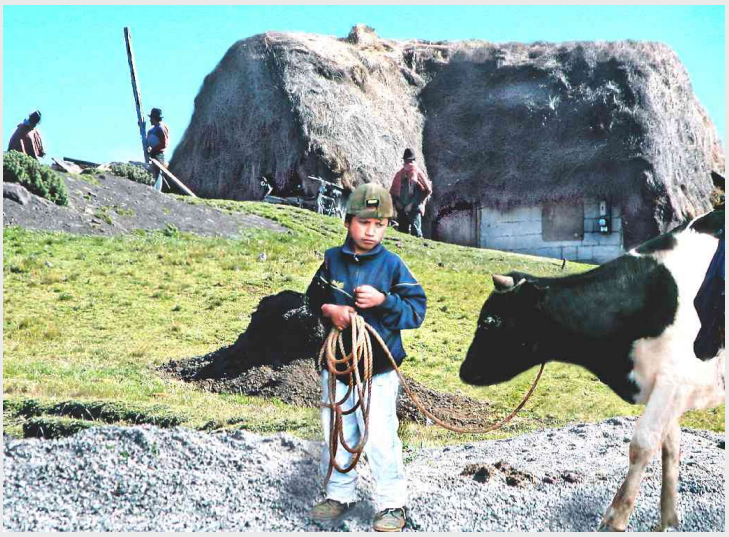

Figure 12 Image @Ursy Potter Photography

Figure 13 *Image @Ursy Potter Photography*

Careful instruction of how to interact with animals and emphasizing that animals can be unpredictable in the 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 text). 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.

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 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 6 lists the activities thought to cause the most serious MSDs in children during farm work[3]. 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".

[3] as reported by parents and supervisors,

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 the their children)
- the benefits of eliminating or reducing risk factors for MSD' for their children

Causes of serious child musculoskeletal disorders	
Primary:	○ Lifting objects ○ Forking ○ Shoveling
Secondary:	○ 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

Table 7. Causes of serious musculoskeletal disorders in children, as reported by parents and supervisors of children working on farms (Bartels et al., 2000).

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. Table 6 (above) summarizes parent and supervisors reports of the primary and secondary causes of child MSDs.

Match task demands with child capabilities

Another approach is to identify high-risk jobs and evaluate the child's capabilities to perform these demands. 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.

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 US to identify size characteristics of children are anthropometric data (infants – 20 yrs, 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.

Researchers at the National Institute for Occupational Safety and Health (NIOSH) and the University of Wisconsin-Milwaukee used the available strength and anthropometric data (above) to develop the NIOSH 2D Child Strength Program, a computerized two-dimensional strength prediction program[4] for use with young workers (Waters 2003)[5].

This NIOSH computer program calculates the percent of young persons who will be sufficiently strong to perform 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).

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.

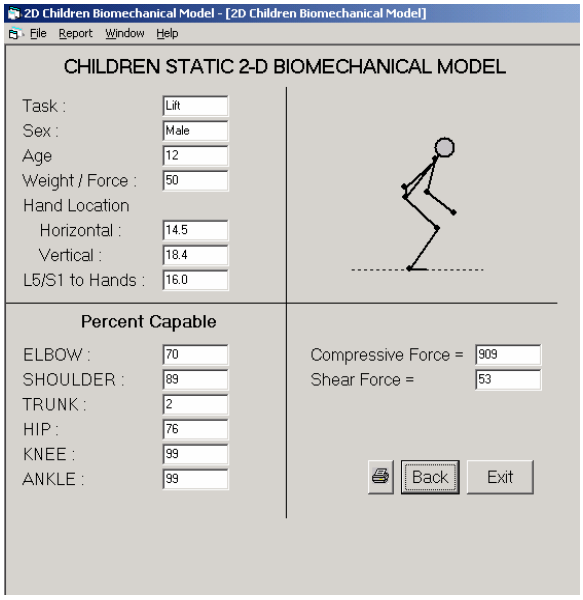

Table 8 Output Screen from NIOSH Static 2-D Biomechanical Model for Children

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 the tasks. The results tell you when to re-engineer a task or when someone with greater strength or a team of workers may be required.

[4] Further information about the NIOSH 2D Child Strength Program is available at www.childergo.com/farmchild-injuries.htm

[5] 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)[6].

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.

Figures 7, 8 and 9 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 (see example in Table 7). 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.

Sample checklist (NAGCAT)	
□ Yes □ No	1. Can the child lift safely?
□ Yes □ No	2. Has the child been trained to lift safely?
□ Yes □ No	3. Can the child easily push up to 10-15% of his or her body weight?
□ Yes □ No	4. Does the amount of material to be lifted weigh less than 10-15% of the child's body weight?
□ Yes □ No	5. Does the child have to carry the object less than 10-15 yards?
□ Yes □ No	6. Are the tools the right size for the child?
□ Yes □ No	7. Has the child shown they can do the job safely 4 to 5 times under close supervision?
□ Yes □ No	8. Can an adult supervise as recommended?

Table 9 Checklist developed from the North American Guidelines for Children's Agricultural 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.

[6] North American Guidelines for Children's Agricultural Tasks can be downloaded at www.nagcat.org

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Sample checklist (NAGCAT)	
□ Yes □ No	9. Can the child lift safely?
□ Yes □ No	10. Has the child been trained to lift safely?
□ Yes □ No	11. Can the child easily push up to 10-15% of his or her body weight?
□ Yes □ No	12. Does the amount of material to be lifted weigh less than 10-15% of the child's body weight?
□ Yes □ No	13. Does the child have to carry the object less than 10-15 yards?
□ Yes □ No	14. Are the tools the right size for the child?
□ Yes □ No	15. Has the child shown they can do the job safely 4 to 5 times under close supervision?
□ Yes □ No	16. Can an adult supervise as recommended?

Table 10 Checklist developed from the North American Guidelines for Children's Agricultural Tasks.

[7] North American Guidelines for Children's Agricultural Tasks can be downloaded at www.nagcat.org

Table 11 NAGCAT Guideline: Manual Labor Lifting

Manual Labor 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 bending are followed:

- Stand close to object to be lifted
- Spread feet wide to straddle the object
- Squat, bending knees and hips
- Keep head up and back straight
- Hold in stomach muscles
- Lift using leg muscles
- Keep the load close to body with a good grip
- Turn feet, not back, in the direction you are going
- 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
- Don¹t 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

Table 12 Can your child do this job?

Main Hazards

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

Weight can strain muscles

Repetitive motion can strain muscles and injure back and joints

ABILITY

1. Can the child bend safety?
(See "Bending")

___Yes.

___ No. STOP! Children must be able to bend correctly to do this job safety.

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.

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.

TRAINING

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 shows he or she can do the job.

SUPERVISION

7. Can an adult supervise as recommended?

___ Yes.

___ No. STOP! The right level of supervision is key to preventing injuries.

Remember

Non-skid shoes

Table 13 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 to 30 minutes, then make sure the child is lifting correctly and not showing signs of fatigue.

NAGCAT Guideline: Hand harvesting vegetables

Manual Labor
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 bathrooms 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.

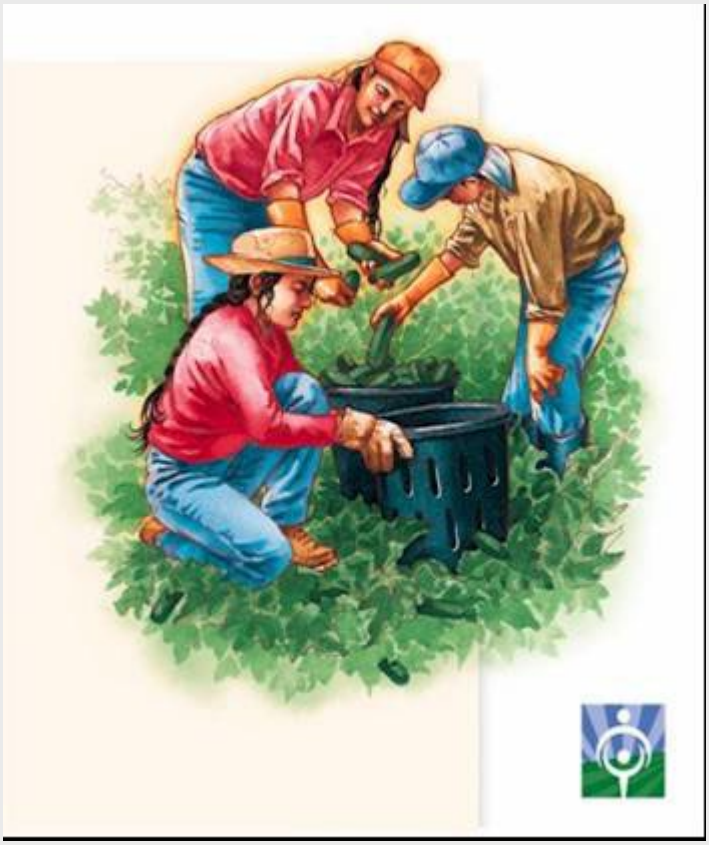

Table 14 NAGCAT Guideline: Hand harvesting vegetables

Table 1 Can your child do this job?

Main Hazards

Sun can cause heat exhaustion

Contact with chemicals can cause disease, now or later

Repetitive motion can strain muscles and injure back and joints

ABILITY

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

___Yes.

___ No. STOP! Children must be able to bend and lift correctly to do this job safely.

2. Are cutting tools the right size for the child?

___Yes.

___ No. STOP! The wrong size tools can cause injury.

3. Does the filled container the child will carry weigh less than 10-15% of the child's body weight?

___ Yes.

___ No. CAUTION! An adult should carry the filled container.

4. 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.

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

___ Yes

___ No. STOP! Children working beyond their endurance are more likely to be injured.

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?

___ Yes

___ No. STOP! Children working beyond their attention span are easily distracted and more likely to be injured.

7. 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.

8. 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

9. Has the child been trained to use cutting tools safely?

___ Yes

___ No. STOP! Training is needed to prevent injury.

10. 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.

11. 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 child shows he or she can do the job.

SUPERVISION

12. Can an adult supervise as recommended?

___ Yes

___ No. STOP! The right level of supervision is key to preventing injuries.

Remember

Non-skid shoes

Good hand washing

Gloves (may be leather or moisture resistant)

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.

Figure 14 NAGCAT Guideline: Tractor Operation

Tractor Fundamental: Tractor operation *chart*

Children should only operate wide-front tractors equipped with ROPS (Roll Over Protection Structure) and seatbelts.

An adult should ensure that the child can reach all controls while wearing a seatbelt, that a pre-operation service check has been completed, and that no extra riders are allowed on the tractor. This guideline assumes 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 ▼		Lawn & garden less than 20hp	Small 20hp to 70hp	Medium/large more than 70hp	Articulated
	Operating a farm tractor (no equipment attached)	12-13 years	12-13 years	14-15 years	16+ years
	Trailed implement fieldwork	12-13 years	12-13 years	14-15 years	16+ years
	3-point implements fieldwork	12-13 years	14-15 years	14-15 years	16+ years
	Remote hydraulics fieldwork	14-15 years	14-15 years	14-15 years	16+ years
	PTO-powered implements fieldwork	14-15 years	14-15 years	14-15 years	16+ years
	Tractor-mounted front-end loader	14-15 years	16+ years	16+ years	16+ years
	Working in an orchard	14-15 years	16+ years	16+ years	16+ years
	Working inside buildings	14-15 years	16+ years	16+ years	16+ years
	Driving on public roads*	N/A	16+ years	16+ years	16+ years
	Pulling oversized or overweight load	**Due to increased hazard and complexity, these jobs should not be assigned to children.**			
	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*				

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 provided 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 co-sponsored a meeting to discuss research gaps and risk factors for MSDs among children and adolescents working in agriculture[8].

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 3 summarizes important research gaps identified at the meeting.

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

Table 3: Important gaps in research on children and youth in farms (Waters & Wilkins, 2004)	
Issues related to assessing high risk jobs	1. Develop an "Enterprise Classification" system and evaluate risk of WMSD 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 un-mechanized production (e.g., tool usage in manual labor).
Surveillance issues	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.
Intervention issues	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, quasi-experimental and blended evaluations. 5. Adopt successful models for implementation of solutions, such as the tobacco model for increasing awareness of interventions.
Etiological issues	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 non-farm workers, evaluation of the permanent effects of physical loading and include groups with maximal exposures, etc.)

Conclusions

Farming is physically demanding. The strength and endurance-training 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.

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.

Box 4 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".

Box 4. Ergonomic Interventions for Youth Working in Agriculture

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 development alternate means of completing the task if the demands exceed the child's abilities.
8. Design work tools to fit the body

Regardless of the risk of MSDs, children and adolescents will work in agriculture and on farms with their families or 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.

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Photo from editor RL of her uncle in 1945.

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Ergonomics for Children

Designing products and places for toddlers to teens

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CHAPTER 18

PREVENTING WORK-RELATED MUSCULOSKELETAL DISORDERS FOR YOUTH WORKING ON FARMS

THOMAS R. WATERS

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