

Agricultural Disability Awareness and Risk Education (AgDARE) for high school students

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Abstract

Objective—Develop and test a farm health and injury prevention educational intervention for high school agriculture students.

Setting—Twenty one high schools in Kentucky, Iowa, and Mississippi.

Methods—A quasiexperimental crossover design was used to test the effectiveness of two sets of instructional materials designed through participatory action research with agriculture teachers and students. Narrative simulations based on farm work stories and simulations of farm work while students pretended to have a disability were completed in 14 schools (n = 373) over the academic year. Students in seven control schools (n = 417) received no intervention but completed, in the same time frame as students in the treatment schools, demographic surveys and pre-measures and post-measures of farm safety attitudes and intent to change safety behaviors. One year after the intervention, 29 students from the treatment group received farm visits to measure their farm safety behaviors.

Results—Students engaged in hazardous work on farms. Thirty two were involved in tractor overturns and 11 had received injuries from rotating power take-off mechanisms. One fourth reported hearing problems, and 21% had respiratory symptoms after working in dusty farm surroundings. Students who completed at least two physical and two narrative simulations of the Agricultural Disability Awareness and Risk Education (AgDARE) curriculum showed statistically significant positive changes in farm safety attitude and intent to change behaviors.

Conclusions—Adolescents engage in farm work that places them at risk for injury and illness. The AgDARE curriculum may be an effective and efficient method of teaching farm safety in high school agriculture classes.

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Agriculture consistently ranks among the top three most hazardous industries, yet children begin work in the fields at young ages. Nearly 1.3 million farm children live, play, and work on farms surrounded by animals, machinery, and structures that provide their families' incomes.¹ Farm work, often beginning in early childhood, creates a melding relationship

between workplace and home, exposing the farm family to risks for injury that may not be present in other settings.²

In 1985 the injury fatality rate for farm child residents, with 129 injuries reported for every fatality.³ A decade later, the mortality rate for farm child injuries had declined by 39%; however, the morbidity rate had increased 10.7%.¹

Farm adolescents, especially males, operate large machinery, work with livestock, and engage in many activities that would be considered hazardous duty in other occupations. During their teens these young workers begin to work unsupervised, often in situations where they have little experience or training. As a result, this age group experiences the highest injury rate of all working youth on farms.^{1 4 5 6 7} In Kentucky, males age 16-18 experienced a farm work injury rate of 9.2/100 children, 3.5 times the risk reported in other studies using similar ages.⁸

In 1990, a congressional mandate turned national attention to preventing agricultural injuries and illnesses. Federal funding sponsored the first full scale examination of farm health and safety. The results of these studies illustrated the epidemic proportion of injuries to farm children. In 1996, the Child Agricultural Injury Prevention Initiative was established to combat the alarming rate of fatal and non-fatal farm injury.⁹ Agricultural Disability Awareness and Risk Education (AgDARE) was developed in response to this initiative.

AgDARE is an experiential learning curriculum for high school agriculture classes. The goal of AgDARE is to decrease the injury rate of adolescent farm children by influencing their work practices through interactive learning techniques in the form of physical and narrative simulation exercises. AgDARE bases its instruction on collages of stories told by farmers with disabilities. Each narrative simulation tells a story about a child or adult who experiences a physical disability as a result of making poor choices about farm safety. Working through simulations allows students to place themselves in the disabled farmer's situation and imagine the future. As a result, students become aware that disability and a permanent change in body image, self efficacy, and vocational choices are possible outcomes of unsafe work performance.

The technique of simulating real life situations is based in learning theory and has been used in other injury prevention research.¹⁰ Children and adolescents can learn to understand the social and cultural relevance associated with actions and people by telling stories,

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listening to stories, and role playing stories. They use these stories to integrate what they and others feel, think, and do. Norms, goals, beliefs, and desires provide the framework for the story. The storyline, plot, characters, goals, obstacles, predicaments, decision alternatives, and consequences of the story must be meaningful, believable, and engaging.¹⁰⁻¹¹ The interactive aspect of the story forces children to interpret the causes of their own behavior (safety choices) and that of others¹² and therefore reveal their own experiences. In a learning situation, one can view how children are logically relating concepts, such as work and injury, by the way they act out the stories.

Cognitive growth varies among adolescents. Children have the capacity to think abstractly at about age 12, but full abstract thought isn't achieved until around age 15–16 years.¹³ Generally at ages 14 and 15, they can generate basic hypotheses, consider contrary-to-fact situations, generate most possibilities from a specific situation, and approach problem solving in a systematic fashion. To accommodate the range of cognitive growth among adolescents, AgDARE used both physical and narrative simulations.

Simulations used in training situations can translate key information into powerful and memorable images that are more likely to change behavior than are didactic presentations of the same material.¹⁴⁻¹⁵ Simulation exercises, in both narrative and physical formats, can provide insights about economic stressors faced by workers, the associated risk of injury, and the long term social, economic, and physical costs of both stressors and injuries. Narrative simulations (stories) serve as mental models that direct one's attitudes, judgments, decisions, and behavior. These stories, when authentic, are powerful in helping the learner translate relevant information into memorable instruction. What is learned becomes "active" knowledge, valued, and remembered and used to direct future actions.¹⁰ Physical simulations ("hands-on" role playing in a safe environment) incorporate all the senses in the learning experience, exerting influence on decisions about behavior, based not only on mental models but also on physical response.

Translation of injury data (such as type and severity of injury, consequences of disability and physical limitations) into narrative simulation exercises for the prevention of occupational injuries has been extensively researched in the mining industry.¹⁶⁻¹⁷ Both physical and narrative simulations have advantages over other forms of instruction: they require active responses from the learner, provide immediate feedback to reinforce positive behaviors and redirect negative behaviors, and allow key decisions to be made in a risk-free environment (where errors may be embarrassing but not physically dangerous).¹³

AgDARE uses both types of simulations as bases for instruction. The cognitive (narrative) simulation is a pencil and paper format in which the student works both independently and in a group in a problem solving exercise. The story unfolds as students make choices

about the work behavior described in the story. Good choices result in positive outcomes, while poor choices may result in injury or negative economic or social impact. Students obtain instant feedback about their choices and have the opportunity to share similar stories from their own experiences. These discussions reinforce the reality of the story.

In the physical simulation, the student "assumes" a disability and attempts to perform simulated farm work in a safe setting. Their peers coach the students as they attempt to master such tasks as doing farm repair work one handed or transferring from a wheelchair to a farm truck. Students and instructors interact during the simulation to highlight the frustration and challenge of working with a disability. At the end of the simulation a group discussion reinforces safe work practices to avoid injury.

The simulations used in the AgDARE curriculum focus on the prevention of four disabilities: amputation, spinal cord injury, hypersensitivity pneumonitis, and noise induced hearing loss. Amputations occur in one out of 10 farmers as a result of machinery entanglement.¹⁸ Spinal cord injury is a primary outcome of tractor overturns and falls.¹⁹ Hypersensitivity pneumonitis (farmer's lung) is due to recurring exposures to dusts, molds, and particulate matter.²⁰ Hearing loss is documented even among teen farm residents and progresses to serious levels as age increases.²¹

Subjects and methods

STUDY DESIGN

The project focused on high school agriculture students, particularly 9th and 10th graders enrolled in 21 schools in Kentucky (n = 9 schools), Iowa (n = 7 schools), and Mississippi (n = 5 schools). These states were selected because of previous cooperative working relationships, cultural diversity, and differences in agricultural production and commodities.

Each state's agricultural education director identified potential schools that had strong agricultural programs. The investigators contacted the agriculture teachers and their principals and invited them to participate in the study. Schools in each state were partitioned by location and commodity, so differences between schools would be minimized. Schools were then randomly assigned to one of two treatment groups or the control group.

A quasiexperimental crossover design was followed.²² The design contained two treatment groups (see table 1), with replication of the intervention occurring in 14 schools across

Table 1 Quasiexperimental crossover design for intervention

Group	Sequence of observations and treatments				
A (n = 7 schools)	O ₁	X _n	X _p	O ₂	O ₃
B (n = 7 schools)	O ₁	X _p	X _n	O ₂	O ₃
C (n = 7 schools)	O ₁			O ₂	

O₁ = first observation on dependent variables, O₂ = second observation on dependent variables, O₃ = on-site (follow up) observation.

X_n = narrative simulation, X_p = physical simulation.

the three states. Survey assessment on the key dependent variables was conducted at three points (pre-intervention, post-intervention, and farm visits) for the two treatment groups. One treatment group (group A) received the narrative simulations prior to the physical simulations; the other treatment group (group B) received the physical simulations before the narrative. Surveys were conducted at two points for the control group.

INTERVENTION

The intervention consisted of two visits to each treatment school to administer the simulations. The visits were temporally separated across the duration of the instructional scheduling in the school. The first visit included the completion of a demographic survey that asked about the student's farm work, health and injury history, and acquaintance with a person with a disability. Students completed the Farm Safety Attitude (FSA) instrument and the Stages of Change (SOC) pre-test. The research team delivered the intervention (either physical or narrative simulations). Each of the four simulations was delivered in 15–30 minute consecutive units. During the second visit the parallel simulations (either the physical or narrative not delivered in the first visit but addressing the same disability) were delivered. Students also completed the post-test versions of the FSA and SOC. Each teacher completed an information sheet that identified additional farm safety instruction, participation in other safety programs, and farm injuries or sentinel events that had occurred since the first visit. One year after treatment, AgDARE researchers and teachers made farm visits to a subset of the treatment students, where students' work behaviors were observed.

Students in control schools completed the same pre-test and post-test and the demographic survey as the treatment groups. These data were collected either by teachers or by the research team in the same time frame as the treatment schools. Control school teachers also completed the teacher information sheet.

INSTRUMENTS

The researchers developed two Likert scaled instruments for this study. The instruments were critiqued by agriculture education experts, revised, and pilot tested in one school prior to the intervention. Scores from 1–5 on each item were possible, with higher scores associated with better safety attitudes and behaviors. Each instrument took students about 10 minutes to complete. The FSA instrument measured attitudes toward safe work behaviors. The SOC instrument was based on the transtheoretical model of readiness to change to assimilate healthy behaviors.²³ It has been suggested that this model has application for the field of injury prevention.²⁴ The process of behavior change is assumed to consist of five stages: (1) pre-contemplation, (2) contemplation, (3) preparation, (4) action, and (5) maintenance. The purpose of this study was to determine whether an intervention could move adolescents from thinking

Table 2 Sample characteristics of treatment and control children for farm safety intervention (n=790); values are %*

	Treatment (n=373)	Control (n=417)	Total (n=790)	p Value (χ^2 , df=1)
Gender				
Male	63.4	71.9	67.9	0.011†
Female	36.6	28.1	32.1	0.011†
Ever lived on a farm	60.4	55.1	57.6	0.130
Ever worked on a farm	75.1	74.4	74.7	0.829

*Percentages based on number of responses to each item.

†Statistically significant ($p < 0.05$).

(contemplation) to doing (action), so only items to index these two stages were created.

Psychometric properties of the instruments were examined using an iterative process. A factor loading of greater than .40 was used for item retention. Varimax and oblique rotations were used to evaluate reduction of cross loading. To assess reliability of the items, Cronbach's coefficient alpha was calculated for each factor.

Results

The final sample consisted of 373 complete treatment data sets and 417 controls, yielding a total sample of 790. A complete dataset included the demographic survey and pre-tests and post-tests. In addition, treatment subjects had to complete at least two units (physical and narrative simulations about the same disability) of the four units of instruction.

Treatment and control groups were compared for equivalency (see table 2). The sample was 98% white. Students in the control group were slightly older (mean = 16.1 years) than the treatment students (mean = 14.9 years old) and were more likely to be in 10th or 11th grade. Control students were more likely to be male; overall 68% of the sample was male. There was no difference between the groups in years of living or working on farms. Approximately 58% of the sample had lived on a farm, and 69% of these reported currently living on a farmstead. Three fourths of the students reported working on farms, and 67% of these reported working on the farm at the time of their participation in AgDARE.

To assess work exposure and work safety practices, the students answered questions about their work and work behavior. Table 3 illustrates these characteristics for the 585 students who reported ever working on a farm. It should be noted that not all students answered every question, and the percentages in the table are based on the number of students actually responding to that item. The majority of students in each group reported farm work exposure that placed them at risk for the four disabilities targeted by AgDARE. Despite their young age, 21% of the sample reported difficulty breathing after performing farm work, and 25% reported they did not hear well. Perhaps even more alarming, 32 students (6%) had already overturned a tractor and eight had experienced an injury due to a power take-off. While 64% of the overall sample reported tractor driving, only 53% of the students who had driven a tractor equipped with a rollover

Table 3 Farm work exposure and behavior at baseline evaluation of treatment and control children for farm safety intervention (n=585); values are %*

Work exposure	Treatment (n=277)	Control (n=308)	Overall sample	p Value (χ^2 , df=1)
Farm work includes dusty jobs	86.6	85.4	86.0	0.707
Use respirators on farm†	12.8	15.0	13.9	0.471
Ever had difficulty breathing after a dusty farm job	24.9	18.1	21.5	0.07
Ever driven a tractor	73.4	82.6	78.3	0.008‡
Ever driven a tractor with a ROPS†	55.6	59.5	57.5	0.368
Tractor used most has a seat belt and ROPS†	48.2	55.6	52.1	0.004‡
Ever overturned a tractor	6.2	8.0	7.2	0.455
Uses power take-off driven equipment	75.0	78.2	76.6	0.387
Ever stepped over a rotating power take-off	29.4	24.0	26.6	0.145
Ever used equipment with missing or damaged power take-off shield	46.4	43.7	44.9	0.528
Use noisy equipment on farm	83.9	83.2	83.5	0.84
Ever used hearing protection†	22.6	26.6	24.6	0.296
Ever experienced not being able to hear well	24.1	31.0	27.7	0.065
Ever experienced hearing problems	60.9	62.6	61.8	0.679

*Percentages based on total responses to each item.

†Protective safety behavior.

‡Statistically significant (p<0.05).

protective structure (ROPS) said the tractor they use most often was equipped with a protective rollbar (ROPS) and seat belt. The groups differed significantly on only three exposure variables: the control group was more likely to have ever driven a tractor, including tractors with ROPS, and more likely to have used power take-off equipment.

Subjects were combined into one group (treatment and control) for assessing the integrity of the pre-test and post-test instruments. Factor analysis was performed on both pre-intervention scores and post-intervention scores with no difference discovered in factor structure. A varimax rotation offered the best solution to the analysis of the FSA instrument. The FSA was reduced to eight items. Two factors, disability and prevention, were present with item loadings between 0.46 and 0.67. Reliability coefficients were 0.67 and 0.73 respectively.

An oblique rotation eliminated cross loading of items in the SOC instrument. The SOC was reduced to 10 items with two factors, action and contemplation. Items loaded between 0.53 and 0.79. Reliability coefficients were 0.81 and 0.88 respectively.

Analysis of covariance (ANCOVA) was used to determine post-intervention differences between the treatment and control groups, adjusting for baseline values of the corresponding scale score. *Post hoc* comparisons were based on Fisher's least significant difference procedure (see table 4). The least squares means presented in the table reflect the post-intervention scores, adjusted for baseline values. For the outcome of FSA, the ANCOVA revealed a significant difference between the two groups. In particular, the treatment group exhibited a significantly higher mean FSA score on post-assessment, even when adjusting

Table 4 Comparison of changes in safety attitudes and stages of change with regard to farm safety intervention and treatment groups. ANCOVA with least squares (LS) means and standard errors (SE) for the post-intervention period, adjusting for baseline values

Scale	Treatment group LS mean (SE of LS mean)	Control group LS mean (SE of LS mean)	Overall F statistic (df)	p Value
Attitude	32.1 (0.3)	31.3 (0.2)	72.0 (2;622)	<0.001
Stages of change	31.1 (0.6)	21.4 (0.5)	134.5 (2;604)	<0.001

for baseline attitude (p = 0.001). The ANCOVA model for SOC also indicated a significant difference between groups. The treatment group had a significantly higher mean SOC score, compared with the control group (p <0.0001). Initial ANCOVA models considered a three group comparison, with the treatment group split in two (the order in which the two intervention components were administered distinguished these two groups). These models revealed that for both FAS and SOC, there were no differences between the two subgroups of the treatment group (p >0.3 for both scales). For this reason, only comparison of treatment versus control is described here.

Discussion

This study highlights the work exposure of farm adolescents. Even during their early teen years, students in this study reported exposure to potentially life threatening situations. Several students had already been injured doing farm work, and others reported symptoms consistent with noise induced hearing loss and respiratory disease.

The primary purpose of the study was to design and test an educational intervention that would increase safety attitudes and safety behaviors of teen farm workers. To meet this purpose the researchers designed a participatory action project aimed at the developmental level of adolescents ages 14–16. Positive changes in farm safety attitude, intent to change farm work behavior, and self reported behavior support that the study's purpose was fulfilled.

Adolescents learn differently than adults. They acquire and retain knowledge better if they are active participants in the learning process. Agricultural students include many adolescents that are already engaged in farm production. They rely on both mental and physical models to acquire work attitudes and behaviors; for example, their agriculture curriculum depends heavily on physical engagement and problem solving. Students may plan and build calf feeders one month and plan crop production the next as part of their school work. They are expected to work individually and in groups. At their ages, these students are a mix of concrete and abstract learners with various learning styles. AgDARE instruction incorporated all learning styles. By using a repeated mixed method of instruction, the learning ability of each student was maximized.

Students in AgDARE demonstrated significant gains in safety attitude and behavior. The instructional materials were administered within allotted class time and were highly adaptable to the physical environment and learning style of each class. The curriculum is portable and affordable. These features should make the AgDARE curriculum attractive to teachers.

There are several limitations to the study. The control group was older than the treatment group. Control students may have had farm experiences that we did not know about that would have influenced their behaviors, and

their behaviors may have been more solidified than the younger treatment group. If this were the case, it would be more difficult to effect a change in their scores.

AgDARE has not been tested in a regular classroom setting where the agriculture teacher teaches the AgDARE curriculum. Students could have responded more favorably to the researchers than they would have to their agriculture teachers. However, the research team did not have the advantage of knowing the learning styles of the individual students, their history, or even the physical environment of the class itself; thus, it is also possible that students would perform better if their own teacher taught AgDARE.

This study relied heavily on self reported behavior. To validate these reports, a convenience sample of 29 students who currently worked on farms and completed the AgDARE program were selected by their teachers and the research team for farm visits one year after the students' participation in AgDARE. Of these students, 22 (76%) had made safety behavior changes in their farm work since the program. Changes included equipment modification, installation of roll bars on tractors, use of hearing protection, respirators, communication devices, vision protection, and safety checks. Changes frequently extended to family units. Although these results cannot be statistically interpreted, they attest to the influence of the program and its lasting effects.

Conclusion

AgDARE should be tested under regular class conditions. It needs further performance evaluation by students and teachers before it is widely adopted; however, the students and teachers in this study were very receptive to its content. Teachers asked for the completed curriculum for their future classes and expressed admiration for AgDARE's utility and comprehensiveness. AgDARE fits nicely into existing curriculum, time constraints, and budget. In this initial study AgDARE demonstrated positive influence on safety attitudes and safety behaviors that lasted after the intervention. Portions of AgDARE are now being transformed into multimedia and bilingual format for further testing.

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