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Occupational safety & health of young adult agricultural workers

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OCCUPATIONAL SAFETY & HEALTH OF YOUNG ADULT AGRICULTURAL WORKERS

by

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CERTIFICATE OF APPROVAL

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PH.D. THESIS

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Wonder is the beginning of wisdom.
-Socrates

To my parents, my favorite farmers.

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ABSTRACT

Agriculture is the most hazardous occupational industry for young adults. Young adults are engaging in agricultural work and interacting with machines and equipment that are known to cause fatal and nonfatal injuries and illnesses. However, it is unknown *how* young adults are engaging with equipment and machinery. Methods to reduce exposures to occupational hazards are defined in the Hierarchy of Controls, which suggest elimination, substitution, or engineering controls are most effective and therefore most desirable. However, there are barriers to applying these controls in agriculture including cost and the decision marking capacities of young adults in the workplace. Therefore, administrative controls and personal protective equipment (PPE) may be more appropriate controls for young adult agricultural workers. However, the influence of administrative controls, including workplace organizational factors and social influences in the workplace on work behaviors, are unknown and interventions to increase the use of personal protective equipment use among the population are limited.

An online survey was developed and administered to young adult agricultural workers in Iowa. Workplace safety and health behaviors within six common agricultural work areas were assessed and information on social influencers, workplace policies, farm characteristics, and individual characteristics were collected. An intervention was developed that coupled behavioral theory with technology to increase the use of hearing protection among young adult swine facility workers. Members of the intervention groups logged their daily use of hearing protection use when working in

swine facilities. Reported use of hearing protection was collected at baseline, immediately post-intervention, and three-month follow-up and compared among study groups.

Results from the cross-sectional, online survey concluded supervisor influence, more so than peers or parents, is most strongly associated with safe work practices. We also observed an association between safe working practices and the number of policies young adults reported in effect at the farm they are employed. In addition, an increase in reported hearing protection use was found among three study groups (intervention with goal setting, intervention without goal setting, and control) at immediate post-intervention in a randomized controlled trial. The greatest increase in hearing protection use was among the intervention group that also set a daily goal for hearing protection use, however, these changes were not maintained at delayed post-intervention follow-up.

Associations between workplace organizational factors and reported safety practices indicate an opportunity for interventions. Results from our theory-based intervention to increase the use of hearing protection among young adults working in swine facilities suggested that incorporating constructs of the Social Cognitive Theory and integrating technology are effective in changing safety behaviors, however, simply providing hearing protection to young adult workers may be most effective in sustaining behavior change.

PUBLIC ABSTRACT

Background: Agriculture is the most hazardous occupational industry for young adults. Young adults are engaging in agricultural work and interacting with common hazards, however, it is unknown *how* young adults are engaging with such hazards and whether administrative controls, including workplace organizational factors and social influences in the workplace, are associated with safe working practice. Furthermore, theoretically-based interventions to reduce exposures are limited in agricultural populations, particularly among young workers.

Methods: Workplace practices were examined among young adult agricultural workers (18-24). Workers reported their participation in six agricultural work areas, indicating their participation in specific behaviors within each work area, rating the risk-taking behaviors of parents, peers, and supervisors, and reporting on the presence of workplace organizational characteristics. A second study, conducted among swine facility workers in the Midwest, tested the effectiveness of an intervention that coupled behavioral theory with technology to increase the use of hearing protection in young adult workers.

Results: Results from the survey indicated supervisor influence was more strongly associated with reported workplace behaviors than coworker/peer or parent influence. Furthermore, organizational factors including number of hours worked each week and the presence of safety and health policies was associated with workplace behaviors. Results from the intervention study suggest behavioral tracking is effective at increasing the use of hearing protection among young adult swine facility workers in the

short term, however, changes in behavior are not maintained over time. Supplying hearing protection is a more effective tool in facilitating sustainable behavioral change.

Conclusions: Results suggest interventions that address social and organizational factors of work to improve workplace behaviors among young adult agricultural workers may be more effective than other types of interventions.

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CHAPTER 1

Introduction

Agriculture

Agriculture consistently ranks among the most hazardous occupational industries and workers are at risk of injuries, illnesses, disability, and death (Missikpode et al., 2015). In 2015, the agricultural fatal work injury rate was 22.8 per 100,000 full-time equivalent workers, nearly seven times the all-worker fatal injury rate of 3.4 per 100,000 full-time equivalent workers (U.S. Bureau of Labor Statistics, 2016). In 2015, the incidence rate of nonfatal injuries and illnesses in agriculture, forestry, hunting, and fishing was 5.7 per 100 full-time workers, nearly twice the all-industry rate of 3.3 per 100 full-time workers. The rate of nonfatal injuries and illnesses was 5.7 per 100 in crop production, and 6.9 per 100 in animal production, two common work areas in the Midwest (U.S. Bureau of Labor Statistics, 2016). While these statistics are high, it is widely accepted the rate of nonfatal occupational injuries in agriculture is largely underestimated (Leigh, Marcin, & Miller, 2004).

Age has been identified as a risk factor for agricultural-related injury. Unlike other industries, agricultural workers range from very young to very old. Children as young as eight report working on family farms (Jinnah, Stoneman, & Rains, 2014; Reed, Kidd, Westneat, & Rayens, 2001a) and farmers remain active beyond the traditional retirement age (O'Neill, Komar, Brumfield, & Mickel,

2010). While children and older adults (over the age 65) have been identified as vulnerable to agricultural-related injury, **the focus of this research is the young adult agricultural worker (18-24 years old) population, a large and important group of agricultural workers and a group at risk of occupational injury and illness.**

Young Adult Workers in Agriculture

Agricultural employs a large proportion of young adult workers (Hard & Myers, 2006; McCallum, Murphy, Reed, Claunch, & Reynolds, 2013; McCallum, Reynolds, Kelley, Conaway, & Braune, 2006; Westaby & Lee, 2003). The United States Department of Agriculture estimated there were over 250,000 young adults serving as the *primary* operator of a farm in 2012 (United States Department of Agriculture, 2014). However, the number of young adults working on farms is projected to be much larger as this data does not include the young adults living and working on their family's farm, young adults working as hourly employees on farms, and young adults engaged in agricultural work as a component of a secondary or post-secondary educational program. Young adults' (18-35 years old) participation in the agricultural workforce is expected to become even more prominent as it is projected that 25% of American farmers will retire given low commodity prices and advanced age in the Midwest in the next 20 years (Utterback, 2014), leaving young farmers to fill the employment need.

Unique to the agricultural industry, workers are a difficult population to reach. Workers are distributed geographically, work in isolation, and do not report to a centralized work location like workers in manufacturing or healthcare. Young adult agricultural workers were recruited into studies included in this dissertation via agricultural programs at community college and universities in the Midwest. While recruiting from educational institutions may limit the generalizability of results to educated agricultural workers, it is important to note that over 70% of Iowa high school graduates enroll in college or training programs after high school (Iowa Department of Education, 2017). In addition, agricultural programs at the post-secondary level have experienced record-setting enrollment figures (Wintersteen, 2014) and Iowa State University reports placing over 95% of College of Agriculture and Life Sciences students in agriculture-related jobs after graduation (Iowa State University College of Agriculture and Life Sciences Career Services, 2017). Though the populations we are sampling from are in college, at least part-time, we are confident we are capturing young adults who are engaged in agricultural activities. Participants were recruited from courses at colleges and universities that require students work on school-owned farms as part of their educational training.

Another important subgroup of the agricultural workforce is young adult hired crop farmworkers. In 2012 the USDA estimated there were just over 1.02 million hired crop farmworkers (both foreign and domestic born) working in crop production in the U.S. The median age of these workers was 34 and 25% were

under the age of 25 (United States Department of Agriculture Economic Research Service, 2016). Many hired crop farmworkers were born outside of the United States and either commute great distances to work or follow the crop, moving from state to state as the agricultural season advances. These unique characteristics, when coupled with low language literacy, low education, and low socioeconomic status, put them at increased risk for occupational injuries and illnesses (NORA Agricultural, 2008). Although hired crop farmworkers make up a large segment of the workforce, the focus of this research is on young adults serving as the primary operator or as hired labor on a family or non-family member's farm in the Midwest.

Occupational Injuries and Illnesses among Young Adults

Despite lower fatal occupational injury rates among young adults, the occupational nonfatal injury rate among young adults is consistent with all other age groups. In agriculture, injuries are often severe and result in significant soft-tissue damage, multi-level fractures, and amputations (Yaffe & Kaplan, 2014). Furthermore, injury severity is exacerbated by their occurrence in rural areas and time and distance to definitive care (Zietlow & Swanson, 1999). Injuries that do not lead to death may result in permanent disability. Occupational illnesses, though less immediately traumatic than injuries, are severe. Illnesses may not develop until long after the time of exposure, however, they can lead to decreased quality of life, disability, or death. Therefore, preventing agricultural

injuries and illnesses is vital to ensuring the productivity and livelihood of agricultural workers.

Agricultural exposures that commonly lead to occupational injuries or illness are well-documented. Large machinery, including tractors, power take-off devices, and livestock are among the most common mechanisms of injuries in agriculture (Hartling et al., 1998; Missikpode et al., 2015; Pickett et al., 2001). Exposures to dust, toxic gases, and physical hazards including heat, cold, and noise, are among the most common causes of occupational-related illnesses among agricultural workers. Common occupational related illnesses include respiratory illnesses, noise-induced hearing loss, and musculoskeletal disorders (Beckett et al., 2000; M. Schenker, 2000; Sprince, Lewis, Whitten, Reynolds, & Zwerling, 2000; Villarejo & Baron, 1999)

Exposure to agricultural hazards begins at a young age. Children as young as eight years old have reported driving tractors (Jinnah et al., 2014). High school aged agricultural workers have reported working with tractors, machinery, chemicals, and livestock (Allread, Wilkins, Waters, & Marras, 2004; McCurdy & Kwan, 2012). Young adults have reported working with large livestock, driving tractors, combines, and all-terrain vehicles, mixing and applying chemicals, and working in livestock confinement buildings (Rudolphi, Sheridan, & Rohlman, 2015; Schulman, Evensen, Runyan, Cohen, & Dunn, 1997). This population has already begun reporting agricultural-related injuries including cuts, burns, and falls (Schulman et al., 1997). Additionally, these workers have reported early

symptoms of agricultural-related illnesses including shortness of breath after working in a grain bin and ringing in the ears after working with loud agricultural equipment (Rudolphi et al., 2015).

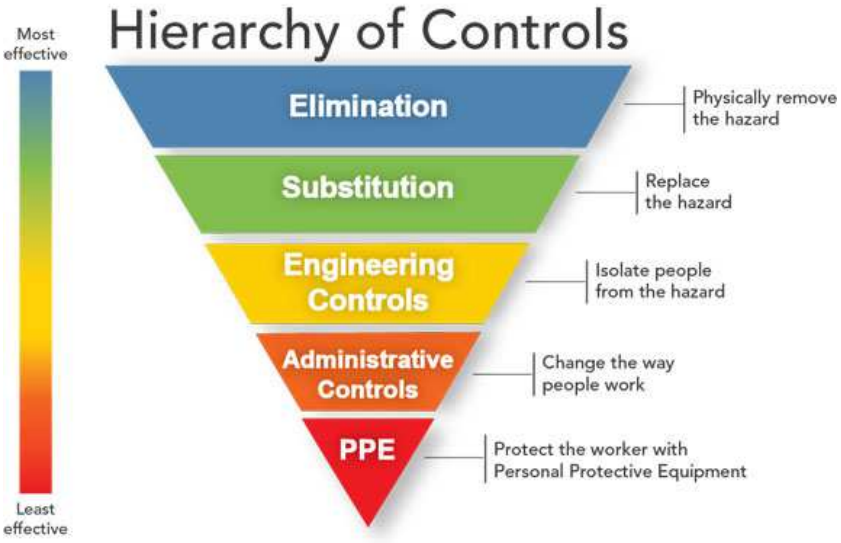
Young adults are engaging in agricultural work and interacting with machines and equipment that are known to cause fatal and nonfatal injuries and illnesses. They also report injuries and symptoms of illnesses; however, it is unknown *how* young adults are engaging with equipment/machinery and if recommended guidelines for operation are being followed. Given many workplace injuries are the result of unsafe work practices of employees as opposed to unsafe working conditions (Garavan & O'Brien, 2001), identifying specific workplace practices of young adult agricultural workers is an important first step in preventing agricultural related injuries. **Therefore, one of the objectives of this dissertation was to identify the workplace safety practices of young adults in six common agricultural work areas; (i) tractors, (ii) ATVs/UTVs, (iii) pesticides, (iv) livestock handing, (v) grain handling, and (vi) livestock confinement work.**

Identifying the workplace safety practices of young adult agricultural workers will provide areas of priority for interventions to prevent occupational injuries and illness among young adults.

Preventing Injuries and Illnesses among Young Adult Agricultural Workers

The application of the Hierarchy of Controls is a well-established approach to controlling hazards in the industrial workplace, and lends itself to the agricultural industry as well. The Hierarchy of Controls prioritizes hazard control methods based on effectiveness. The control methods at the top of the hierarchy—elimination and substitution are considered more effective than those in the middle of the hierarchy such as engineering and administrative controls, which are more effective than prescribing personal protective equipment which is a the very bottom of the hierarchy (National Institute for Occupational Safety and Health, 2016) (Figure 1.1). Each tier of the hierarchy of controls offers advantages and disadvantages when implementing a method to prevent injuries or illness among young adult agricultural workers as described below.

Figure 1.1: Hierarchy of Controls (National Institute for Occupational Safety and Health, 2016)



Elimination & Substitution:

Eliminating the hazard or substituting a safer alternative are regarded as the most effective types of controls, and therefore the most desirable. However, elimination and substitution can be difficult to implement, particularly in agriculture (National Institute for Occupational Safety and Health, 2016). In agriculture, an example of eliminating the hazard could be self-driving tractors or replacing the ubiquitous tractor with a new piece of equipment. However, this is unlikely and comes at a high cost to farmers. Eliminating processes and machines will require major industry shifts and investment by agribusinesses. Substitution has been successful among pesticide use, replacing those most hazardous to health and the environment with products less toxic. These substitutions and eliminations result from advanced engineering and are therefore difficult for a farmer or rancher to implement on a farm.

Engineering Controls:

Designed to remove the hazard at the source and reduce exposure to the worker, engineering controls are considered more effective than either administrative controls or personal protective equipment (National Institute for Occupational Safety and Health, 2016). While considered among the most effective means of reducing hazardous exposures, many engineering controls still require active participation by a worker. For example, in order for a rollover protective structure to protect a tractor driver from being crushed in the event of a rollover, the driver must elect to wear a seatbelt. This reliance on human

behavior reinforces the first objective of this dissertation - the need for an appraisal of young adults work practices.

The initial cost to engineering controls can be higher than implementing administrate controls or purchasing personal protective equipment (National Institute for Occupational Safety and Health, 2016). Young adult agricultural workers may not have the financial means to implement engineering controls into their operation. Additionally, young adults working as a non-principal operator or non-owner or on their family's farm or the farm of a non-family member, may not have the decision-making power to implement engineering controls.

Administrative Controls:

Administrative controls to occupational safety and health include policies, training, and scheduling. Considered less effective than engineering controls, administrative controls rely heavily on the actions and behaviors of workers and supervisors (National Institute for Occupational Safety and Health, 2016). However, administrative controls are considered more cost effective than engineering controls, particularly in industries like agriculture, with a multitude of exposures and hazards. For example, a policy requiring hearing protection in an indoor swine facility may be less costly for a farm than installing noise-reducing engineering solutions.

Personal Protective Equipment:

Providing workers with personal protective equipment (PPE) including ear muffs, gloves, and googles is often considered the least effective method to controlling occupational exposures. Similar to administrative controls, PPE requires active participation by the worker. However, PPE is often less expensive than engineering controls (National Institute for Occupational Safety and Health, 2016). When considering the young adult agricultural workforce, encouraging the adoption of PPE may have advantages over more costly exposure control methods, especially among hired workers who may not have the decision-making authority to implement a more permanent control.

Elimination, substitution, or engineering controls can be costly to implement and young adult agricultural workers may not have the financial means or decision making authority to adopt them. Interventions that change behaviors and promote safe operating practices, either through an administrative control or personal protective equipment, may be more appropriate for this young adult population. There may also be components of workers' social lives or the organization of the workplace that influence work practices and provide an opportunity for intervention. **Therefore, the second and third objectives of this dissertation were to: (1) examine the association, if any, between social influences (supervisors, peers, and parents) and reported safety practices of young adult agricultural workers, and (2) examine the**

association, if any, between organizational work factors (policies, scheduling) and reported safety practices of young adult agricultural workers.

Social Influences

Social influencers, such as supervisors, coworkers, and parents, may impact the way in which young adults behave in the workplace. However, the relationship is unclear and not yet examined among young adult agricultural workers.

Supervisory Influence:

In the occupational setting, supervisors have been identified as individuals who may encourage or discourage safe work practices. Worker risk-taking on the job is reduced when supervisors are explicit about rules and prohibit risk-taking (Kaplan & Miller, 1987). In addition, supervisor safety behavior is related to subordinate worker safety behavior (Zohar, 2002). It is expected that workers reduce their risk-taking tendencies at work when supervisors emphasize safety, or prioritize safety over productivity, because of the authority of the supervisor in the work setting. This relationship is even more pronounced among adolescent workers and adult supervisors given adolescents are more likely to conform to pressures from authoritative figures than adults (Bronfenbrenner, 1970). As expected, youth working in agricultural settings were less likely to participate in risk-taking activities when their supervisors were explicit about prohibiting unsafe practices (Westaby & Lowe, 2005).

Coworker Influence:

Coworkers' attitudes towards safety and pressure to get a job done quickly also influence the work behaviors of an individual. In the absence of supervisors to guide and monitor behaviors, workers observe their coworkers and learn job tasks vicariously through this observation (Reingen, 1982; Graham, Marks, & Hansen, 1991). Adolescents are especially vulnerable to peer pressure and adjust their behaviors to match the behaviors of those around them to gain acceptance (Aloise-Young, Graham, & Hansen, 1994). For example, on the job risk-taking among youth employed in agriculture increased when youth perceived their coworkers were also taking risks (Westaby & Lee, 2003).

Parental Influence:

Parents have also been identified as social influencers among young workers. Adolescents' attitudes towards risk in the workplace are influenced by parents and developmental experiences throughout their youth (Westaby & Lee, 2003). Young adult agricultural workers report learning to perform agricultural tasks from parents through observation (Darragh, Stallones, Sample, & Sweitzer, 1998), which is unique to agriculture. Within the family farm structure is not uncommon for two or three generations to be working side-by-side, however, it is unknown if risk-taking among parents is associated with risk-taking among young adult agricultural workers in the agricultural setting.

Research in identifying the association between social influencers and agricultural workers has been limited to adolescents, workers who may be under close supervision from a supervisor or parent. Outside of agriculture, studies examining the relationship between social influences and workers are dated (i.e., (Bronfenbrenner, 1970; Kaplan & Miller, 1987) and it is unknown if a similar association is observed between social influencers and today's young adult agricultural workers. Understanding the impact of these social influences on young adult agricultural workers is an important step in developing effective interventions for the population to reduce injuries and illnesses.

Organizational Work Factors

In addition to social influences, there are organizational factors which may provide opportunities for occupational safety and health interventions. Organizational factors including workplace safety and health policies and scheduling have also been linked to a number of safety-related outcomes including performance of safe work practices in healthcare and manufacturing (Cheyne, Cox, Oliver, & Tomas, 1998; Cooper & Phillips, 2004; Griffin & Neal, 2000; M Mattila, Rantanen, & Hyttinen, 1994).

Safety and health related policies are an important component to a successful safety program, a reflection of management's commitment to safety, and management's ability to promote and facilitate safe work practices among employees (Bartling & Hutchison, 2000). Safety and health policies include rules or regulations that limit the permissible behaviors of individuals. Safety and

health policies are one of the leading factors that determine a workplace's safety climate (DeJoy, Schaffer, Wilson, Vandenberg, & Butts, 2004). While this research will not explore safety climate specifically, safety climate has been identified as an antecedent to workplace safety and injury occurrence. However, the extent to which safety and health policies are in effect on farms that employ young adults is unknown. Furthermore, the association of safety and health policies, if any, on workplace practices has not been identified within agriculture.

Another organizational factor which may be associated with safe working practices is scheduling. Scheduling and work/rest rotations have been found to reduce error among employees and improve workplace practices (Landrigan et al., 2004). Long work hours have been associated with increased injury rates and working more than 40 hours a week has been associated with unhealthy weight gain, increased alcohol use, and increased tobacco use (Caruso, 2014). Agricultural work is seasonal and often requires long hours. Over half of adult farmers and ranchers report spending 10-14 hours a day on agricultural work, and 17% report working more than 15 hours (Schafer, 2013). Work schedules are further complicated by the seasonality of agricultural work in the Midwest. Seasonal demands may influence the amount and quality of sleep a worker receives, which may influence their workplace practices (Landrigan et al., 2004), risk of injury (Barnes & Wagner, 2009; Sprince et al., 2003) and overall health (Foundation, 2017). However, the effect of working hours and sleep received on

work practices of young adults have not been examined within the agricultural workplace.

Examining the association, if any, between social influences (supervisors, peers, parents) and organizational work factors (safety and health policies, work hours) on young adults' workplace safety practices may identify the need for future interventions. In addition, research could provide evidence of the effectiveness of administrative controls to prevent occupational injuries and illness among young adult agricultural workers.

As mentioned above, personal protective equipment is considered the last line of defense against occupational hazards, and considered the least desirable (National Institute for Occupational Safety and Health, 2016). However, personal protective equipment is effective when used properly. For example, hearing protection devices, including ear muffs and ear plugs, are effective in reducing exposure to noise (S. W. Smith et al., 2008). And while farming ranks among the occupations with the highest rate of noise-induced hearing loss (NIHL) (Ehlers & Graydon, 2011), only a small proportion of the agricultural population reported using hearing protection (Carpenter, Lee, Gunderson, & Stueland, 2002). ***The final objective of this dissertation was to evaluate an intervention designed to increase the use of hearing protection among young adults who work in a swine facility.***

Interventions to Increase Use of Hearing Protection Among Young Adult Agricultural Workers

Although many interventions have been proposed to reduce injury and illness among agricultural workers, few interventions have been specifically tailored to young adult workers. Typically, studies of agricultural populations group young adult agricultural workers with older, more experienced workers (i.e. those over age 35). However, including young adults in intervention studies with more experienced farmers may not be appropriate. Within health promotion, interventions tailored to specific audiences have been found to be more effective than interventions that utilize a "one-size-fits-all" approach (Kreuter, Strecher, & Glassman, 1999; Kreuter & Wray, 2003). Today's young adults are members of the millennial generation born between 1980 and 2000, are reported to be different from their parents and, as a group, different from all previous generations (Howe & Strauss, 2000).

Research characterizing the millennial generation suggests they may engage in safer behaviors than previous generations. There are several factors that may have contributed to this. As children they were protected--their safety was a top priory of their parents (Venne & Coleman, 2010), and a priority of the government. By 1985, all 50 states had adopted laws requiring child safety seats for children in motor vehicles (Committee on Injury, Violence, and Poison Prevention, 2011). Graduated licensing systems were passed by several states in the late 1990s and beginning in 1992, states started adopting bike helmet laws

for youth (Schieber, Gilchrist, & Sleet, 2000). Millennials were bombarded by safety campaigns (such as anti-smoking) as youth (Anatole, 2012). Additionally, they have a strong sense of self-worth and do not partake in as many risky behaviors as previous generations. When they do engage in unsafe behaviors, it is not to act out, but because they believe the payoff outweighs the risk (Anatole, 2012). Texting while driving is one of the most dangerous activities millennials are participating in. Similar to texting while driving, underage millennials drink and smoke pot (35% reported trying marijuana) because they associate a bigger reward with this behavior than risk. However, 97% of millennials wear their seatbelt and only 9% report smoking cigarettes on a weekly basis (Anatole, 2012).

Millennials are further characterized as being technologically savvy and "digital natives" meaning they grew up with technology (McCurdy & Kwan, 2012). Their comfort with technology may provide opportunities to use new formats to deliver safety and health interventions. While this generation has been described as sheltered, doted on as children, and narcissistic (Venne & Coleman, 2010) they are also described as group/team oriented and have powerful peer bonds (McCurry & Martins, 2010), which may also be characteristics of the population to capitalize on when attempting to influence behavioral change especially if designing an intervention using behavioral theory.

Agricultural safety and health interventions are often criticized for their lack of theory-based design (Witte et al., 1992). Interventions based in social and behavioral science theories are often more effective than those without a theoretical base (K. Glanz & Bishop, 2010). There is a need for interventions that incorporate behavioral change theory. The third project aim will utilize constructs from the Social Cognitive Theory (SCT), which has been used as the foundation in many health-based interventions outside the agricultural industry and has been successful in modifying behaviors. This theory suggests that in order for behavioral change to occur, an individual must develop self-regulatory skills, which requires that one pay close attention to his or her behaviors and habits (Bandura, 1998). Behavioral tracking (*e.g.,* logging behaviors, keeping a diary) is a tool to aid in the development of self-regulatory skills (Stajkovic & Luthans, 1998) and has been effective in facilitating behavior change across a variety of *health* behaviors (*e.g.,* weight management and smoking cessation) (Kirwan, Duncan, Vandelanotte, & Mummery, 2012), however, its effectiveness in modifying *safety* behaviors is unknown. This project will innovatively incorporate smartphone technology. Using smartphone apps as a self-monitoring tool, aligning with the Social Cognitive Theory, has been tested among young adults, with success in modifying behaviors related to weight loss and weight management (Carter, Burley, Nykjaer, & Cade, 2013; Dennison, Morrison, Conway, & Yardley, 2013; Patrick et al., 2014), physical activity (Carter et al., 2013; Kirwan et al., 2012) smoking cessation (Buller, Borland, Bettinghaus,

Shane, & Zimmerman, 2014), and cancer screening (Lee, Koopmeiners, Rhee, Raveis, & Ahluwalia, 2014). However, this technology has not been tested or evaluated in changing agricultural work behaviors among young adults.

Research Goals and Objectives

Young adults' participation in the agricultural workforce is expected to increase as older farmers retire at a faster-than-expected rate in the next 20 years. This important population is at risk of occupational injuries and illnesses and preventing injuries and illnesses should be a focus for research. There are controls to reduce exposure to occupational hazards, however, there are limits to their application in agriculture. Furthermore, the specific work practices of this population are unknown, and there is limited information available on the influence of social or work organizational factors on safety practices, and interventions to improve workplace practices are not rigorously designed or evaluated and lack theoretical foundation.

Broadly, the goals of this research were to identify work practices of young adult agricultural workers, examine the influence of social and organizational factors on safety practices, and to test an intervention to improve a specific workplace practice (hearing protection device use). Two studies were conducted to achieve these goals, a cross-sectional study of young adult agricultural workers in Iowa and a randomized controlled trial among swine facility workers in the Midwest.

The specific objectives of the cross-sectional study of young adult agricultural workers in Iowa were to:

1. Characterize the workplace practices of young adult agricultural workers across six common agricultural exposure areas (Chapter 2, Chapter 3).
2. Identify the influence of supervisors, peers, and parents on tractor operating practices of young adult agricultural workers (Chapter 2).
3. Identify the influence of organizational factors on tractor operating practices of young adult agricultural workers (Chapter 3).

The specific objectives of the randomized controlled trail among swine facility workers in the Midwest were to:

1. Determine the impact of behavioral tracking on safety and health behaviors among young adult swine production workers (Chapter 4).
2. Determine the effect of goal setting on safety and health behaviors among young adult swine production workers who track their daily safety and health behaviors (Chapter 4).

Significance of this Research

Young adults represent the workforce of the future. Ensuring a productive and sustainable agricultural workforce is vital to ensuring a bountiful food supply. Agricultural workers are at increased risk for occupational injuries and illnesses when compared to workers in other industries. Identifying

opportunities for interventions to improve workplace safety and health for young adult agricultural workers is an important step to preventing occupational injuries and illnesses among the population.

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CHAPTER 2

Social and Individual Influences on Tractor Operating Practices of Young Adult Agricultural Workers

Abstract

Purpose: Tractor rollovers and run-overs are the leading cause of agricultural-related fatalities in the United States. Injuries from rollovers can be prevented by equipping tractors with rollover protective structures (ROPS, an engineering approach) and the use of seatbelts (a behavior-based approach). While adult farmers report low seatbelt use and frequent use of tractors without rollover protective structures, it is unknown whether the young adult population has adopted similar tractor driving practices as older generations. This study was designed to identify tractor operating practices among young adult agricultural workers and the influence of supervisors, peers, and parents on their safety behaviors.

Methods: An online survey was conducted among college students enrolled in agricultural science classes in four Iowa colleges and universities. Participants answered questions about their tractor operating practices, the influence of supervisors, peers, and parents on their workplace practices, and the influence of their individual risk-taking tendencies on their workplace practices. A tractor operation safety score was estimated from participants' responses. Linear

regression was used to examine the association of these influences and the tractor operation safety score.

Results: Of the 193 respondents, most (78.8%) young adult agricultural workers reported that they never or rarely wear a seatbelt when operating a tractor with a rollover protective structure and 80% allow extra riders. Supervisory influences, such as being negatively evaluated by a supervisor, were found to affect tractor operating behaviors more than peer or parent influence.

Conclusions: Young adult agricultural workers frequently reported unsafe tractor operating behaviors. Supervisors were found to have the most influence, compared to peers or parents, over reported behaviors of young adult agricultural workers.

Introduction

Tractors are the leading cause of agricultural-related fatal and non-fatal injuries in the United States (Hard, Myers, & Gerberich, 2002). Common causes of tractor-associated injuries include rollovers, particularly on a hill or incline, malfunction during repair, being jolted out of the operator station, and being struck by an object (Dogan, Demirci, Sunam, Deniz, & Gunaydin, 2010; Fulcher, Noller, & Kay, 2012). Injuries that result from operating or driving tractors are preventable. Engineering solutions including rollover protective structures (ROPS) and seatbelts have been proven to be extremely effective in preventing operator injury and death. The National Institute for Occupational Safety and Health estimates over 90% of tractor overturn deaths could be eliminated if all tractors in the United States were equipped with ROPS and operators used seatbelts (NIOSH, 2015).

In addition to engineering controls, manufacturer-recommended operating procedures and distribution of educational trainings and materials have been developed to promote safe operating practices. Tractor manufacturers publish operating manuals with recommendations on prevention of injuries. Common recommendations include use of seatbelts, when so equipped, avoiding steep slopes or driving on uneven terrain, setting the parking brake before dismounting the tractor, and not allowing extra riders. In the past 20 years, education programs targeting youth have been developed with the goals of increasing knowledge of agricultural related hazards, including tractors,

and encouraging the adoption of safe tractor operating practices. Examples or these programs include farm safety day camps, tractor driving safety courses, and curricula distributed through 4-H clubs and FFA chapters (Carrabba, Field, Tormoehlen, & Talbert, 2000).

The effectiveness of most available prevention approaches for reducing tractor-related injuries is dependent on the tractor operator's compliance with recommended practices. For example, a driver must manually buckle the seatbelt in order for the seatbelt to keep him or her from being ejected from or crushed by a ROPS-equipped tractor in the event of an overturn. Studies of adult farmers report that few use the seatbelt when operating a tractor with ROPS, and many are operating tractors not equipped with rollover protective structures (Jinnah et al., 2014; M. B. Schenker, Orenstein, & Samuels, 2002).

Although some information is available about tractor operating practices of adult farmers, such practices among young adult agricultural workers (18-24 years old) have not been characterized. Young adult workers are at increased risk of occupational injury, and the agricultural industry employs a large proportion of young adult workers (Hard & Myers, 2006; McCallum et al., 2013; McCallum et al., 2006; Westaby & Lee, 2003). Exposure to tractors, whether by driving or riding, is known to begin at young age. Youth report driving a tractor independently as young as age 10 years (Browning, Westneat, & Szeluga, 2001). Over 80% of college-aged agricultural students report using tractors consistently (Rudolphi et al., 2015). However, it is unknown whether this young adult

population has adopted tractor driving practices similar to those of the older generations.

Furthermore, is it unclear who may influence the tractor driving practices of young adult agricultural workers. In other occupational settings, supervisors, peers, and parents are known to affect the adoption of safe work practices among young adults. Among adult workers, supervisors who apply pressures on workers to be productive and supervisors that do not emphasize safety have been associated with workers performing unsafe work practices (Bartling & Hutchison, 2000; Hofmann & Stetzer, 1996). Similarly, though among adolescent workers, supervisors who do not allow workers to take risks on the coworkers' attitudes towards safety and production pressure also influence the safety practices of an individual (Westaby & Lowe, 2005). Adolescents are especially vulnerable to peer pressure and adjust their practices to match the practices of those around them to gain acceptance (Aloise-Young et al., 1994).

Despite the targeting of young agricultural workers with agricultural safety and health educational programs, their effectiveness for injury prevention and for promotion of safer behavior is unknown. Tractor operating practices are not documented among young adult agricultural workers. Furthermore, determinants of tractor driving practices are largely unknown within the young adult farmer population. Perceived risk-taking activities of peers, parents, and supervisors have been found to influence adolescent and adult work practices, however, the effect of these social influencers on young adult agricultural work

practices is undetermined. To address these gaps in knowledge, this study was conducted to characterize tractor operating practices of young adult agricultural workers and to examine the influence of supervisors, peers, and parents on their practices. Characterizing the work practices of young adult agricultural workers and identifying individuals who influence their practices is an important first step to developing interventions to improve the health and safety of this agricultural population.

Methods

Participants

Young adult agricultural workers were recruited from among students enrolled in agricultural science courses at four post-secondary institutions in Iowa. These institutions included both four-year and two-year degree programs and were selected based on the agricultural science courses they offer emphasizing agricultural production and their high student enrollment in the agricultural programs. Iowa State University's College of Agriculture and Life Sciences has recorded record enrollment for two consecutive years, and undergraduate enrollment has increased 75% since 2005 (Wintersteen, 2014). These institutions were also selected based on their placement of graduates in production agricultural settings after graduation. In order to participate in the study students must have met the following inclusion criteria: 1) between the

ages of 18-24, 2) report participating in agricultural work four hours a week, on average.

Twelve informational presentations were made by the project PI to students enrolled in agricultural production, animal science, agronomy, and agricultural education courses at the four institutions during Fall 2014 and Spring 2015. The study objectives and methods were explained and interested students were asked to provide their email address to receive the link to the online survey. Of the 373 students enrolled in the classes, 351 provided their email address. Of the 351 email address provided, 342 emails were delivered and 242 students completed the survey for an overall participation of 64.8%.

Procedures

Participants were emailed a link to the survey administered through Qualtrics (Qualtrics Labs; Provo, UT). To increase participation, three reminder emails were sent to students. The online survey took less than 30 minutes to complete and participants who completed the survey were mailed a check for $15.

Measures

The purpose of the survey was to characterize work practices of young adult agricultural workers. Six agricultural work areas were identified; (i) tractor use, (ii) ATV/UTV use, (iii) grain handling, (iv) pesticide handling/application, (v) livestock handling, and (vi) swine facility work. Within each of the six work areas,

participants reported their frequency of engaging in specific operating practices. There were between 6 and 12 operating practices listed within each work area. In the current manuscript, only the results relevant to tractor use are presented.

Demographic information: Personal information including age, collected as a continuous variable and later categorized (18-19, 21-21, 22-24), gender (male, female), educational status (full-time student, part-time student), institution type (2-year program, 4-year program) and type of farm primarily worked on (family farm, non-family farm, as principal operator) were collected from each participant.

Tractor Operating Practices: Twelve questions related to tractor operation (*e.g.,* "I wear a seatbelt if the tractor has a rollover protective structure") were presented to participants who indicated they operated or drove a tractor (Cronbach α =0.83) (Table 2.2). The 12 tractor operating activities included items related to personal protective equipment, distracted driving, and driving conditions/environment and were selected based on manufacturer's recommended best practices. Respondents indicated on a five-point Likert scale (1=Never to 5=Always) how frequently they participate in each of the activities.

Social Influence: Participants rated their level of agreement (disagree, neither agree nor disagree, agree) with statements (Table 2.3) regarding the influence of (i) their supervisors at work (two items, Cronbach α =0.71) (Westaby & Lee, 2003), (ii) peer/coworker risk-taking (two items, Cronbach α =0.93) (Gibbons, Helweg-Larsen, & Gerrard, 1995; Westaby & Lee, 2003) and (iii)

parental risk-taking (two items, Cronbach α = 0.72) (Raffaelli & Crockett, 2003; Westaby & Lee, 2003).

Global Risk-taking: Participants rated their level of agreement (disagree, neither agree nor disagree, agree) with statements regarding their individual risk-taking tendencies (five items, Cronbach α =0.80) (Table 2.3). Westaby and Lee's (2003) five-item scale was used.

Risk-taking Orientation at Work: Participants rated their level of agreement (disagree, neither agree nor disagree, agree) with statements regarding their perception of risks and hazards in their workplace (five items, Cronbach α=0.84) (Table 2.3). These questions were adopted from the risk-taking ideology and psychology literature (Kowaleski-Jones & Mott, 1998; Raffaelli & Crockett, 2003; Westaby & Lee, 2003).

Survey materials were pilot tested for comprehension and clarity by recent graduates from agricultural programs who met the study inclusion criteria and were revised in response to their recommendations. All procedures were approved by the Institutional Review Board at the University of Iowa.

Statistical Analysis

Analyses were performed using SAS version 9.4 (SAS Institute; Cary, NC). Means and frequency distributions were used to summarize the demographic characteristics of the study sample and the frequency of reported tractor operating practices.

A dimensionless *tractor operating safety score* ranging from 1-5 was calculated for each participant who responded to the 12 tractor operating behavior items by averaging the 12 item responses. A score of 5 indicated a participant reported *always* participating, or complying with the 12 safety practices (i.e. *always* wear their seatbelt when operating a tractor with a ROPS), whereas a score of 1 indicated a participant reported *never* participating in the 12 safety practices.

A dimensionless *supervisor influence score* ranging from -1 to 1 was calculated for each participant who responded to the two items related to supervisory influence. A score of -1 indicated that a participant disagreed with the statement that his/her supervisor encouraged him/her to take risks in the workplace, whereas a score of 1 indicated that a participant agreed with the statement that his/her supervisor encouraged him/her to take risks in the workplace. Items contributing to the supervisor influence score were equally weighted.

A dimensionless *peer influence score* and a *parental influence score.* ranging from -1 to 1, were calculated for each participant who responded to the two items related to peer risk-taking and the two items related to parental risk-taking (Table 2). A score of -1 indicated a participant disagreed their peer or parents were risk-takers, whereas a score of 1 indicated a participant agreed their peer or parents were risk-takers. Items contributing to the peer and parental scores were equally weighted.

A *global risk-taking score* ranging from -1 to 1 was calculated for each participant who responded to the five items related to individual risk taking (Table 2). A score of -1 indicated a participant did not report participating in risky activities, whereas a score of 1 indicated a participant did report participating in risky activities. The five items contributing to the global risk-taking score were equally weighted.

A *risk-taking at work score* ranging from -1 to 1 was calculated for each participant who responded to the five items related to risk and hazards in their workplace (Table 2). A score of -1 indicated a participant consistently disagreed to statements suggesting work is hazardous and there is a chance they could get hurt, whereas a score of 1 indicated a participant consistently agreed the work they do is hazardous and there is a chance they could get hurt. The five items contributing to the risk-taking at work score were equally weighted.

We examined bivariate relationships between all potential explanatory variables and tractor safety scores, the continuous outcome variable, using t-test or ANOVA. Explanatory variables included the supervisor influence score, peer influence score, parental influence score, global risk-taking score, risk-taking at work score, and demographic characteristics.

Linear regression was used to examine associations between social and individual influence scores and tractor safety score. The first step was to separately estimate crude associations between each of the five influence scores and the continuous tractor safety score. The analyses were then repeated while

controlling for gender and then controlling for gender and age. A final multivariable linear regression model began with all five of the social and individual influence scores and two covariates, gender and age, regressed on the continuous tractors safety score. From there, social and individual influence scores and covariates were removed one at a time, beginning with the dependent variable with the largest p-value, until all remaining dependent variables were significant at the >0.20 level.

Results

Demographics

Of the 242 students who completed the online survey, nine participants were removed because they did not meet the study criteria. Of the remaining 233, 80% (n=193) indicated they routinely drove tractors and responded to the 12 tractor operating activity items. Of the 193 in this analysis, 80% were male, 97% reported being a full-time student, and 99% were white. Age groups, education level, and institution types were equally represented. Sixty-four percent indicated they currently work primarily on their family farm, 34% indicated they primarily work on a non-family or non-relatives farm, and 2% indicated they primarily work as the principal owner/operator on their own farm (Table 2.1).

The mean tractor score was 2.98 (SD=0.68). Scores were normally distributed and ranged from 1.00 to 4.92. Female participants had a significantly

higher mean tractor safety score than male participants (males=2.92, females=3.23 p-value p=0.01). No statistically significant difference in tractor safety scores were observed across age categories, education level, post-secondary enrollment status, institution type, or type of farm the participant primarily worked on (Table 2.1).

Table 2.1: Mean tractor safety scores by demographic characteristics

		N	Mean tractor score[1] (SD)	P-value
Gender	Male	154	2.92 (0.70)	0.01*
	Female	39	3.23 (0.56)	
Age	18-19	68	2.92 (0.73)	0.47
	20-21	65	2.98 (0.64)	
	22-24	60	3.07 (0.67)	
Enrollment Status	Full-time student	188	2.99 (0.68)	0.54
	Part-time student	5	2.80 (0.68)	
Institution	2-year degree program	94	2.94 (0.71)	0.42
	4-year degree program	96	3.02 (0.63)	
Farm primarily work on	Principal owner/operator	3	3.11 (0.13)	0.67
	Family farm	106	2.99 (0.73)	
	Non-family farm	56	2.90 (0.64)	

[1]Tractor safety score range is 1-5. 1=low safety score (NEVER report performing safety practice), 5= high safety score (ALWAYS report performing safety practice)

Tractor Operating Practices

Nearly 80% of respondents indicated they never or rarely wore a seatbelt when operating a tractor with a ROPS and nearly half reported he/she never or rarely avoided using a tractor that did not have a ROPS. Conversely, nearly 75% reported avoiding operating a tractor near ditches, embankments, or holes, and 69% reported avoiding slopes too steep for safe operation (Table 2.2).

Table 2.2: Tractor operating safety practices of young adult agricultural workers (N=193)

Tractor Safety Practice	Never n (%)	Rarely n (%)	Sometimes n (%)	Usually n (%)	Always n (%)
Wear a seatbelt if the tractor has a rollover protective structure (ROPS)	118 (61.14)	34 (17.62)	26 (13.47)	7 (3.63)	8 (4.15)
Wear hearing protection when driving or operating a tractor without a cab	96 (49.47)	35 (18.13)	35 (18.13)	19 (9.84)	8 (4.15)
Avoid operating a tractor when excessively tired	89 (46.11)	43 (22.28)	36 (18.65)	15 (7.77)	10 (5.18)
Avoid operating or driving a tractor that does not have a rollover protective structure (ROPS)	47 (24.35)	41 (21.24)	58 (30.05)	35 (18.13)	12 (6.22)
Prohibit extra riders unless there is a designated passenger (buddy) seat	44 (22.80)	65 (33.68)	50 (25.91)	24 (12.44)	10 (5.18)
Avoid operating a tractor when under the influence of drugs or alcohol	31 (16.15)	38 (19.79)	64 (33.33)	42 (21.88)	17 (8.85)
Avoid talking on the cell phone when driving or operating a tractor	28 (14.15)	49 (25.39)	49 (25.39)	47 (24.35)	20 (10.36)
When tractor is stopped, set brakes securely and use park lock if available	26 (13.47)	43 (22.28)	77 (39.90)	26 (13.47)	21 (10.88)
Stay off slopes too steep for safe operation	8 (4.15)	11 (5.70)	41 (21.24)	54 (27.98)	79 (40.93)

(Table 2.2 continued)

Reduce speed when turning, crossing slopes, and on rough, slick, or muddy surfaces	5 (2.62)	17 (8.90)	40 (20.94)	69 (36.13)	60 (31.41)
Avoid texting, emailing, using the web or social media when operating a tractor	5 (2.62)	5 (2.62)	21 (10.99)	25 (13.09)	135 (70.68)
Avoid operating the tractor near ditches, embankments, and holes	4 (2.07)	8 (4.15)	37 (19.17)	57 (29.53)	87 (45.08)

Social and Individual Influences

Participants who agreed their supervisor does not allow them to take risks and they would be negatively evaluated if they took risks at work had significantly higher tractor safety scores than participants who disagreed with the statements (Table 2.3). There was no significant difference between participants who agreed with the statement that their coworkers take risks or other people at work take risks and those who disagreed in regards to tractor safety score. Young adult agricultural workers who identified their parents as risk takers did not report different tractor scores than those who did not identify their parents as risk takers (Table 2.3).

Participants who agreed or strongly agreed with the statement *dangerous tasks at work have to get done* had a significantly lower tractor safety score than those who did not agree with the statement. Additionally, participants who agreed to the statement *I sometimes do things at work that may get me injured* had significantly lower tractor safety scores than

respondents who disagreed to the statement. Finally, young adult agricultural workers who agreed to the statement *I get my job done faster by taking risks* had a significantly lower tractor safety score than respondents who disagreed with the statement.

Table 2.3: Tractor safety scores and parental, peer, supervisor, and individual risk-taking

		n	Mean Tractor Score (SD)	P-value
My boss does not allow me to take risks (supervisor influence).	Disagree	46	2.64 (0.64)	<0.0001
	Neither	68	2.89 (0.63)	
	Agree	72	3.24 (0.68)	
I would be negatively evaluated if I took risks at work (supervisor influence).	Disagree	52	2.78 (0.63	0.0001
	Neither	64	2.85 (0.67)	
	Agree	70	3.25 (0.68)	
Other people take risks at work (peer influence).	Disagree	32	3.20 (0.72)	0.073
	Neither	63	3.02 (0.63)	
	Agree	91	2.89 (0.71)	
My coworkers take risks (peer influence).	Disagree	38	3.14 (0.77)	0.155
	Neither	65	3.01 (0.67)	
	Agree	83	2.89 (0.66)	
My parents take risks (parent influence).	Disagree	40	3.09 (0.74)	0.495
	Neither	54	2.97 (0.66)	
	Agree	91	2.95 (0.69)	
My parents could be considered risk takers (parent influence).	Disagree	52	3.05 (0.72)	0.32
	Neither	69	3.02 (0.65)	
	Agree	63	2.87 (071)	
I would rather take risks than be overly cautious (global risk-taking).	Disagree	54	3.13 (0.66)	0.030
	Neither	79	3.01 (0.69)	
	Agree	53	2.79 (0.69)	
In the past month, I've done some exciting things that other people think are dangerous (global risk-taking).	Disagree	37	3.10 (0.72)	0.094
	Neither	54	3.09 (0.62)	
	Agree	95	2.87 (0.71)	
I love to take risks even when there is a small chance I could get hurt (global risk-taking).	Disagree	61	3.15 (0.69)	0.034
	Neither	62	2.97 (0.65)	
	Agree	63	2.83 (0.70)	
I value having fun more than being safe (global risk-taking).	Disagree	78	3.12 (0.66)	0.045
	Neither	75	2.91 (0.67)	

(Table 2.3 continued)

	Agree	33	2.81 (0.77)	
Sometimes people get on my nerves when they tell me how to act more safely (risk-taking orientation at work)	Disagree	54	3.11 (0.68)	0.019
	Neither	71	3.04 (0.66)	
	Agree	59	2.78 (0.70)	
Dangerous tasks have to get done at work (risk-taking orientation at work).	Disagree	29	3.32 (0.76)	0.007
	Neither	60	2.99 (0.63)	
	Agree	97	2.87 (0.67)	
There is a chance I will do something at work that could get me hurt (risk-taking orientation at work).	Disagree	24	3.23 (0.76)	0.118
	Neither	55	3.03 (0.63)	
	Agree	95	2.91 (0.72)	
I like taking risks at work (risk-taking orientation at work).	Disagree	78	3.24 *0.64)	0.0001
	Neither	74	2.83 (0.62)	
	Agree	34	2.72 (0.77)	
I sometimes do things at work that may get me injured (risk-taking orientation at work).	Disagree	43	3.22 (0.72)	0.0007
	Neither	52	3.10 (0.67)	
	Agree	90	2.78 (0.63)	
I get my job done faster by taking risks (risk-taking orientation at work).	Disagree	67	3.27 (0.98)	<0.0001
	Neither	73	2.95 (0.61)	
	Agree	46	2.63 (0.65)	

[1]Tractor safety score range is 1-5. 1=low safety score (NEVER report performing safety practice), 5= high safety score (ALWAYS report performing safety practice)

Social and Individual Influence Scores

The mean supervisor influence score was -0.14 (SD=0.69). The mean peer influence score was 0.26 (SD=0.74). The mean parent influence score was 0.13 (SD=0.74). The mean global risk-taking score was -0.03 (SD=0.60). The mean risk-taking at work score was 0.09 (SD=0.60). All five mean scores had a range of -1 to 1 and had a median score of 0.00. None of the five social or individual influence scores were normally distributed.

Unadjusted and adjusted individual associations between social and individual influence scores and tractor safety score are presented in Table 2.4. All five social and individual influence scores were negatively associated with the tractor safety score outcome. As participants reported agreeing with statements indicating higher levels of supervisor, peer, parent, or individual risk-taking, and mean influence scores increased, tractor safety scores decreased. Among social influences, supervisors contributed most substantially to reported tractor safety scores. Results from the adjusted (age and gender) linear regression indicate a decrease in tractor safety score of 0.31 for every one-unit increase in supervisor influence score. Of the five social and individual influence scores, only the parent influence score did not contribute significantly to tractor safety score (p=0.18). Among individual measures, both global-risk taking scores and risk-taking at work scores were negatively associated with reported tractor safety scores. As participants agreed with statements about being risk-takers and their work being risky, reported tractor safety scores decreased.

Table 2.4: Individual associations of each social and individual influence score and tractor safety score; Unadjusted, adjusted for gender, and adjusted for gender, age and all other social influence scores

Variable	Unadjusted, crude estimate		Adjusted for Gender & Age		Adjusted for Gender, Age & All Social Influence Scores	
	β (95% CI)	P-value	β (95% CI)	P-value	β (95% CI)	P-value
Supervisor Influence	-0.35 (-0.49 - -0.22)	<0.001	-0.37 (-0.49 - -0.23)	<0.001	-0.31 (-0.46 - -0.16)	<0.001
Peer Influence	-0.15 (-0.28 - -0.01)	0.03	-0.15 (-0.28 - -0.02)	0.005	0.005 (-0.15 – 0.16)	0.94

(Table 2.4 continued)

Parent Influence	-0.09 (-0.22 - 0.04)	0.18	-0.09 (-0.22 – 0.04)	0.02	0.08 (-0.07 – 0.24)	0.30
Global Risk-taking	-0.28 (-0.45 - -0.12)	0.002	-0.27 (-0.43 - -0.10)	0.0006	-0.04 (-0.26 – 0.17)	0.70
Risk-taking at work	-0.40 (-0.56 - -0.24)	<0.001	-0.38 (-0.54 - -0.22)	<0.001	-0.26 (-0.47 - -0.04)	0.02

The multiple linear regression analysis (Table 2.5) showed that supervisor influence score, risk-taking at work, age, and gender were strong predictors of tractor safety score (R-square = 0.21, F= 7.02, p= <0.0001). The remaining social and individual influence scores, peer influence, parent influence, and global risk-taking, were removed from the model as they did not meet the inclusion criteria of p>0.20. In the final multivariable model, two observations had a Studentized Residual that exceeded the absolute value of 3 and were not included in the final multivariable model.

Table 2.5: Final multivariable linear regression model of social and individual influence scores and demographic characteristics on tractor safety score

Variable	β (95% CI)	P-value
Supervisor Influence	-0.29 (-0.42 - -0.42)	<0.001
Risk-taking at work	-0.26 (-0.43 - -0.10)	0.002
Gender[1]	0.24 (0.02 – 0.47)	0.03
Age[2]	0.04 (-0.02 – 0.10)	0.20

[1] Gender referent group= males
[2] Age referent group = 18-19
R-square = 0.21

Discussion

Similar to the demographic characteristics of Iowa, where the farming population is over 95% white, the study population was 99% white and majority male. While the number of female farmers is increasing, over 70% of principal operators in Iowa are male (United States Department of Agriculture, 2014).

Consistent with previous findings of adult farmers, results from this study indicate a majority of young adult agricultural workers do not wear the seatbelt when operating a tractor that has a rollover protective structure, they do not wear hearing protection when operating a tractor without a cab, and many report operating a tractor when they are excessively tired. Previous studies have also found low use of seatbelts among experienced farmers (Jinnah et al., 2014; M. B. Schenker et al., 2002), and high prevalence of tractors without rollover protective structures (ROPS) (M. B. Schenker et al., 2002).

Females reported participating in safe tractor operating practices more than men. This is consistent with previous research, though not in agriculture specifically, that has identified males as being more risky than females (Weber, Blais, & Betz, 2002). Age has also been found to be associated with risk-taking practices (Steinberg, 2004) and in our study population, tractor operating practices improved slightly as the study population aged (from 18 to 24). Tractor operating practices did not vary regardless of type of academic institution a participant was enrolled in or whether they were a full-time or par-time student. This is important when considering intervention development and

dissemination, suggesting tailored interventions to specific institutions are not necessary.

Social influences including supervisory influence, peer/coworker risk-taking, and parental risk-taking have been found to influence workplace practices in young adult and adult workers. In our study, the two items related to supervisory influence were found to be significantly associated with safer tractor operating practices, suggesting supervisors and management may influence work practices among young adult agricultural workers. Results from previous studies have found that if management is committed to safety, employees will also demonstrate a commitment to safety (Barling, Loughlin, & Kelloway, 2002). Pressures to perform by management or supervisors (Hofmann & Stetzer, 1996), a management that does not emphasize safety (Barling et al., 2002), lack of training (Hofmann & Stetzer, 1996) have all be found to contribute to unsafe work practices in occupational settings. In our survey we did not identify if the supervisor a participant was referencing was also a course instructor or college professor. Agricultural educators have been identified as a role model for agricultural students and a potential avenue to disseminate agricultural safety and health information and model appropriate safety behaviors (Saucier, Schumacher, Funkenbusch, Terry, & Johnson, 2008). In the future, we recommend collecting information on educators and instructors influence on young adult agricultural workers to determine the applicability of safety and health in agricultural classrooms.

Peers and coworkers have been found to influence work and risk-taking practices across age groups. Adolescent and young workers are especially vulnerable to peer pressure, and Westaby and Lee (2003) found peer risk-taking to be associated with individual risk-taking orientation at work among high school aged (14-18 years old) agricultural workers. Among employed adults, coworkers who disregard safety, and even bully, others to ignore safety protocol lead individuals to enact unsafe work behaviors (Westaby & Lee, 2003). Unlike these previous studies, we did not find peer or coworker risk-taking to effect individual workplace behaviors. It is unknown how many agricultural workers in the present study are working with coworkers. Agricultural workers and farmers often work in isolation and it is possible interaction with coworkers is limited which would then limit their influence.

High school and college-aged agricultural workers report adopting agricultural-related behaviors through observational learning and modeling by a parent/adult farm worker. Young workers watch adults perform agricultural tasks and work under the supervision of an adult before eventually performing the task independently, often adopting the unsafe behaviors they observed from a parent or authoritative figure (Darragh et al., 1998; Sanderson, Dukeshire, Rangel, & Garbes, 2010). In regards to tractor operating behaviors specifically, fathers have been found to play an important role as teachers and role models (Darragh et al., 1998; Jinnah et al., 2014). Results from our study, however, indicate parental risk-taking may be the least influential on individual work

behaviors. No significant associations were found between the parental risk-taking items and tractor safety score. We know over half of the participants are spending the most working hours on a family farm or a relative's farm, but postulate that by early adulthood workers may have some autonomy in how they perform work-related tasks.

Several of the global risk-taking and risk-taking orientation work items were significantly associated with tractor safety scores. Results from these items indicate young adult agricultural workers are aware of the risks associated with farm work and have accepted the risk as part of the job. This is consistent with previous studies that indicate farmers are well aware of agricultural hazards but interact with them regardless. Dennis Murphy coined the disconnect between what farmers know and how they behave the Farm Safety—Risk Paradox (Murphy, 1992). Results from this study suggest the Farm Safety –Risk Paradox may persist among agricultural workers and farmers.

The results of this study should be interpreted in light of some limitations. The sample was limited to young adult agricultural workers who were enrolled in agricultural science courses at four post-secondary institutions within Iowa which may limit the generalizability of these findings. Access to young adult agricultural workers is difficult given the population is dispersed geographically and often work independently. Agricultural colleges and universities provided access to some of the population, but not all young adult agricultural workers in Iowa. Additionally, characterizing the tractor operating

behaviors relied on self-report from the study participants, which may not reflect their true work practices. However, field-observations would have been time and resource intensive and not without their own limitations. Finally, given the cross-sectional design of the study we cannot confirm a causal relationship between tractor safety behaviors and social influences.

To our knowledge this is the first study to identify risky tractor driving behaviors of young adult agricultural workers and investigate factors associated with such behaviors. Results of this study should be considered when planning agricultural safety and health interventions for the young adult population. Recognizing the potential influence of supervisors, peers, and parents can help direct and guide an intervention.

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Appendix A

Table 2.6: Pearson correlation coefficients

Variable	Supervisor Influence	Risk-taking at work	Peer Influence	Parent Influence	Global Risk-taking
Supervisor Influence	1.00				
Risk-taking at work	0.32	1.00			
Peer Influence	0.41	0.38	1.00		
Parent Influence	0.35	0.34	0.58	1.00	
Global Risk-taking	0.25	0.66	0.32	0.38	1.00

CHAPTER 3

The Influence of Organizational Factors on Young Adults' Tractor Operating Practices

Abstract

Purpose: Hazards in the agricultural workplace include chemicals, livestock, and large machinery such as tractors. Tractors are among the most common piece of agricultural equipment and the most hazardous. However, tractor-related injuries can be prevented by installing rollover protective structures (ROPS) combined with the use of seatbelts. While adult farmers report low seatbelt use and frequent use of tractors without rollover protective structures, it is unknown whether the young adult population has adopted similar tractor driving practices. Furthermore, it is unknown if workplace organizational factors are associated with tractor driving practices. This study was designed to identify tractor operating practices among young adult agricultural workers and the influence of employee reported organizational factors including workplace safety and health policies and work scheduling.

Methods: An online survey was conducted among college students enrolled in agricultural science classes in four Iowa colleges and universities. Participants answered questions about their tractor operating practices, the presence of workplace safety and health policies, the number of hours worked each week on average, and the average number of hours of sleep received in the past work

week. A tractor operation safety score was estimated from participants' responses to the tractor operating practices. Linear regression was used to examine the association of organizational work factors and the tractor operation safety score.

Results: Of the 193 respondents, over 70% of young adult agricultural workers reported that they never or rarely wear a seatbelt when operating a tractor with a rollover protective structure. Participants who reported safety and health policies were in effect reported a significantly higher tractor operating safety score than those who reported the policy was not in place. Number of hours worked each week was also associated with tractor operating safety score.

Conclusions: Young adult agricultural workers frequently reported unsafe tractor operating practices. The association between workplace safety and health policies and hours worked and tractor operating practices suggest organizational factors may encourage safe working practices. This preliminary data indicates there is a relationship between organizational policies and safety behaviors indicating that employers with policies addressing specific, task-based behaviors (i.e., seatbelt use on tractors) can increase the adoption of safe work practices and ultimately prevent injuries.

Introduction

Young adults contribute substantially to the agricultural workforce. Young adults not operating as the principal owner/operator of a farm typically work as hired labor on a non-family farm or on their family's farm. Hired farmworkers, including full-time, part-time, and contract workers, make up a third of all those working on farms. In 2012, 25% of the 1.06 million hired farmworkers were under the age of 25, 82% were male, 92% were white, and 25% had at least some college education (United States Department of Agriculture Economic Research Service, 2016).

Ascertaining the number of young adults working on their family's farm is more difficult. In 2016, the USDA estimated there were close to one million youth (under the age of 18) living and working on a farm (USDA, 2016). While this statistic does not capture all workers under the age of 24, some youth who grew up on farms mature and move off the farm to pursue a career or education, but many remain active on family farm and work in some capacity.

Young adults' participation in the agricultural industry is expected to increase. Historic commodity prices in the last ten years have encouraged older farmers to remain active in farming; however, if profits erode as projected, there will be a faster-than-expected exit of many farmers in the next 18 months (Utterback, 2014). Looking further ahead, it is projected in the next 20 years 25% of American farmers will retire or be forced out of farming (Utterback, 2014), leaving young farmers to fill the employment need.

Agriculture has been identified as one of the most hazardous occupational industries for young adults (ages 18-25) (White & McManus, 2015). Young adults are exposed to hazards in the agricultural work environment known to cause injuries including livestock, large machinery, chemicals, and tractors (Rudolphi et al., 2015; Schulman et al., 1997). Children as young as eight years old report driving tractors (Jinnah et al., 2014) and high school and college-aged agricultural workers report routine use of tractors (Allread et al., 2004; McCurdy & Kwan, 2012; Rudolphi et al., 2015).

Tractors are the leading cause of agricultural fatal injuries (Hard et al., 2002) and one of the leading causes of nonfatal injuries (Pickett et al., 2001). Tractors are ubiquitous in agriculture, used for a variety of tasks and activities. While young adults report operating tractors, how they engage with the machines is unknown. Identifying the specific safety practices young adults are engaging in while operating tractors inform prevention efforts.

Preventing fatal and nonfatal tractor injuries among young adults is an important step to ensuring the sustainability of the agricultural workforce. Preventing injury and illness on farms relies on the implementation and enforcement of hazard control methods by owners and managers. Occupational hazards are typically controlled via engineering or administrative control or by prescribing appropriate personal protective equipment (National Institute for Occupational Safety and Health, 2016). While engineering controls are often regarded as the most effective in reducing risk of occupational injuries and

illness, many require active participation or behavior change by an employee. For example, rollover protective structures and seatbelts are engineering controls to reduce injury or death from a tractor rollover. Considered a highly effective engineering control, the success of a rollover protective structure and seatbelt relies on the tractor driver to wear seatbelt and in some cases install a rollover protective structure. As such, the emphasis has been placed on modifying workplace practices to improve employee safety and wellbeing (Garavan & O'Brien, 2001; Huang, Ho, Smith, & Chen, 2006).

Organizational factors including workplace safety and health policies, on-the job training and safety training, scheduling, and availably of safety materials (*i.e.,* personal protective equipment) have been linked to a number of safety-related outcomes including performance of safe work practices in healthcare and manufacturing (Cheyne et al., 1998; Cooper & Phillips, 2004; Griffin & Neal, 2000; M Mattila, Hyttinen, & Rantanen, 1994).

An organization's safety and health related policies are considered an indicator of the basic values and beliefs the organization holds concerning workplace safety. Policies are important components of an effective safety program, and a reflection of management's commitment to safety, ability to provide a safe work environment, and willingness to promote and facilitate safe work practices (Bartling & Hutchison, 2000). However, the extent to which the presence of safety and health policies are present on farms where young adult agricultural workers are employed is unknown and the influence of safety and

health policies on workplace practices has not been identified within the young adult agricultural population.

In addition to policies, modifications to work schedules and work/rest rotations have also improved workplace practices and been found to reduce error among employees (Landrigan et al., 2004). Long work hours have been associated with health and safety risks including poorer perceived general health and increased injury rates. Working over 40 hours a week has been associated with unhealthy weight gain, increased alcohol use, and increased tobacco use (Caruso, 2014). Agricultural work is often seasonal and workers report long hours. Fifty-six percent of adult farmers and ranchers report spending 10-14 hours a day on agricultural work, and 17% report working more than 15 hours (Schafer, 2013). Seasonal demands may influence the amount and quality of sleep a worker receives, which may influence their workplace practices (Landrigan et al., 2004), risk of injury (Barnes & Wagner, 2009), and overall health (Foundation, 2017). However, the effects of hours worked and scheduling on safety practices of young adults have not been examined within the agricultural workplace.

Young adults are important to the agricultural workforce and many report working with known hazards, including tractors. In order to prevent occupational related injuries with tractors, an appraisal of the tractor safety practices of young adults is necessary. Various methods to prevent occupational injuries by improving workplace practices have been identified, including

implementing safety and health policies and modifying work schedules; however, these methods have not been evaluated within agriculture and the young adult population. Therefore, the objectives of this study were to determine the tractor safety practices of young adults, and compare these behaviors across two types of farms and identify the organizational factors in effect on farms young adults are employed on, and compare these across two types of farms. Finally, we examined the association between reported safety practices and organizational factors.

Methods

Participants

Study participants were recruited from animal science, agronomy, farm operation, and agricultural education courses at four Iowa agricultural community colleges (2-year program) and universities (4-year programs). These colleges and universities were selected because they have high student enrollment in agricultural programs and a high placement rate in the agricultural industry, specifically agricultural production, after graduation. The students in these intuitions were similar, demographically, to hired agricultural workers and farmers in the United States as identified by the USDA (United States Department of Agriculture Economic Research Service, 2016).

Three informational presentations were made by the project PI at each of the four selected institutions in the fall of 2014 and spring of 2015. The study

objectives, methods, online survey, and compensation were explained students, and those interested in participating provided their email address to the project PI. In order to participate in the survey students must have met the following criteria: (1) been between the ages of 18 and 24, (2) report working on a farm or performing agricultural related tasks four hours a week, on average. Presentations were made to 351 students, 342 of which provided their email address, and 242 completed the online survey. The overall response rate was 64.8%.

Procedures

Participants were emailed a link to the survey administered through Qualtrics (Qualtrics Labs; Provo, UT). To increase participation, three reminder emails were sent to students. The online survey took less than 30 minutes to complete and participants who completed the survey were mailed a check for $15.

Measures

An online survey was developed to identify workplace practices of young adult agricultural workers within six common agricultural work areas; (i) tractor use, (ii) ATV/UTV use, (iii) grain handling, (iv) pesticide handling/application, (v) livestock handling, and (vi) swine facility work. Participants reported their frequency of engaging in specific operating practices within each of the six work areas. There were between 6 and 12 operating practices listed within each work

area. In the current manuscript, only the results relevant to tractor use are presented.

Tractor Operating Behaviors: Twelve activities related to safe tractor operation (i.e. I wear a seatbelt if the tractor has a rollover protective structure) were presented to participants who indicated they operated or drove a tractor (Cronbach $\alpha = 0.84$) (Table 1). Respondents indicated on a Likert scale how often they participate in each of the activities. Response options ranged from 1 (never) to 5 (always).

Individual Characteristics: Personal information including age (18-19, 21-21, 22-24), gender (male, female), educational status (full-time student, part-time student), institution type (2-year program, 4-year program) and place of primary employment (family farm, non-family farm, principal operator) were collected from each participant.

Work Organizational Characteristics: Participants responded with *yes/no* whether 14 workplace safety and health policies were in effect on the farm they were employed. The 14 workplace safety and health policies were compiled by identifying common policies in place on farms and in agricultural settings (i.e. *the seatbelt must be worn when operating a tractor*). Participants reported how many hours they work, on average, during each of the four seasons. Work hours were collected as a continuous variable and then categorized into *40 or less*, and *41 or more* per week. Participants were asked whether the amount of hours they work depended on the agricultural season. Response options were *yes/no*.

Participants reported how many hours of sleep they have received each night in the past work week, on average. Hours were reported as a continuous variable and then categorized into *6 or less* and *more than 6.*

The survey was reviewed for comprehension and clarity by young adults who met the study inclusion criteria. All procedures were approved by the Institutional Review Board at the University of Iowa.

Statistical Analysis

Analyses were performed using SAS version 9.4 (SAS Institute; Cary, NC). Means and frequency distributions were used to summarize the individual characteristics of the study sample, organizational work characteristics and the frequency of reported tractor operating practices. Frequency of tractor operating practices were collapsed from five category response options (never, rarely, sometimes, usually, always) to three categories (never/rarely, sometimes, usually/always).

A dimensionless tractor operating safety score ranging from 1-5 was calculated for each participant who responded to the 12 tractor operating behavior items by averaging the 12 item responses. A score of 5 indicated a participant reported *always* participating in the 12 safety practices (i.e. *always* wear their seatbelt when operating a tractor with a ROPS), whereas a score of 1 indicated a participant reported *never* participating in the 12 safety practices. Participants reported how many hours they worked on a farm, on average,

during the week during each of the four seasons as a continuous variable. Hours worked for each season was then categorized (40 or less, 41 or more). Sleep was also reported as a continuous variable and dichotomized based on recommendations from the National Sleep Foundation (less than 6, 6 or more). A total policy score ranging from 0-14 was calculated for each participant who responded to the whether the 14 safety and health policies were in place on the farm they worked on by summing the number of policies they responded "yes" to. The total policy score was then categorized (0, 1-4, 5-8, 9 or more).

Chi square was used to determine if there was an association between categorical, individual characteristics and type of farm young adults reported working on (family farm or non-family farm). Chi-square was also used to determine if there was an association between categorical, workplace organizational characteristics and type of farm young adults reported working on (family farm or non-family farm). Workplace organizational characteristics included self-reported workplace policies, hours worked each week each season, how much sleep participants reported getting each night, and whether sleep patterns change given the agricultural season. Associations were considered significant at the $p=0.05$ level. In the event cell counts were less than or equal to five, Fisher's exact test was used to determine significance.

We used t-tests and ANOVA to examine the relationship between categorical, individual characteristics and tractor safety scores, the continuous outcome variable. T-tests and ANOVA were also used to determine if there was

an association between categorical, self-reported workplace organizational characteristics and tractor safety scores. Self-reported organizational characteristics included workplace policies, hours worked each week each season, how much sleep participants reported getting each night, and whether sleep patterns change given the agricultural season. Associations were considered significant at the p=0.05 level.

Results

Of the 242 participants who completed the online survey, 80% (n=193) indicated they routinely drive tractors and responded to the 12 tractor operating activities. In the sample of young adult agricultural workers, 80% were male, 97% reported being a full-time student, and 99% were white. Age groups, education level and institution types (2-year, 4-year) were equally represented. Sixty-four percent indicated they are primarily employed primarily their family's farm, 34% on a non-family or non-relatives farm, and 2% indicated they were employed as the principal owner/operator on their own farm.

Female participants were more likely to work on family farms than non-family farms (p=0.001). No statistically significant difference in farm type were observed across age categories, education level, post-secondary enrollment status, or institution type (Table 3.1).

Table 3.1: Association between individual characteristics and farm type young adults report working on

Individual Characteristic		Farm Type		
		Family Farm N=112	Non-family Farm N=59	P-value
Gender	Male	79	55	<0.001
	Female	33	4	
Age	18-19	38	25	0.31
	20-21	33	15	
	22-24	41	19	
Enrollment Status	Full-time student	110	56	0.18
	Part-time student	2	3	
Institution	2-year degree program	50	32	0.21
	4-year degree program	61	26	

Tractor Operating Practices

The 12 tractor operating activities included items related to personal protective equipment, distracted driving, and driving conditions/environment. Over 60% of respondents reported never wearing a seatbelt when operating a tractor with a rollover protective structure (ROPS) and almost half reported never wearing hearing protection when driving a tractor without a cab. However, nearly 75% reported avoiding operating a tractor near ditches, embankments, or holes, and 68.9% report avoiding slopes too steep for safe operation and 70% reported they always avoid texting, emailing, using the web or social media when operating a tractor (Table 3.2).

Table 3.2: Tractor operating practices of young adult agricultural workers (N=193)

Tractor Safety Practice	Never n (%)	Rarely n (%)	Sometimes n (%)	Usually n (%)	Always n (%)
Wear a seatbelt if the tractor has a rollover protective structure (ROPS)	118 (61.14)	34 (17.62)	26 (13.47)	7 (3.63)	8 (4.15)
Wear hearing protection when driving or operating a tractor without a cab	96 (49.47)	35 (18.13)	35 (18.13)	19 (9.84)	8 (4.15)
Avoid operating a tractor when excessively tired	89 (46.11)	43 (22.28)	36 (18.65)	15 (7.77)	10 (5.18)
Avoid operating or driving a tractor that does not have a rollover protective structure (ROPS)	47 (24.35)	41 (21.24)	58 (30.05)	35 (18.13)	12 (6.22)
Prohibit extra riders unless there is a designated passenger (buddy) seat	44 (22.80)	65 (33.68)	50 (25.91)	24 (12.44)	10 (5.18)
Avoid operating a tractor when under the influence of drugs or alcohol	31 (16.15)	38 (19.79)	64 (33.33)	42 (21.88)	17 (8.85)
Avoid talking on the cell phone when driving or operating a tractor	28 (14.15)	49 (25.39)	49 (25.39)	47 (24.35)	20 (10.36)
When tractor is stopped, set brakes securely and use park lock if available	26 (13.47)	43 (22.28)	77 (39.90)	26 (13.47)	21 (10.88)
Stay off slopes too steep for safe operation	8 (4.15)	11 (5.70)	41 (21.24)	54 (27.98)	79 (40.93)
Reduce speed when turning, crossing slopes, and on rough, slick, or muddy surfaces	5 (2.62)	17 (8.90)	40 (20.94)	69 (36.13)	60 (31.41)

(Table 3.2 continued)

Avoid texting, emailing, using the web or social media when operating a tractor	5 (2.62)	5 (2.62)	21 (10.99)	25 (13.09)	135 (70.68)
Avoid operating the tractor near ditches, embankments, and holes	4 (2.07)	8 (4.15)	37 (19.17)	57 (29.53)	87 (45.08)

The mean tractor score was 2.98 (SD=0.68). Scores ranged from 1.00 to 4.92 and were normally distributed. Female participants had a significantly higher mean tractor safety score than male participants (males=2.92, females=3.23 p-value p=0.01). No statistically significant difference in tractor safety scores were observed across age categories, education level, post-secondary enrollment status, institution type, or type of farm the participant primarily worked on (Table 3.3).

Table 3.3: Association between individual characteristics and tractor safety score

Individual Characteristic		N	Mean tractor score[1] (SD)	P-value
Gender	Male	154	2.92 (0.70)	0.01*
	Female	39	3.23 (0.56)	
Age	18-19	68	2.92 (0.73)	0.47
	20-21	65	2.98 (0.64)	
	22-24	60	3.07 (0.67)	
Enrollment Status	Full-time student	188	2.99 (0.68)	0.54
	Part-time student	5	2.80 (0.68)	
Institution	2-year degree program	94	2.94 (0.71)	0.42
	4-year degree program	96	3.02 (0.63)	

(Table 3.3 continued)

Farm primarily work on	Principal owner/operator	3	3.11 (0.13)	0.67
	Family farm	106	2.99 (0.73)	
	Non-family farm	56	2.90 (0.64)	

[1]Tractor safety score range is 1-5. 1=low safety score (NEVER report performing safety behavior), 5= high safety score (ALWAYS report performing safety behavior)

Workplace Organizational Characteristics

Workplace Safety and Health Policies

The mean number of safety and health policies in place on farms was 4.51 (SD= 3.50), and ranged from 0 to 13. Participants who reported working on a non-family farm reported significantly more policies in place (mean = 5.38, SD=4.19) than those who indicated they work primarily on their family's farm (mean =3.87, SD=2.96, p value = 0.01). Almost 15% of respondents indicated the family farm they work on did not have any of the 14 workplace safety and health policies in place, whereas only 5.9% of respondents indicated the non-family farm they worked on did not have any of the safety policies in place (Table 3.4).

Table 3.4: Association between number of workplace safety and health policies in effect and farm type young adults report working on

Number of safety policies in place	Family Farm N (%) N=100	Non-Family Farm N (%) N=51	P-value
0	16 (14.6%)	3 (5.9%)	0.07
1-4	50 (45.4%)	22 (43.1%)	
5-8	35 (31.8%)	15 (29.4%)	
9 or more	9 (8.2%)	11 (21.6%)	

The mean tractor safety score among young adult agricultural workers increased as the number of safety and health policies in effect on a farm increased (Table 3.3).

Table 3.5: Tractor safety score by number of safety policies on farms

Number of safety policies in place	N	Mean tractor safety score	P-value
0	21	2.81 (0.78)	<0.0001
1-4	81	2.78 (0.68)	
5-8	57	3.14 (0.58)	
9 or more	24	3.43 (0.64)	

The most common health and safety policies in place on family and non-family farms were *personal protective equipment (PPE) is provided if required by employer* and *appropriate personal protective equipment (PPE) is required when handling pesticides or chemicals* (Table 3.4). Less than 3% of participants who worked primarily on a family farm reported that *the seat belt must be worn when operating a tractor*, compared to 17% of participants who worked primarily on a non-family farm (p-value=0.001).

No statistically significant differences in workplace health and safety policies were observed between family farms and non-family farms, as reported by participants, except for the following policies; *lock-out tag-out of all controls is required before entering a bin* (p-value =0.02), seat belt must be worn when operating a tractor (p-value =0.001), *passengers or extra riders on tractors are prohibited when there is not a designated passenger seat (buddy seat)* (p-value

=0.04), and *seatbelt must be worn when operating or driving a UTV* (p-value

=0.01) (Table 3.6).

Table 3.6: Association between workplace safety and health policies in effect and farm type young adults report working on

Workplace policy	Farm Type		p-value
	Family n=105 N[1] (%[2])	Non-family n=53 N[1] (%[2])	
Entrance into a grain transport vehicle or bin is prohibited unless absolutely necessary	38 (36.25%)	22 (41.5%)	0.81
Lock-out tag-out of all controls is required before entering a bin	18 (17.1%)	19 (35.8%)	0.02
The use of ATVs or UTVs on public roads is prohibited	10 (9.5%)	10 (18.9%)	0.22
Helmet must be worn when using an ATV	8 (7.6%)	8 (15.1%)	0.33
Seat belt must be worn when operating a tractor	3 (2.9%)	9 (17.0%)	0.001
Passengers or extra riders on tractors are prohibited when there is not a designated passenger seat (buddy seat)	16 (15.2%)	15 (28.3%)	0.04
Pesticides must be kept in locked storage facility	35 (33.3%)	24 (45.3%)	0.22
Appropriate personal protective equipment (PPE) is required when handling pesticides or chemicals	61 (58.1%)	32 (60.4%)	0.82
Appropriate restraining equipment must be used when working with large livestock	47 (44.8%)	26 (49.1%)	0.31
Appropriate personal protective equipment (PPE) must be worn when working with livestock (hearing protection, steel toed shoes, etc.)	35 (33.3%)	21 (39.6%)	0.46
A double strap dust mask or organic dust filter equipped respirator must be worn when working in dusty environments	46 (43.8%)	24 (45.3%)	0.75
All tractors are equipped with a cab or a rollover protective structure (ROPS)	30 (28.6%)	23 (43.4%)	0.18

(Table 3.6 continued)

Seatbelt must be worn when operating or driving a UTV	7 (6.7%)	12 (22.6%)	0.01
Personal protective equipment is provided if required by employer	59 (56.2%)	36 (67.9%)	0.28

[1] number of young adult who responded *yes* the policy is in effect
[2] percent of young adults who responded *yes* the policy is in effect

In every instance, participants who reported a safety policy was in place at their primary workplace reported significantly higher tractor safety scores than those who indicated the policy was not in place (Table 3.7), regardless of whether the policy referenced tractor operation. The most common safety and health policies on farms included *appropriate personal protective equipment (PPE) is required when handling pesticides or chemicals* and *personal protective equipment is provided if required by employer.* In regards to tractor operation, less than 10% of participants reported the farm they worked on had a policy requiring the seatbelt be worn when operating a tractor. Almost a quarter (23%) of participants *indicated passengers or extra riders on tractors are prohibited when there is not a designated passenger seat (buddy seat)* on farm equipment and 38% indicated *all tractors are equipped with a cab or a rollover protective structure (ROPS).*

Table 3.7: Association between tractor safety scores and workplace policies

	Response	n	Mean tractor score[1] (SD)	P value
Entrance into a grain transport vehicle or bin is prohibited unless absolutely necessary	No	77	2.75 (0.68)	0.0004
	Yes	76	3.13 (0.61)	

(Table 3.7 continued)

Lock-out tag-out of all controls is required before entering a bin	No	98	2.77 (0.64)	0.0002
	Yes	52	3.19 (0.63)	
The use of ATVs or UTVs on public roads is prohibited	No	140	2.84 (0.64)	0.0004
	Yes	26	3.32 (0.58)	
Helmet must be worn when using an ATV	No	149	2.86 (0.63)	<0.0001
	Yes	20	3.52 (0.74)	
Seat belt must be worn when operating a tractor	No	158	2.89 (0.65)	0.001
	Yes	16	3.46 (0.69)	
Passengers or extra riders on tractors are prohibited when there is not a designated passenger seat (buddy seat)	No	136	2.82 (0.65)	<0.0001
	Yes	40	3.40 (0.61)	
Pesticides must be kept in locked storage facility	No	87	2.76 (0.64)	0.0001
	Yes	73	3.17 (0.66)	
Appropriate personal protective equipment (PPE) is required when handling pesticides or chemicals	No	55	2.67 (0.72)	0.0001
	Yes	110	3.09 (0.61)	
Appropriate restraining equipment must be used when working with large livestock	No	71	2.75 (0.63)	0.0004
	Yes	87	3.12 (0.64)	
Appropriate personal protective equipment (PPE) must be worn when working with livestock (hearing protection, steel toed shoes, etc.)	No	95	2.79 (0.59)	<0.0001
	Yes	63	3.21 (0.68)	
A double strap dust mask or organic dust filter equipped respirator must be worn when working in dusty environments	No	86	2.79 (0.64)	0.0012
	Yes	82	3.12 (0.68)	
All tractors are equipped with a cab or a rollover protective structure (ROPS)	No	108	2.81 (0.62)	0.0004
	Yes	65	3.18 (0.69)	
Seatbelt must be worn when operating or driving a UTV	No	141	2.85 (0.65)	0.0005
	Yes	25	3.35 (0.64)	
Personal protective equipment is provided if required by employer	No	51	2.64 (0.63)	<0.0001
	Yes	115	3.08 (0.65)	

[1]Tractor safety score range is 1-5. 1=low safety score (NEVER report performing safety behavior), 5= high safety score (ALWAYS report performing safety behavior)

Work Hours and Schedule

Young adults who reported working primarily on non-family farms more often reported working 41 or more hours per week (Table 3.8). Working on a non-family farm was also associated with getting less than 6 hours of sleep each night. Less than 10% of participants who work primarily on a family farm reported getting less than 6 hours of sleep a night, whereas 51.6% of participants who work primarily on a non-family farm reported getting less than six hours of sleep a night.

Table 3.8: Association between seasonal work hours and farm type young adults report working on

		Family Farm N=112 N (%)	Non-family Farm N=59 N (%)	p-value
Hours worked in fall	40 hours or less	87 (77.7%)	32 (54.2%)	0.001
	41 or more	25 (22.3%)	27 (45.8%)	
Hours worked in winter	40 hours or less	99 (88.4%)	44 (74.6%)	0.02
	41 or more	13 (11.6%)	15 (25.4%)	
Hours worked in spring	40 hours or less	82 (73.2)	32 (54.2)	0.01
	41 or more	30 (26.8)	27 (45.8)	
Hours worked in summer	40 hours or less	67 (59.8)	24 (40.7)	0.02
	41 or more	45 (40.2)	35 (59.3)	

(Table 3.8 continued)

Hours of sleep each night (past 5 week nights)	Less than 6	9 (8.7)	11 (51.6)	0.02
	6 or more	95 (91.3)	40 (78.4)	
Sleep changes given agricultural season	Yes	92 (85.2)	49 (94.2)	0.06
	No	16 (14.8)	3 (5.8)	

Reported hours worked and amount of sleep received had an effect on the reported tractor safety score of young adult agricultural workers in our sample. Participants who reported working more than 40 hours a week during the fall, spring, and summer, reported significantly lower tractor safety scores than those who reported working 40 hours or less (Table 3.6). While the number of reported hours of sleep received each night did not have a significant effect on reported tractor safety score (p=0.35), participants who reported the amount of sleep they received changed according to the agricultural season reported a significantly lower tractor safety score than those who reported the amount of sleep they received did not change with the agricultural season.

Table 3.9: Association between seasonal work hours and tractor safety score

	Response	n	Mean Tractor Score (SD)	P-value
Hours work in fall	40 hours or less	142	3.10 (0.67)	0.0001
	41 or more	51	2.67 (0.61)	
Hours work in winter	40 hours or less	166	3.01 (0.67)	0.229
	41 or more	27	2.84 (0.73)	
Hours work in spring	40 hours or less	137	3.10 (0.65)	0.0003
	41 or more	56	2.71 (0.69)	

(Table 3.9 continued)

Hours work in summer	40 hours or less	114	3.09 (0.65)	0.015
	41 or more	79	2.84 (0.67)	
Hours of sleep each night	Less than 6	25	2.86 (0.71)	0.35
	6 or more	148	2.99 (0.65)	
Sleep changes given agricultural season	Yes	158	2.95 (0.66)	0.03
	No	26	3.26 (0.77)	

[1]Tractor safety score range is 1-5. 1=low safety score (NEVER report performing safety behavior), 5= high safety score (ALWAYS report performing safety behavior)

Discussion

Over half (64%) of young adult agricultural workers reported being employed on a family owned farm, even as full-time or part-time students. We were surprised the proportion of young adults working on a family farm was not higher, however, we recognize we specifically recruited college students who are living away from their family farm. Of the individual characteristics we examined, only gender yielded a significant difference across farm types, with females more likely to work on their family farm as opposed to a non-family farm.

Young adult agricultural workers report low use of seatbelts when operating tractors, low use of hearing protection when operating a tractor without a cab, and high use of operating a tractor without a rollover protective structure, which is consistent with previous findings of adult agricultural workers (Jinnah et al., 2014; M. B. Schenker et al., 2002). Nonetheless, young adults report reducing their speed when turning, crossing slopes, and on rough, slick or muddy surfaces, they also report staying off slopes too steep for safe operation, and avoiding operating tractors near ditches, embankments, and holes. These

three factors are all related to environmental driving conditions. Results from our study indicate there is inconsistency in young adults' safety practices; it is unknown why young adult agricultural workers abide by some recommended operating procedures, but not others.

Of the individual characteristics we examined, females reported significantly higher tractor safety scores than males. This finding was expected given what we know about risk-taking differences among males and females (Weber et al., 2002). No significant differences in tractor safety scores were observed across age categories. While it is well documented that risk-taking tendencies change with age, we suspect the age criteria for inclusion of our study was too restricted (ages 18-24) to observe significant differences across age groups. We also observed no significant difference in tractor safety score by farm type (family farm and non-family farm) either. We hypothesized that young adults working on non-family farms may report higher tractor safety scores than young adults working on family farms, but the data did not support this outcome.

Results indicated there was no association between workplace policies and farm type (family farm or non-family farm) for 12 of the 16 listed safety and health policies. There was, however, an association between four of the workplace safety and health policies and farm type, two of which related to tractor operation specifically. Workers on non-family farms were more likely to report having the following policies in place; *seatbelt must be worn when*

operating a tractor and *passengers or extra riders on tractor are prohibited when there is not a designated passenger seat*. We hypothesized workplace safety and health policies would be associated more so with non-family farms, however, with the exception of four policies, there was no observed difference (Table 3.6).

Regardless of place of employment, family or non-family farm, participants who reported the existence of a safety and health policy also reported a significantly higher tractor safety score. We hypothesized participants who reported tractor-related policies at their place of employment would report higher tractor safety scores; however, we were not expecting an association between all 16 policies and tractor safety score. Policies have been found to promote safe working practices in healthcare and manufacturing settings (Cheyne et al., 1998; Cooper & Phillips, 2004; Griffin & Neal, 2000; M Mattila et al., 1994) and our results suggest a similar association in agriculture. What is unknown, however, is if and how policies are enforced and by whom. Regardless, our results support safety and health policies in the workplace and suggest the presence of policies are associated with safer work practices.

Agricultural workers are often characterized as working long hours, and in the Midwest, agricultural work is seasonal with much of the work occurring in the spring and the fall. Our study indicates that young adult agricultural workers who work primarily on family farms report working less than young adults who work primarily on non-family farms. We were expecting the opposite, that working for a non-family farm may be more restrictive on the number of hours a

young adult works. In all four seasons, workers on non-family farms were more likely to work 41 or more hours a week as compared to those who work on family farms.

This point is further supported by our results comparing tractor safety scores with the number of hours young adult agricultural workers report working. We found that young adults who worked 41 or more hours a week reported a significantly lower tractor safety score than those who worked 40 hours or less in the fall, spring, and summer. These results support limiting the number of hours young adults work to 40 or less and maintaining regular work schedules. Working more than 40 hours per week has been associated with increased injury rates, unhealthy weight gain, increased alcohol use, and increased tobacco use (Caruso, 2014).

Young adults working on non-family farms were also more likely to report getting less than six hours of sleep a night. These results are especially important when considering the safety and health of young adult workers. Young adult workers are already at increased risk of occupational injury or illness (Estes, Jackson, & Castillo, 2010; Rohlman, Parish, Elliot, Montgomery, & Hanson, 2013; Westaby & Lowe, 2005), and irregular, disruptive, or lack of sleep increases the risk of injury in the workplace. Sleep deprivation can slower an individual's reaction time and interfere with decision making, which may lead to injury (Foundation, 2017). Our survey was conducted during the academic school year and we cannot confirm young adult agricultural workers who reported receiving

less than six hours a sleep a night was due to agricultural work. However, regardless of why sleep was limited, performing agricultural tasks while sleep deprived may be a risk factor for injury. Though the amount of sleep employees receive is not generally considered a supervisor's concern, it may be important for supervisors to encourage employees to receive adequate sleep and schedule work accordingly. Lack of sleep also leads to decreased productivity, which may be a motivating factor for supervisors (Fryer, 2006).

Until now, it was unknown which types of organizational factors, such as workplace policies, farms had in effect. By collecting information on tractor operating practices, we were able to examine the association between organizational factors and workplace practices. These results suggest both workplace safety and health policies and scheduling (i.e., number of hours worked per week) may be effective in preventing occupational injuries and illness in agriculture. Rigorously designed studies to evaluate the effectiveness of policies on work practices should be developed.

According to agricultural census data, our study population was similar to the demographic characteristics of the agricultural workforce in the United States (United States Department of Agriculture, 2014; United States Department of Agriculture Economic Research Service, 2016), predominantly male (80%) and white (99%). We recognize the changing demographics of agriculture in the United States, females and minorities are playing an increasingly larger role in agriculture as both principal owners/operators and as

hired labor; however, in the Midwest, white males still represent a substantial portion of the agricultural workforce (United States Department of Agriculture, 2014). Furthermore, our study population recruited from colleges and universities (all participants in our study were perusing a post-secondary education) which differentiates our sample from the general population, However, USDA data on farmworkers indicate nearly 25% hold a college degree (United States Department of Agriculture Economic Research Service, 2016) and we expect that number to continue to increase (Wintersteen, 2014).

Workplace organizational factors including policies, hours worked each week, and hours slept each night may be subject to under-or over-reporting. Collecting observational data and confirming policies with employers would provide additional information, however, that was beyond the scope of this project. It is important to note, however, confirming the presence of safety and health policies on farms by either follow-up with supervisors/managers or site visits may be unnecessary. Workers reported safety and health policies they perceived being in effect and whether they are or are not is irrelevant since their perception may drive their behaviors.

This preliminary data indicates there is a relationship between organizational policies and safety behaviors indicating that employers with policies addressing specific, task-based behaviors (i.e., seatbelt use on tractors) can increase the adoption of safe work practices and ultimately prevent injuries.

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CHAPER 4

Coupling Behavioral Theory and Smartphone Technology to Increase the use of Hearing Protection among Young Adult Swine Facility Workers

Abstract

Purpose: Farming ranks among the top occupations for noise-induced hearing loss (NIHL). NIHL is permanent, irreversible, and though commonly considered an illness of older farmers, agricultural workers as young as high school aged have reported symptoms of NIHL. Hearing protection devices (i.e. ear muffs and ear plugs) are effective at preventing exposure to noise, however, few farmers report consistent use. The purpose of this study was to test an intervention to increase the use of hearing protection among young adult swine facility workers.

Methods: A randomized controlled trial that evaluated a smartphone intervention developed using the Social Cognitive Theory. Participants were randomized into three study groups; intervention with goal setting, intervention without goal setting, and control. The two intervention groups were instructed to track their daily use of hearing protection use when in swine buildings for 60 days. Reported hearing protection device use was compared between study groups at baseline, immediate post-intervention, and delayed follow-up.

Results: We observed an increase in reported hearing protection use among all three study groups at immediate post-intervention. The greatest increase in reported hearing protection use was in the intervention *with* goal group, who reported a mean increase of 47.1%. The intervention *without* goal group

reported a mean increase of 42.3% and the control group reported a mean increase of 32.0%.

Conclusions: The interactive, behavioral theory-based intervention increased the reported use of hearing protection among swine facility workers; however, differences among groups at immediate post-intervention were not significant. Increases in reported hearing protection use were not maintained from immediate post-intervention to delayed follow-up among the two intervention groups.

Introduction

It is well documented that farmers and agricultural workers are exposed to hazardous levels of noise and that farming ranks among the occupations with the highest rate of noise-induced hearing loss (NIHL) (Ehlers & Graydon, 2011). Some studies estimate that by age 50 half of all male farmers will be hearing impaired; however, hearing loss is known to begin at a much younger age (Ehlers & Graydon, 2011). In a recent survey of young adult agricultural workers (18-22 years old), over 90% of males and 80% of females reported ringing in their ears or decreased ability to hear after working in a noisy environment and similar health effects have been reported in even younger agricultural populations, including high school students (Reed, Kidd, Westneat, & Rayens, 2001b; Rudolphi et al., 2015).

Indoor swine production facilities have been identified as a source of hazardous noise for agricultural workers. A 2008 study found swine production facility workers were exposed to noise levels that exceeded the National Institute for Occupational Safety and Health's (NIOSH) recommended exposure limit (REL) of 85 dBA (8-hr TWA). (Humann, Donham, Jones, Achutan, & Smith, 2005). A survey of agricultural college students in Iowa found 40% reported regularly feeding confinement animals and 24% reported regularly cleaning confinement buildings, (Rudolphi et al., 2015) both tasks associated with elevated noise levels.

NIHL is irreversible yet preventable. Hearing protection devices (ear muffs, ear plugs) have been identified as effective means of reducing personal exposure to noise (S. W. Smith et al., 2008). However, when young adult agricultural workers (ages 18-24) were asked about their use of hearing protection, only 16% reported wearing hearing protection *often* or *always* when working in a swine building and 40% reported wearing hearing protection *often* or *always* when operating a power washer to clean a swine building (Rudolphi unpublished data). These results support previous studies in which only a small proportion of the agricultural population reported using hearing protection (Carpenter et al., 2002).

While many industries and workplaces are required to comply with the Occupational Safety and Health Administration's (OSHA) noise standards, farms with fewer than 11 employees are exempt from OSHA inspections, and hearing conservation programs are often not implemented (Sherman & Azulay Chertok, 2014). Furthermore, there are few interventions to increase the use of hearing protection among agricultural workers and most have either targeted children (Berg et al., 2009; Knobloch & Broste, 1998; Sherman & Azulay Chertok, 2014) or older adult farmers (Gates & Jones, 2007; S. W. Smith et al., 2008). However, young adults engaged in agriculture are exposed to hazardous noise and are known to report symptoms of NIHL (Rudolphi, Sheridan, & Rohlman, 2014); therefore there is a need to develop interventions specifically targeting the young adult agricultural worker population.

Agricultural safety and health interventions are frequently criticized for their lack of a theory-based foundation (Witte et al., 1992). Interventions that are based on behavioral theories are more effective than those without a theoretical base (K. Glanz & Bishop, 2010). Rigorously designed interventions that appeal to the unique characteristics of the population and have a theoretical foundation should be developed (Witte et al., 1992) (Kreuter et al., 1999; Kreuter & Wray, 2003)

We report on the results of a randomized-control trial of a hearing conservation intervention that couples constructs from the Social Cognitive Theory and interactive, smartphone technology to aid in behavioral tracking to increase the use of hearing protection among young adult swine production workers.

The Social Cognitive Theory

Social Cognitive Theory (SCT) has been used as the foundation of many health-based interventions that have been successful in modifying health behaviors. This theory suggests that in order for behavioral change to occur, an individual must develop self-regulatory skills, which requires that he/she pay close attention to his/her behaviors and habits (Bandura, 1998). Three major factors of the social cognitive theory are 1) personal cognitive factors, 2) the physical and social environment, and 3) behavioral factors. The intervention tested in the current study draws on these three major factors.

Personal cognitive factors include the ability to self-regulate behavior and reflect on experiences (K Glanz, Rimer, & Viswanath, 2015). In this newly developed intervention, participants reflect on and regulate their hearing protection use by actively tracking their behaviors each day. Behavioral tracking (i.e., logging behaviors, keeping a diary) is an effective tool in developing self-regulatory skills (Stajkovic & Luthans, 1998) and has been effective in facilitating behavior change across a variety of health behaviors (Kirwan et al., 2012) but has had limited use with safety behaviors.

Socioenvironmental factors can serve as barriers or facilitators that permit or discourage a particular behavior (K Glanz et al., 2015). For example, limited physical access to hearing protection devices may be a barrier to their use (McCullagh, Ronis, & Lusk, 2010). In this study, all participants received appropriate and high quality hearing protection devices.

Finally, behavioral factors are actions that enhance the adoption of a behavior and include personal intention or goals (K Glanz et al., 2015). Setting a daily goal for hearing protection use and receiving feedback from a smartphone app, such as positive or negative messages when a goal is achieved or not (described below) is hypothesized to encourage the use of hearing protection devices among participants.

Smartphone Technology

Advances in technology have allowed behavioral tracking to become an efficient, interactive process. Smartphone apps loaded on mobile phones are an engaging, portable, and appealing intervention platform, especially among young adults (Klasnja & Pratt, 2012). They are also ubiquitous; as of 2015, 92% of young adults (ages 18-29) owned a smartphone (A. Smith, 2017).

Using smartphone apps as a self-monitoring tool has been tested among young adults with success in modifying behaviors related to weight loss and weight management (Carter et al., 2013; Dennison et al., 2013; Patrick et al., 2014), physical activity (Carter et al., 2013; Kirwan et al., 2012) smoking cessation (Buller et al., 2014), and cancer screening (Lee et al., 2014); however, there has been limited use of this technology to change safety behaviors.

The objectives of this study were to determine the impact of a smartphone app-based behavioral tracking on hearing protection device use and determine the effect of goal setting on hearing protection device use among young adult swine facility workers.

Methods

Research Design

This research study was a randomized-control design to evaluate the effectiveness of an intervention to increase the use of hearing protection among young adults who work in swine buildings from baseline to immediate post-intervention (60-days after baseline) and delayed follow-up (three months after

immediate post-intervention). Young adults who met the study criteria were randomly assigned to either of two intervention groups (intervention *with* goal setting or intervention *without* goal setting) or the control group. Baseline, immediate post-intervention, and delayed follow-up data were collected with online surveys. All participants were compensated for completing the project. The research study was approved by the Institutional Review Board at the University of Iowa.

Participant Recruitment

Participants were recruited from a variety of agricultural organizations. The study was advertised to the 4,000 producer-members of the Iowa Pork Producers trade organization with a notice in their bi-weekly online newsletter. The Iowa Farm Bureau's Young Farmer Program provided study information to potential participants via their social media outlets. Land-grant university faculty, community college instructors, and high school agricultural education teachers were provided with a written description of the study and asked to provide it to interested and eligible students.

Individuals who were interested in participating were directed to an online screening questionnaire. In order to participate, the individual must have met the following inclusion criteria: (1) be between the age of 18 and 35 years; (2) enter a swine production building at least once per day; (3) currently report using hearing protection devices less than 50% of the time spent in a swine

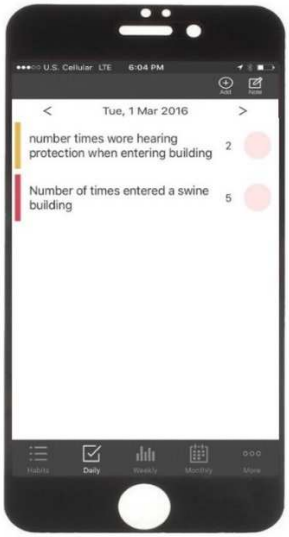
production building; (4) be employed by a facility that does not have a hearing conservation program in place, (5) own and use a smartphone.

Intervention

The intervention coupled constructs from the Social Cognitive Theory with interactive, smartphone technology to increase reported use of hearing protection among young adult swine workers. Only those participants in the intervention *with* goal setting group were instructed to set a personal, daily goal for hearing protection use based on the average number of times they enter a swine building each day. They were encouraged to set a goal of wearing hearing protection every time they enter a swine building, but were encouraged to make the goal personal and manageable.

The smartphone app, *Habitbull,* was assigned to the two intervention groups to allow them to track their hearing protection use (Oristats Ltd). Participants in the two intervention groups download *Habitbull* onto their iPhone or Android device. Participants were instructed to track the number of times they entered a swine building each day (0, 1, 2, etc.) and the number of times they wore hearing protection when entering a swine building each day (0, 1, 2, etc.) (Figure 1). Participants in the intervention *with* goal group were instructed to set a daily goal for hearing protection use based on the average number of times they enter a building each day. Participants in the intervention *without* goal group were not instructed to set a daily goal.

Figure 4.1: Screenshot of the *Habitbull* app as it appears on an iPhone



The app, *Habitbull* was selected because it allows users to customize the activities they want to track (i.e. number of times they entered a swine building, number of times they wore hearing protection), and allowed users to set a daily goal (intervention *with* goal group) or not set a daily goal (intervention *without* goal group). *Habitbull* sent reminders to participants to track their behaviors daily via a push notification. The app was available for free in both the Android and iPhone app stores.

Implementation & Materials

Group randomization: Young adults who met the study criteria were randomized into one of three study groups. The three study groups were:

1) *Intervention with Goal:* Participants (n=24) in the goal setting intervention group tracked their hearing protection use when in

swine confinements. This group was also instructed to set a daily goal for hearing protection device use based on the average number of times they entered a building. It was recommended to these participants to wear hearing protection every time they entered a building, but also encouraged to make the goal manageable and personal.

2) *Intervention without Goal:* Participants (n=24) in the non-goal setting intervention group tracked their hearing protection use when in swine building. Participants in this group were NOT instructed to set a daily goal for hearing protection use.

3) *Control Group:* Members of the control group (n=24) did not track their daily use of hearing protection using the *Habitbull* app.

***Delivery of study materials*:** After completing the baseline survey (described below), members of the three study groups received a set of study materials. Materials included an introductory letter from the PI, two types of hearing protection equipment (120 pairs of disposable ear plugs and one pair of over-the-ear muffs), and a brochure produced by the Great Plains Center for Agricultural Health on noise-induced hearing loss among farmers. Members assigned to the two intervention groups received directions for downloading, installing and using the *Habitbull* app. Members of the intervention *with* goal group were provided written instructions on how to set a daily hearing protection goal using the *Habitbull* app.

Intervention—Behavioral tracking period (60 days): Participants in both intervention groups were instructed to track the number of times they entered a swine building each day and the number of times they wore hearing protection when entering a swine building each day using the *Habitbull* smartphone app for 60 days. The behavioral change literature suggests that it takes 60 days for a behavior to become a habit- or automatic (Lally et al., 2009). The intervention was administered after all participants completed the baseline survey (described below). Study investigators did not have access to the daily logs of participants in the two intervention groups, the focus of this study was to compare changes in reported use of hearing protection from baseline to immediate post-intervention and delayed follow-up and not examine the actual daily smartphone logs of participants.

Data Collection

Baseline survey: After being randomized to one of the three study groups, participants completed the online, baseline survey. The survey collected the following information: gender (male/female), age, race (American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islanders, Black or African American, white, More than one race), marital status (never married, married, divorced, separated, widowed), education (elementary to some high school, high school graduate, tech training or trade school, associate degree and or some college, college graduate or beyond), role on swine farm (owner/operator, hired full-time worker, hired part-time worker, other), hours per week spent in a swine

building, hours per week spend performing farm/agricultural work, hours per week spend performing non-farm/agricultural work, type of swine operation they work on (farrow-to-wean, farrow-to-feeder, farrow-to-finish, wean-to-buying, feeder-to-finish, other), size of operation (less than 499, 500-999, 1000-1999, 2000-4999, 5000-9999, 10,000 or more hogs), whether they have purchased hearing protection devices in the past 60 days (no, no but if I needed new hearing protection devices I would, yes), type of smartphone they own (Android, iPhone) and mailing address. The baseline survey presented a list of swine-related tasks to participants. Participants were instructed to 1) select the activities in which they had participated during previous 6 months, 2) enter the number of times (0, 1, 2, etc.) they participated in each activity during the past three working days, and 3) enter the number of times (0,1,2, etc.) they wore hearing protection when participating in each activity during the past three working days. The activities listed were feeding pigs, walking pens, loading/unloading, inseminating, processing piglets, cleaning buildings, inoculating swine, heat checking, ultrasound monitoring, other (please specify).

Immediate post-intervention survey: An online, immediate post-intervention survey was emailed to all participants after the 60-day behavior tracking period. The immediate post-intervention survey presented the same list of swine-related tasks as the baseline survey. Again, participants were instructed to 1) enter the number of times (0, 1, 2, etc.) they participated in each activity in the past three working days, and 2) enter the number of times (0,1,2, etc.) they

wore hearing protection when participating in each activity in the past three working days. The activities listed were: feeding pigs, walking pens, loading/unloading, inseminating, processing piglets, cleaning buildings, inoculating swine, heat checking, ultrasound monitoring, other (please specify). The immediate post-intervention also asked whether they have purchased hearing protection devices in the past 60 days (no, no but if I needed new hearing protection devices I would, yes). Participants rated several types of hearing protection devices (i.e., ear muffs, ear plugs, other (please specify)) based on their personal preference (not at all desirable, somewhat desirable, very desirable, extremely desirable).

In addition, members of the two intervention group were asked to indicate how often they used the *Habitbull* app to track their daily entry and use of hearing protection when in swine buildings (never, less than once a week, 1-2 days a week, 3-4 days a week, 5-6 days a week, or every day).

Delayed follow-up survey: An online, delayed follow-up survey was sent three months after the immediate post-intervention survey to determine use of hearing protection use among participants three months after the intervention. The follow-up survey presented the same list of swine-related tasks as the baseline survey and immediate post-intervention survey. Again, participants were instructed to 1) enter the number of times (0, 1, 2, etc.) they participated in each activity in the past three working days, and 2) enter the number of times (0,1,2, etc.) they wore hearing protection when participating in each activity in

the past three working days. The activities listed were: feeding pigs, walking pens, loading/unloading, inseminating, processing piglets, cleaning buildings, inoculating swine, heat checking, ultrasound monitoring, other (please specify). The immediate post-intervention also asked whether they have purchased hearing protection devices in the past 3 months.

In addition, members of the two intervention groups were asked if they had continued to use to use the *Habitbull* app (yes, no) after completion of the study, if they had continued to track their daily use of hearing protection (yes, not) after completion of the study, and if they had started to use the app to track other activities (yes, no). The intervention *with* goal group was asked if they had set goals for other activities (yes/no) and asked what they liked/disliked about the goal tracking option.

Sample Size Determination

Given the limited published guidelines and pilot nature of this study, a formal sample size calculation was not performed. We aimed to recruit 90 participants (30 per study group) which was the largest feasible sample given resources. The sample size is similar to pilot studies using smartphone technology in health promotion research (Casey et al., 2014; Glynn et al., 2014; Hebden et al., 2014; Kirwan et al., 2012; Lee et al., 2014) and to a study that piloted similar technology in an occupational setting (Olson et al., 2014).

Data Analysis

Analyses were performed using SAS version 9.4 (SAS Institute; Cary, NC). Frequency distributions and means were used to summarize the demographic characteristics of the study sample. Homogeneity in the baseline characteristics between the intervention and control group was assessed using a chi-square test/Fisher's exact test for categorical variables and an analysis of covariance (ANOVA) for continuous variables. Education status was modified from the original five categories to three: High school (included high school and elementary to some high school), some college, tech school graduate, 2-yr program graduate (included tech training or trade school and associate degree and/or some college) and 4-year degree graduate (4-year degree graduate or beyond). Marital status was collapsed from four categories to two: married (included married) and not married (included never married, divorced, separated, widowed).

The proportion of hearing protection use was calculated for each participant at baseline, immediate post-intervention and delayed follow-up. The proportion of hearing protection use was calculated by dividing the total number of times a participant reported wearing hearing protection when entering a swine confinement by the total number of times a participant reported entering a swine confinement in the past three days on the baseline survey, immediate post-intervention survey, and delayed follow-up survey. The proportion of use variable has permissible values ranging from 0-1.0. We multiplied the proportion

of use at baseline, immediate post-intervention, and delayed follow-up by 100 in order to report a mean percent use of hearing protection at each time point.

The mean reported percent use of hearing protection was reported for each study group at three time points; baseline, immediate post-intervention, and delayed follow-up. T-tests were used to compare the mean reported percent use of hearing protection of the intervention *with* goal group to the control group and intervention *without* goal group to the control group at the three time points; baseline, immediate post-intervention, and delayed follow-up.

Linear regression was used to examine the association between reported hearing protection use at immediate post-intervention and group status, while controlling for reported use of hearing protection at baseline and additional covariates. Demographic characteristics that were not evenly distributed among study groups and resulted in p-value less than or equal to 0.20 were selected for inclusion in the linear regression model. These included gender, age, hours per week spent in a swine building, role on the swine farm. A final multivariable linear regression model began with all six variables (reported hearing protection use at baseline, group status, age, hours per week spent in a swine building, role on the swine farm) regressed on the dependent variable, reported use of hearing protection at immediate post-intervention. From there, variables were removed, beginning with the dependent variable with the largest p-value, until all remaining dependent variables were significant at the <0.20 level.

Results

Recruitment efforts resulted in 119 individuals completing the screening questionnaire. Of the 119, nine were excluded because they did not meet the age criteria, five reported not entering a swine building at least once per day, eight reported that their workplace required they wear hearing protection, 16 reported they currently wear hearing protection 50% or more of the time, and two reported they did not own a smartphone. The remaining 79 individuals were invited to complete the bassline survey. Seventy two completed the baseline survey and were randomized into study groups (n=24 per group).

After the 60-day behavioral tracking period, 21 participants from the control group, 20 participants from the intervention *without* goal group, and 20 participants from the intervention *with* goal group completed the immediate post-intervention survey. Three participants failed to complete the immediate post-intervention survey in the control group, four in the intervention *without* group, and four in the intervention *with* goal group, despite repeated efforts to contact participants via email. Three months after completing the immediate post-intervention survey, 21 control group participants, 18 intervention *without* goal group participants, and 16 intervention *with* goal group participants completed the delayed follow-up survey. Three participants (2 from the intervention *with* goal group and 1 from the intervention *without* goal group) reported not entering a swine building in the past three working days on the delayed follow-up survey, and were excluded from the delayed follow-up

analyses. The remaining participants failed to complete the delayed follow-up survey despite multiple email reminders. The overall retention rates were 87.5% for the control group, 75.0% for the intervention *without* goal group, and 66.7% for the intervention *with* goal group at delayed follow-up.

We compared participants assigned to each of the three study groups on demographic characteristics at baseline (N=72). Results indicate the three groups differed significantly on gender and farm role but did not differ significantly on reported use of hearing protection at baseline (Table 4.1). While the three study groups did not differ significantly (p= 0.14) on reported use of hearing protection at baseline, it is important to note that the intervention *with* goal group did report using hearing protection 28% of the time, whereas the intervention *without* goal group reported using hearing protection 12% of the time and the control group 13% of the time.

Table 4.1: Demographic characteristics of study sample by study groups; Intervention *with* goal, intervention *without* goal, and control

		Intervention *with* Goal (N=24)	Intervention *without* Goal (N=24)	Control (N=24)	p-value
Gender	Male	16 (66.7%)	21 (87.5%)	19 (79.2%)	0.02
	Female	8 (33.3%)	3 (12.5%)	5 (20.8%)	
Age (years)	Mean (SD)	22.54 (5.48)	26.17 (6.21)	25.71 (5.15)	0.06
Education	High school	11 (45.8%)	9 (37.5%)	6 (25.0%)	0.43

(Table 4.1 continued)

	Some college, tech school graduate, community college graduate	6 (25.0%)	8 (33.3%)	6 (25.0%)	
	4-year degree college graduate	7 (29.3%)	7 (29.2%)	12 (50.0%)	
Marital Status	Not married	15 (62.5%)	13 (54.2%)	12 (50.0%)	0.67
	Married	9 (37.5%)	11 (45.8%)	12 (50.0%)	
Race	White	24 (100.0%)	23 (95.8%)	24 (100.0%)	0.33
	Other	0 (0.0%)	1 (4.2%)	0 (0.0%)	
Farm Role	Owner operator	4 (16.7%)	11 (45.8%)	11 (45.8%)	<.0001
	Full-time hired worker	11 (45.8%)	9 (37.5%)	10 (41.7%)	
	Part-time hired worker	9 (37.5%)	2 (8.3%)	1 (4.2%)	
	Other	0 (0.0%)	2 (8.3%)	2 (8.3%)	
Cell phone type (n)	iPhone (1)	15 (62.5%)	8 (33.3%)	12 (50.0%)	0.13
	Android (2)	9 (37.5%)	16 (66.7%)	12 (50.0%)	
Hours/week in swine building	Mean (SD)	29.7 (6.69)	24.0 (13.60)	20.0 (12.23)	0.07
Hours/week in other ag	Mean (SD)	44.54 (17.60)	45.83 (8.22)	45.66 (22.61)	0.97
Hours/week non ag	Mean (SD)	8.04 (3.79)	7.75 (3.98)	7.75 (3.98)	0.96
Percent of reported use of hearing protection at Baseline	Mean % (SD)	25.9 (33.3)	12.0 (20.9)	12.8 (26.2)	0.15

The most common tasks young adult workers reported having participated in the six months prior to the study were walking pens/monitoring (97.3%) and loading/unloading hogs in or out of a building (93.1%) (Table 4.2). Less common tasks include heat checking, inseminating, and performing ultrasounds.

Table 4.2: Tasks young adult agricultural swine building workers reported having participated in during the past 6 months (N=72)

Task	**n (%)**
Walking pens/ monitoring	70 (97.2%)
Loading/unloading	67 (93.1%)
Moving	65 (90.3%)
Feeding	60 (83.3%)
Inoculating	28 (38.9%)
Heat checking	20 (27.8%)
Inseminating	14 (19.4%)
Ultrasound	5 (6.9%)

The intervention *with* goal and intervention *without* goal groups reported how often they used the *Habitbull* app to track their daily entry in to a swine building and how often they wore hearing protection when entering a swine building. The intervention *with* goal group was more likely to report never using the app (20% intervention *with* goal, 4.8% intervention *without* goal) and also more likely to report using the app every day (55% intervention *with* goal vs. 38.1% intervention *without* goal). However, differences in the number of days per week participants logged did not differ significantly (p=0.14).

Table 4.3: Association between number of days per week reported logging with *Habitbull* and study group

Days of week reported logged activities using *Habitbull*	intervention *with* goal (N=20) % (n)	intervention *without* goal (N=21) % (n)	P-value
Never	4 (20.0%)	1 (4.8%)	0.14
Less than once a week	1 (5.0%)	0 (0.0%)	
1-2 days a week	0 (0.0%)	2 (9.5%)	
3-4 days a week	2 (10.0%)	3 (14.3%)	
5-6 days a week	2 (10.0%)	7 (33.3%)	
Every day	11 (55.0%)	8 (38.1%)	

At immediate post-intervention, the mean reported percent use of hearing protection was 73.0% among the intervention *with* goal group, 54.3% among the intervention *without* goal group, and 44.8% among the control group. At delayed follow-up, the mean reported percent use of hearing protection was 53.9% among the intervention *with* goal, 27.8% in the intervention *without* goal, and 48.8% in the control group (Table 4.4).

Table 4.4: Percent of time intervention and control groups report hearing protection use at baseline, immediate post-intervention, and delayed follow-up.

	Intervention *with* Goal	Intervention *without* Goal	Control
	Mean (SD)	Mean (SD)	Mean (SD)
Percent of time report wearing hearing protection devices in swine buildings at baseline (%) [1]	25.9 (33.3)	12.0 (20.9)	12.8 (26.2)
Percent of time report wearing hearing protection devices in swine buildings at immediate post-intervention (%) [2]	73.0 (33.6)*	54.3 (34.1)	44.8 (36.9)

(Table 4.4 continued)

Percent of time report wearing hearing protection devices in swine buildings at delayed follow-up (%) [3]	53.0 (43.9)	27.8 (32.0)	48.8 (42.0)

* Statistically significant difference (p=0.05) in reported hearing protection use when compared to the Control Group at same time point
[1] Intervention *with* goal n=24, Intervention *without* goal n=24, control n=24
[2] Intervention *with* goal n=20, Intervention *without* goal n=20, control n=21
[3] Intervention *with* goal n=16, Intervention *without* goal n=18, control n=21

The multiple linear regression analysis showed hearing protection use at baseline, group status, hours worked per week in swine buildings, and role on the swine farm were strong predictors of hearing protection use at immediate post-intervention (R-square =0.33, F=2.84, p<0.01) (Table 4.5). Participants in the intervention with goal group reported using of hearing protection 19.37% more often than participants in the control group at immediate post-intervention, when controlling for use of hearing protection at baseline. Hearing protection use at baseline was also a significant predictor of hearing protection use at immediate post intervention (p<0.01).

Table 4.5: Multivariate linear regression model of relationship between reported hearing protection use at immediate post-intervention and group status, hours a week in a swine building, role on swine farm, and hearing protection use at baseline.

Parameter		**β (95% CI)**	**p-value**
Hearing protection device use at baseline		0.49 (0.20 - 0.79)	0.0015
Hours/week in swine building		0.59 (-0.10 – 1.29)	0.09
Group Status			
	Control	Ref	-

(Table 4.5 continued)

	Intervention *without* Goal	7.50 (-12.45 – 27.44)	0.45
	Intervention *with* Goal	19.37 (-3.19 – 41.92)	0.09
Role on swine farm			
	Full-time hired worker	Ref	
	Part-time hired worker	13.99 (-15.00 – 42.99)	0.34
	Owner	20.42 (-0.39 – 41.24)	0.05
	Other	19.86 (-15.57 – 55.30)	0.27

Discussion

In terms of recruitment, we were able to recruit 74 eligible participants into the study, which was 82.2% of the original recruitment goal. In Iowa, agricultural works are not formally organized, which makes even contacting workers difficult. As we expected, a large proportion of the study sample were males (78%) and white. These demographic characteristics are consistent with reports from the United States Department of Agriculture for agricultural workers in the United States (United States Department of Agriculture, 2014).

Each of the study groups in the intervention suffered from varying levels of attrition. The control group had the lowest rate of attrition at follow-up, three months after the end of the behavioral tracking period, of 12.5%, and the intervention *with* goal group had the highest rate of attrition at 33.3%. A review of web-based interventions found that attrition rates of greater than 20% were common (Neve, Morgan, Jones, & Collins, 2010). Unequal dropout among study groups is likely the result of the intervention. The highest rate of attrition was among the intervention *with* goal group. This group was asked to engage with

the smartphone app, *Habitbull*, at a higher level than the intervention *without* goal group and control group. This may have been too burdensome and encouraged some participants to dropout.

When demographic characteristics were compared across study groups, there was a significant difference across the three groups in regard to gender and farm role. The intervention *with* goal group had more females than the intervention *without* goal group and control group. The intervention goal group also had more part-time workers than either of the other two study groups. The intervention goal group was also a bit younger than the other two study groups, though not significantly. We suspect their younger age contributed to them being part-time hired workers. Importantly, the intervention *with* goal group reported higher use of hearing protection at baseline than the other two study groups. We suspect this may be the result of this group being a bit younger than the other two study groups. In agriculture, males and females report similar use of hearing protection use (McCullagh, Banerjee, Yang, et al., 2016), While previous studies have found the use of hearing protection is higher among younger workers, differences in age between our groups were not significant (Cramer, Wendl, Sayles, Duysen, & Achutan, 2016; M. B. Schenker et al., 2002).

Importantly, we observed an increase in reported hearing protection use among all three study groups at immediate post-intervention. The greatest increase in reported hearing protection use was in the intervention *with* goal group, who reported a mean increase of 47.1%. The intervention *without* goal

group reported a mean increase of 42.3% and the control group reported a mean increase of 32.0%. While all study groups reported an increase in hearing protection use, greatest increase in hearing protection use was observed in intervention *with* goal study group, suggesting a dose-response with the level of intervention engagement. The intervention *with* goal group had the most engagement with the *Habitbull* app. The app would send feedback via push notifications regarding their success or failure in meeting their daily goal and we hypothesize this feedback and communication with the app increased the use of hearing protection among this study group. The intervention *without* goal group did not receive any feedback from the app regarding their use of hearing protection.

Changes in reported use of hearing protection among the intervention *with* goal group and intervention *without* goal group from baseline to immediate post intervention are similar to those reported in interventions to increase the use of hearing protection among adult agricultural workers. Among high school agricultural students, 87.5% of participants in the intervention group of a school-based hearing conservation program reported using hearing protection devices at least some of the time after the intervention, compared to 45% of control students, however, baseline reports were not available (Knobloch & Broste, 1998). More recently and among adult agricultural workers, McCullagh et al (2011) reported an increase in reported hearing protection use among farmers in a pre-post study who received hearing protection as the intervention from 23%

to 64%, however there was no comparison group (McCullagh, 2011). A randomized controlled trial conducted by McCullagh et al (2016) showed an increase in reported hearing protection use from 29.5% to 48.7% six months after an intervention among three study arms; however, changes between study arms was not significant (McCullagh, Banerjee, Cohen, & Yang, 2016).

As previously mentioned, we observed an increase in reported hearing protection device use among our control group. The control group was not instructed to track their daily use of hearing protection, but did receive a box of hearing protection as part of the study. We hypothesize the increase in reported hearing protection use among the control group was the result of receiving high quality hearing protection devices (ear muffs and ear plugs) at the beginning of the study period. McCullagh et al (2016), reported similar results. In a randomized controlled trial to increase the use of hearing protection among farm operators, the study arm that received a mailed box of hearing protection devices increased their use of hearing protection as much as participants in the other two study arms (static web based intervention and interactive web-based intervention) (McCullagh, Banerjee, Cohen, et al., 2016). Greater access and availably to hearing protection devices has been associated with increased use (McCullagh et al., 2010).

At delayed follow-up we observed a decrease in reported hearing protection use among the two intervention groups from immediate post-intervention. The greatest decrease in reported use was among the intervention

without goal group (-26.5%). The intervention *with* goal group decreased reported use by 20.0%. The control group reported a slight increase (4.0%) in reported hearing protection use from immediate post-intervention to delayed follow-up. We do not know if participants continued to use the *Habitbull* app after the immediate post-intervention survey to track their use of hearing protection when in swine buildings and what effect, if any, it had on reported use of hearing protection. McCullagh et al (2016), reported an increase in hearing protection use among all three study arms from 6-months to 12-month follow-up from 48.7% to 49.3%, however, did not report results for each group (McCullagh, Banerjee, Cohen, et al., 2016).

An important component of our study was the incorporation of the Social Cognitive Theory in the development of the intervention. Interventions based in social and behavioral science theories are often more effective than those without a theoretical base (K. Glanz & Bishop, 2010). The Social Cognitive Theory has been used as the foundation in many health-based interventions (Kirwan et al., 2012), and think the application of the theory is promising at promoting safety behaviors as well. The theory suggests behavior change can be influenced by observing others within the context of social interactions (Bandura, 1998), however, we did not include social interaction in our intervention. Smartphone apps, such as Fitbit, allow users to share information (i.e. steps walked in a day) with individuals in their network which may encourage or further promote the health behavior. We recommend future studies that emphasize the social nature

of participants. Today's young adults are group oriented and have strong peer bonds (McCurry & Martins, 2010) and networking via the smartphone app with friends, regardless of where they work or live – which would be especially applicable to agricultural workers—could promote the adoption of safe behaviors, such as wearing hearing protection.

The smartphone app, *Habitbull*, was selected by the research team as the tool for participants in the two intervention groups to track their use of hearing protection use during the 60-day behavioral tracking intervention. Smartphone apps (sentence about being used). Among young adults, smartphones are ubiquitous (A. Smith, 2017) and apps have been used as a tool to aid in behavioral change in health interventions related to weight management (Carter et al., 2013; Dennison et al., 2013; Patrick et al., 2014), physical activity (Carter et al., 2013; Kirwan et al., 2012) smoking cessation (Buller et al., 2014), and cancer screening (Lee et al., 2014). We see promise in using the technology to assist with changing safety behaviors. Of the participants assigned to the intervention groups in our study (n=48), almost 60% reported using the app five or more days a week, suggesting this an accepted technology among the young adult population. As stated above, we recommend future studies use an app that allows for participants to share tracking information with one another, to determine the effect of peer pressure and public accountability on safety behaviors.

Limitations

Generalizability of these pilot results is limited given the study sample was primarily white males. Furthermore, while assignment to the study arms was random, selection into the study was not, and individuals interested in increasing use of hearing protection may have been motivated to participate in the study. Use of hearing protection at baseline, immediate post-intervention, and delayed follow-up relied on self-reports of participants. Self-report of hearing protection use may be an overestimation or underestimation of the true use of hearing protection. In this study, observations of participants at work was not feasible given resources and time. Self-report of health behaviors may also be subject to social desirability bias, however, McCullagh and Rosemburg (2015) found there was no social desirability bias among farmers self-reporting use of hearing protection devices, which supports the validity of self-report of hearing protection among this population (McCullagh & Rosemberg, 2015). We asked participants to report hearing protection use in the past three working days, providing a short reference period, to improve reporting accuracy. However, participants in the two intervention groups were instructed to log their daily use of hearing protection using a smartphone app and the control group was not. At immediate post-intervention and delayed follow-up the intervention groups may more accurately have reported hearing protection use than the control group, resulting in differential misclassification of the outcome variable.

Noise-induced hearing loss has serious implications on health. Workers who suffer hearing loss are at increased risk of injury or death from an

agricultural or non-agricultural incident (Choi et al., 2005). Individuals with hearing loss have been found to be at higher risk for hypertension and decreased quality of life (Sherman & Azulay Chertok, 2014). However, hearing loss is preventable. Hearing protection devices are an effective, low cost, method to preventing exposure to noise if used, however, they have been shown to be underutilized in the agricultural population. Reviews of interventions in agricultural safety and health have highlighted the paucity of rigorous, randomized controlled trials. This study adds to the body of knowledge and supports the need for continued research and interventions to increase the use of hearing protection among young adult agricultural workers.

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Appendix B

Steps to Final Multivariable Linear Regression Model

Table 4.6: Multiple linear regression model of association between reported use of hearing protection at immediate post-intervention and group status, gender, age, farm role, hearing protection use at baseline, and hours a week in swine building.

Parameter		β (95% CI)	p-value
Hearing protection device use at baseline		0.48 (0.18 - 0.79)	0.0023
Hours/week in swine building		0.60 (-0.15 – 1.36)	0.11
Group Status			
	Control	Ref	-
	Intervention *without* Goal	7.74 (-12.67 – 28.15)	0.45
	Intervention *with* Goal	18.29 (-5.00 – 41.59)	0.12
Role on swine farm			
	Full-time hired worker	Ref	
	Part-time hired worker	13.99 (-15.00 – 42.99)	0.34
	Owner	20.42 (-0.39 – 41.24)	0.05
	Other	19.86 (-15.57 – 55.30)	0.27
Gender			
	Male	Ref	-
	Female	1.84 (-24.52 – 28.20)	0.89
Age		-0.54 (-2.30 – 1.22)	0.54

AIC= 607.74, model fit F value = 2.84, p=0.0087, r-square= 0.33

Table 4.7: Multiple linear regression model of association between reported use of hearing protection at immediate post-intervention and group status, age, farm role, hearing protection use at baseline, and hours a week in swine building.

Parameter		β (95% CI)	p-value
Hearing protection device use at baseline		0.48 (0.18 - 0.79)	0.002
Hours/week in swine building		0.62 (-0.09 – 1.33)	0.08
Group Status			
	Control	Ref	-
	Intervention *without* Goal	7.57(-10.53 – 25.68)	0.45
	Intervention *with* Goal	18.49 (-2.15 – 39.13)	0.11
Role on swine farm			
	Full-time hired worker	Ref	
	Part-time hired worker	12.49 (-17.11 – 42.10)	0.40
	Owner	22.63 (0.45 – 44.79)	0.04
	Other	20.02 (-15.65 – 55.69)	0.26
Age		-0.51 (-2.03 – 1.01)	0.54

AIC= 605.76, model fit F value = 3.25, p=0.0045, r-square= 0.33

Table 4.8: Multiple linear regression model of association between reported use of hearing protection at immediate post-intervention and group status, farm role, hearing protection use at baseline, and hours a week in swine building.

Parameter		β (95% CI)	p-value
Hearing protection device use at baseline		0.49 (0.20 - 0.79)	0.0015
Hours/week in swine building		0.59 (-0.10 – 1.29)	0.09
Group Status			
	Control	Ref	-
	Intervention *without* Goal	7.50 (-12.45 – 27.44)	0.45
	Intervention *with* Goal	19.37 (-3.19 – 41.92)	0.09
Role on swine farm			
	Full-time hired worker	Ref	
	Part-time hired worker	13.99 (-15.00 – 42.99)	0.34
	Owner	20.42 (-0.39 – 41.24)	0.05
	Other	19.86 (-12.14 – 52.19)	0.27

AIC= 604.19, model fit F value = 3.71, p=0.0025, r-square= 0.33

CHAPTER 5

Discussion and Conclusions

Introduction

Agricultural has been identified as the most hazardous occupational industry for young adults (18-25) (White & McManus, 2015). Though considered a resilient group, young adult agricultural workers (18-22) have already begun reporting agricultural related injuries and symptoms of illnesses (Rudolphi et al., 2015). Young adults' contributions to the agricultural workforce are expected to increase over the next 20 years as older farmers leave the occupation (Utterback, 2014). Therefore, preventing occupational injuries and illness among this population will be necessary to ensure a sustainable and productive workforce.

The Hierarchy of Controls offers methods to controlling occupational hazards (National Institute for Occupational Safety and Health, 2016). Elimination, substitution, and engineering controls are regarded as the most effective, however, there are disadvantages to their application in agriculture. Promoting behavior change, though considered less effective, may be more appropriate than alternative controls in agriculture. There may also be opportunity for interventions addressing social and organizational work factors, however, the influence of such factors on workplace practices is unknown. Social influences, including perceived risk-taking of supervisors, peers, and parents,

have been associated with workplace risk-taking among young workers (Westaby & Lee, 2003; Westaby & Lowe, 2005). In addition, organizational factors such as work scheduling, have been linked to errors in the workplace (Landrigan et al., 2004) however, limited research has examined the influence of these factors within agriculture.

Personal protective equipment, though often considered the last line of defense against occupational hazards, offer some advantages over other methods of hazard control in agriculture. For example, hearing protection devices are effective at reducing exposure to noise and are cost efficient. Agriculture ranks among the occupations with the highest rate of noise-induced hearing loss (NIHL) (Ehlers & Graydon, 2011); however, only a small proportion of workers in agriculture report consistent use of hearing protection devices (Carpenter et al., 2002). Few interventions have been developed and tested to increase the use of hearing protection among agricultural workers. Furthermore, these interventions lack a theoretical foundation and are not audience specific. There is a need for rigorously evaluated, theory-based, audience specific interventions to increase the use of hearing protection among agricultural workers.

Study Summary

The goals of this research were to characterize the workplace practices of young adult agricultural workers across six common agricultural work areas, identify the influence of supervisors, peers, and parents on work practices of

young adult agricultural workers, identify the influence of organizational factors on work practices of young adult agricultural workers, and determine the impact of behavioral tracking on safety behaviors among young adult swine production workers.

To achieve these aims, an online survey was developed and administered to young adult (18-24) agricultural workers and college students at four public institutions in Iowa. Information about individual workplace practices within six agricultural work areas; (i) tractor use, (ii) ATV/UTV use, (iii) grain handling, (iv) pesticide handling/application, (v) livestock handling, and (vi) swine facility work. Within each work area we asked about participation in specific safety practices. In addition, social influencers, workplace policies, farm characteristics, and individual characteristics were collected.

An intervention was developed that coupled behavioral theory with technology to increase the use of hearing protection among young adult swine facility workers. This randomized controlled trial instructed participants in the two intervention groups to track their daily use of hearing protection using a smartphone app for 60 days. Logging behaviors is a method used to increase individual awareness of behaviors and self-regulatory skills. Reported use of hearing protection was collected at baseline, immediately post-intervention, and three-month follow-up and compared among study groups.

Synthesis of Findings

The purpose of this dissertation was to determine the workplace safety behaviors of young adult agricultural workers, potential influencers of their workplace behaviors, and then evaluate an intervention to improve workplace safety practices of young adult agricultural workers. Collectively, the results of these studies provide a basis for future studies, specifically, interventions that may be effective in improving safety and health behaviors of the population.

In characterizing the workplace behaviors of young adult agricultural workers, we determined their tractor operating safety behaviors were similar to those of experienced, studied farmers—low use of seatbelts and high prevalence of operating tractors without cabs (CITE). Interestingly, however, the population reported participating in safe practices in regards to environmental and terrain conditions such as avoiding steep slopes, ditches, and embankments. Chapters 2 and 3 identified social and organizational factors that may influence working practices of young adult agricultural workers. Of the three social influences, supervisors, peers, and parents, the strongest association was observed between supervisors, indicating that supervisors are more influential than parents or peers in the agricultural workplace. Because many young adults reported having learned to perform tasks on the farm from observing parents and grandparents (Darragh et al., 1998), we were surprised that there was less of an association between parent risk-taking and safety scores. We were less surprised at the weak association between perceived peer risk-taking tendencies and work

practices. Young adults in agriculture frequently work alone and interactions with coworkers and interactions with peers may be limited.

When considered in light of the results from Chapter 3, the influence of supervisors in the workplace becomes more pronounced. In Chapter 3 we examined the association between organizational work factors and workplace safety behaviors. We found an association between perceived workplace policies in effect and workplace behaviors—as the number of policies young adults reported to be in effect on their farm of employment increased so did the frequency of their safe working practices. This supports research which suggests safety and health policies are part of a larger safety culture and demonstrate management's broad commitment safety (Bartling & Hutchison, 2000). Furthermore, this supports the influence of supervisors on young adult agricultural workers' workplace practices initially identified in Chapter 2. We make the assumption supervisors are responsible for establishing and/or enforcing workplace safety and health policies. Chapter 3 also concluded that work hours and scheduling is associated with reported workplace safety behaviors and supervisors may be responsible for setting work schedules for young adult agricultural workers.

Considering the results from Chapter 2 and Chapter 3 collectively, the potential importance of supervisors to young adult agricultural workers' safety and health should be further researched. Findings from Chapter 4 offer some

guidance and recommendations for future interventions that may include supervisors.

While Chapter 4 deviated from tractor operating behaviors and focused on increasing hearing protection device (ear muffs and ear plugs) use among young adult swine facility workers, the results of the randomized controlled trial, when coupled with findings from Chapter 2 and Chapter 3, provide important information regarding the future direction of interventions for the population.

The randomized controlled trial was moderately successful at increasing the use of hearing protection among young adult swine facility workers, however, changes in hearing protection use were not maintained over time. While the intervention was designed using the Social Cognitive Theory, it was admittedly missing an important social component. The theory suggests behavior change can be influenced by observing others within the context of social interactions (Bandura, 1998). While we had previously suggested the intervention allow for peer-to-peer contact, and provide young adults the opportunity to connect with one another using the app and even compete to perform the safety behaviors (i.e. wear hearing protection) most often. However, results from Chapter 2 suggest peers are not as influential as supervisors on workplace behaviors. Therefore, connecting and competing with peers or coworkers may not be motivating for young adult workers.

This dissertation (Chapter 2, Chapter 3, and Chapter 4) highlights the need for additional research into young adult agricultural workers and

interventions that target the population specifically. All three studies characterize the current working practices of young adult agricultural workers and identified areas of intervention. Results from Chapter 2, Chapter 3, and Chapter 4 confirmed speculated characteristics of the population—low use of seatbelts on tractors with rollover protective structures, high prevalence of using tractors without cabs, and low use of hearing protection when exposed to noise.

Theoretical Contributions

A noted strength of this dissertation was the inclusion of behavioral theory in the intervention to increase the use of hearing protection among swine facility workers described in Chapter 4. The intervention was founded in the Social Cognitive Theory (Bandura, 1998). Agricultural safety and health is often criticized for the lack of behavioral theory implemented in interventions (Witte et al., 1992). The Social Cognitive Theory has been used as the foundation in many health-based interventions outside the agricultural industry and has been successful in modifying behaviors. This theory suggests that in order for behavioral change to occur, an individual must develop self-regulatory skills, which requires that one pay close attention to his or her behaviors and habits and behavioral change is often facilitated in a social environment that allows for group interaction and observation (Bandura, 1998).

We acknowledged a limitation to the randomized controlled trial was the lack of social interaction among participants and would recommend testing an intervention that includes a social component where participants either

motivate or compete against one another. However, as explained above, we are unsure a social component among coworkers or peers should be recommended given the lack of influence coworkers and peers have on workplace safety behaviors. The association between supervisory influence and workplace safety practices was much stronger.

Chapter 2 and Chapter 3 identified potential behavioral influencers of young adult agricultural workers. However, this is not a comprehensive list. Preliminary results suggest there are both social and organizational factors that are associated with young adult agricultural worker's workplace behaviors. We recommend a more formal evaluation of workplace behaviors influencers using the Social Ecological Model to identify all potential influencers and more clearly identify opportunities for interventions.

Main Findings & Conclusions

Results from our cross-sectional, online survey found that the majority of young adult agricultural workers are routinely operating tractors (80%). Tractors are among the most prevalent pieces of agricultural equipment on farms and also the leading cause of fatal and nonfatal injuries in agriculture. Wearing a seatbelt on a tractor with a rollover protective structure (ROPS) is effective at reducing the risk of injury or death in the event of a rollover. However, seventy-eight percent of respondents indicated they never or rarely wore a seatbelt when operating a tractor with a ROPS and 46% reported he/she never or rarely avoided using a tractor that did not have a ROPS. These reported behaviors of

young adult agricultural workers reinforce the need for interventions that improve workplace safety and health practices.

A tractor safety score was calculated for each participant, based on their reported frequency of tractor safety practices (Chapter 2, Chapter 3), and we examined the association between this score and perceived risk-taking of supervisors, peers, and supervisors as reported by participants. We found that tractor safety scores decreased (indicating more unsafe behaviors) as perceived risk-taking tendencies of supervisors, peers, and parents increased. Of the three social influences, supervisors, peers, and parents, the strongest association was observed between supervisors and the tractor safety scores, indicating that supervisors are more influential than parents or peers in the agricultural workplace. Because many young adults reported having learned to perform tasks on the farm from observing parents and grandparents (Darragh et al., 1998), we were surprised that there was less of an association between parent risk-taking and safety scores. We were less surprised at the weak association between perceived peer risk-taking tendencies and work practices. Young adults in agriculture frequently work alone and interactions with coworkers and interactions with peers may be limited. These findings indicate a need to test interventions directed towards supervisors on young agricultural workers.

In addition, we examined the association between various workplace organizational factors and tractor safety scores to determine if workplace safety and health policies, scheduling, or place of employment (family farm or non-

family farm) is associated with reported practices among young adults. Importantly, we found that tractor safety scores did not vary based on place of employment (family farm or non-family farm). This finding may suggest risk of injury to young adult agricultural workers does not differ based on type of farm and interventions should target both places of employment.

Furthermore, we found an association between the number of policies young adults reported in effect at the farm they are employed and reported tractor safety behaviors. As the number of policies in effect increased so did tractor safety scores, regardless of whether the policies were specific to tractor operation. In addition, there was an association between each of the individual workplace safety and health policies and tractor safety score. Participants who reported the policy was in effect reported a higher tractor safety score. This supports research which suggests safety and health policies are part of a larger safety culture and demonstrate management's broad commitment safety (Bartling & Hutchison, 2000). Associations between workplace organizational factors and reported safety practices indicate there is an opportunity for interventions. Additional research to further test the relationship between organizational factors and worker behaviors is necessary.

The final chapter focused on preventing occupational illness among young adult agricultural workers, specifically noise-induced hearing loss (NIHL) by increasing the use of personal protective equipment (PPE). Although focused on hearing loss, one of agriculture's most ubiquitous hazards, the intervention

method could be implemented in a variety of agricultural settings to reduce injuries. We incorporated constructs from the Social Cognitive Theory, which has demonstrated effectiveness in modifying health behaviors among young adults, although not safety behaviors in occupational setting. Two intervention groups were instructed to track their daily use of hearing protection using a smartphone app. One of the intervention groups set a daily goal for hearing protection use and one did not. The control group did not use the smartphone app to track behaviors or set a goal.

We observed an increase in reported hearing protection use among all three study groups (intervention with goal setting, intervention without goal setting, and control) at immediate post-intervention. The greatest increase in hearing protection use was from participants in the intervention *with* goal group, who reported a mean increase of 47.1%. The intervention *without* goal group reported a mean increase of 42.3% and the control group reported a mean increase of 32.0%.

Although all groups reported an increase immediately following the intervention, there was a decrease in self-reported hearing protection use among both intervention groups at delayed follow-up (three months after the behavioral tracking period). However, the intervention *with* goal group showed less of a decrease than the intervention *without* goal group. The control group reported a slight increase (4.0%) in reported hearing protection use from immediate post-intervention to delayed follow-up. The intervention groups were

not instructed to track their daily use of hearing protection using *Habitbull* after the immediate post-intervention survey, and the absence of the app and logging daily activities may have resulted in a decrease in hearing protection use. The control group, however, was never instructed to use the *Habitbull* app, therefore, the absence of the smartphone app had no effect on their use.

Results from our theory-based intervention to increase the use of hearing protection among young adults working in swine facilities suggested that incorporating constructs of the Social Cognitive Theory and integrating technology are effective in changing safety behaviors.

Strengths

Strengths of the cross-sectional study among young adult agricultural workers included the large study sample. The survey was developed to identify the frequency of specific safety practices within six agricultural work areas (tractors, ATVs/UTVs, pesticides, livestock handing, grain handling, and livestock confinement work). We used recommended safety practices from manufactures, prevention materials, and operation guidelines to develop comprehensive lists of safety practices within each agricultural work area. This allowed us to identify the agricultural areas young adults are working in, as well as identify specific practices within each area that workers were or were not engaging in, allowing us to target interventions towards these practices. For example, the majority of participants, almost 70%, were engaging in safe practice by *usually* or *always* avoiding slopes too steep for operation when driving a tractor. However, 78%

were *never* or *rarely* wearing the seatbelt when operating a tractor with a ROPS. The use of safety scores will allow us to examine the behaviors across work areas (i.e. tractors vs. pesticides) and to examine the impact of social influence and organizational factors on these different work tasks.

A randomized controlled trial was used to evaluate the effectiveness of an intervention to increase the use of hearing protection among swine facility workers included the study design. Randomized controlled trails are among the most rigorous study designs and allow for researchers to observe the effect of an intervention. Random allocation of participants into study groups eliminated selection bias and collecting baseline information allowed us to control for confounders and hearing protection use prior to the intervention.

An additional strength of this study was the incorporation of the Social Cognitive Theory in the development of the intervention. Interventions based in social and behavioral science theories are often more effective than those without a theoretical base (K. Glanz & Bishop, 2010). The Social Cognitive Theory has been used as the foundation in many health-based interventions outside the agricultural industry and effective in facilitating behavior change across a variety of *health* behaviors (*e.g.,* weight management and smoking cessation) (Kirwan et al., 2012), however, it has not been widely incorporated in occupational safety interventions.

Finally, we incorporated smartphone technology into our intervention to appeal to the population. Young adults (ages 18-24) are technologically savvy

and “digital natives” (McCurry & Martins, 2010) and 84% of young adults between 18 and 29 report owning a smartphone (A. Smith, 2017). The app we selected sent prompts to participants to encourage participation and remind participants to log their behaviors. These features are low cost, automated and require less resources than other methods of used to send prompts or reminders such as postcards or other materials.

Potential Limitations

The cross-sectional study of young adult agricultural workers may be limited in its generalizability. Our sample was limited to young adult agricultural workers who were enrolled in agricultural science courses in four colleges/universities in Iowa. The experiences of these individuals may be different than the experiences of agricultural workers not enrolled in post-secondary education or hired farmworkers. Additionally, selection into the study was not random which may further limit the generalizability of the study results. The study relied on self-report of work practices, workplace policies, and organizational factors, all of which may be subject to error in recall or reporting. This error would be non-differential and attenuate the resulting associations. Finally, this was a cross-sectional study. This design did not allow us to make causal inferences between workplace characteristics and workplace practices of young adult agricultural workers.

The randomized controlled trial to increase the use of hearing protection among swine facility workers may also be limited in its generalizability. A non-

random, snowball recruitment method was used to identify swine facility workers to participate. Swine facility workers who volunteered into the study may be systematically different than swine facility workers who did not volunteer to participate. Hearing protection use at baseline, immediate follow-up, and delayed follow-up was self-reported by participants and maybe subject to misclassification. We asked participants to report hearing protection use in the past three working days, providing a short reference period, to improve reporting accuracy. However, participants in the two intervention groups were instructed to log their daily use of hearing protection using a smartphone app and the control group was not. At immediate post-intervention and delayed follow-up the intervention groups may more accurately have reported hearing protection use than the control group, resulting in differential misclassification of the outcome variable.

Public Health Implications

Agriculture is the most hazardous occupational industry. Occupational hazards include large equipment, unpredictable livestock and physical hazards such as heat, cold, and noise. Preventing injuries and illnesses in agriculture should be a public health priority. Our research provides preliminary data describing the association between various workplace factors (social influence, organizational characteristics) and reported workplace safety behaviors of young adult agricultural workers and supports the need for more rigorously designed, intervention studies. Intervention studies targeting young adults working outside

of agriculture could provide evidence of effective methods to prevent occupational injuries and illness among the estimated 20.5 million young adults (18-25) employed in the United States.

However, the contributions of this research to public health extend beyond agriculture and even occupational safety and health. The preliminary results of our randomized controlled trial to increase the use of hearing protection among swine facility workers may have applications to many sectors of public health. The application of behavioral theory and technology are suitable for a range of safety and health topics within public health.

Direction for Future Research

As reported, we observed an association between social influences, specifically supervisors, and reported safety practices of young adult agricultural workers. Results from this pilot study suggest interventions that include supervisors may be effective in improving safety practices of young adults. Given these were the result of our cross-sectional study, we recommend the development of rigorously designed, intervention studies to test the effect of supervisors on young adult agricultural workers' safety practices.

We also recommend additional epidemiological studies examining this association among hired farmworkers and young adult workers in occupational settings other than agriculture.

Results from our randomized controlled trial to test the effectiveness of an intervention to increase the use of hearing protection among young adult swine facility workers suggest the behavioral theory coupled with smartphone technology has potential to improve safety behaviors. We recommend additional tests of this intervention with some modifications including a larger sample size, longer time to follow-up, and an app that allows participants to connect with one another. Finally, we recommend applying this type of intervention to additional safety and health practices within agriculture.

Conclusion

The goals of this research were to identify work practices of young adult agricultural workers (age 18-24), workplace factors that may be associated with their occupational practices and to test an intervention to improve workplace practices.

Results from our research confirm young adults are exposed to hazards while working in agriculture, and identified the specific safety practices the population is engaging in. These findings strengthen the need for additional interventions to improve workplace practices of young adult agricultural workers. Furthermore, the association between social and organizational workplace factors highlight the opportunity for innovative safety and health interventions beyond the traditional methods of control. Finally, interventions that couple behavioral theory with technology are promising methods for improving safety practices of young adult agricultural workers. Importantly,

these methods are easily transferable to a variety of agricultural work areas and hazardous exposures.

Young adult agricultural workers are an important subgroup of the agricultural workforce. As future principal operators, hired workers, and supervisors, protecting the safety and health of young adult agricultural workers is vital to ensuring a productive and sustainable agricultural workforce.

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APPENDIX C

Data Collection Instruments

Young Farmer Pilot Survey

Q3 What is your current age (in years?)

- 18 (1)
- 19 (2)
- 20 (3)
- 21 (4)
- 22 (5)
- 23 (6)
- 24 (7)
- 25 (8)
- 26 (9)
- 27 (10)
- 28 (11)
- 29 (12)
- 30 (13)
- 31 (14)
- 32 (15)
- 33 (16)
- 34 (17)
- None of these options (18)

Q5 What is your gender?

- Male (1)
- Female (2)

Q7 Are you Hispanic or Latino?

- Yes (1)
- No (2)
- I don't know (3)

Q6 What is your race?

- White (1)
- Black or African American (2)
- American Indian or Alaskan Native (3)
- Asian (4)
- Hawaiian or Pacific Islander (5)
- More than one race (6)
- Other (please specify) (7) _____

Q109 Which of the following describes the academic institution you are currently enrolled in?

- 2-year degree program (community college) (1)

- 4-year degree program (university) (2)

Q9 What is your current education level?

- First year undergraduate (1)
- Second year undergraduate (2)
- Third year undergraduate (3)
- Fourth year undergraduate (4)
- Fifth year undergraduate (5)
- Not seeking a degree (7)
- Other (please specify) (8) _____

Q10 What is your enrollment status?

- Full time student (1)
- Part time student (2)
- Other (please specify) (3) _____

Q12 Where do you currently live?

- On campus (1)
- Off campus with parents/family (2)
- Off campus without parents/family (3)

Q102 Up to the age of 18, did you routinely engage in farm work of any kind, paid or unpaid?

 Yes, I worked and lived on a farm owned by my parents. (1)

 Yes, I worked on a farm owned by an extended family member (e.g. grandparents, uncles, aunts). (2)

 Yes, I worked on a farm owned by a non-relative (e.g. neighbor, community person). (3)

 No, I did not engage in agricultural work before the age of 18. (4)

 Other (please specify): (5) _____

If No, I did not engage in agr... Is Selected, Then Skip To End of Block

Q29 At what age did you begin working on this farm? (enter age)

Q27 How many immediate family members (mother/father, siblings) worked on the farm? (full or part-time)

Q30 How many hired, NON-family members worked on the farm? (full or part-time)

Q23 Do you currently work on a farm as part of an academic course at your institution? (e.g. school farm, the 450 farm, etc)

 Yes (1)

 No (2)

Display This Question:

If Do you currently work on a farm as part of an academic course at your institution? (e.g. school f... Yes Is Selected

Q20 How many hours PER WEEK do you spend per season performing agricultural-related tasks on the academic farm, on average? (Estimate for each season. Reminder: a standard work week is 40 hours (5, 8-hour days))

_____ Fall (1)

_____ Winter (2)

_____ Spring (3)

_____ Summer (4)

Q24 Do you currently work on a farm other than an academic course farm? (e.g. a family farm, your own farm, work as a hired worker or farm hand)

- Yes (1)
- No (2)

Display This Question:

If Do you currently work on a farm other than an academic course farm? (e.g. family farm, own farm,... Yes Is Selected

Q25 What type of farm do you work on outside of school?

- Work on a family farm (1)
- Work as a hired worker on a non-family farm (2)
- Work as the principal operator or owner (3)
- Other (please specify) (4) _____

Display This Question:

If Do you currently work on a farm other than an academic course farm? (e.g. family farm, own farm,... Yes Is Selected

Q21 How many hours PER WEEK do you spend per season performing agricultural-related tasks on this farm, on average? (Estimate for each season. Reminder: a standard work week is 40 hours (5, 8-hour days))

_____ Fall (1)

_____ Winter (2)

_____ Spring (3)

_____ Summer (4)

Display This Question:

If Do you currently work on a farm other than an academic course farm? (e.g. family farm, own farm,... Yes Is Selected

Q100 For the farm you spend the MOST TIME (not including an academic farm) please enter the number of acres the farm typically raises of each crop annually.

_____ Cash crops (corn, soybeans, wheat) (1)

_____ Field Crops (hay, straw) (2)

_____ Horticultural Crops (fruits, vegetables, flowers) (3)

_____ Other (please specify): (4)

Display This Question:

If Do you currently work on a farm other than an academic course farm? (e.g. family farm, own farm,... Yes Is Selected

Q101 For the farm you spend the MOST TIME (not including an academic farm) please enter the number of head the farm typically raises of each animal annually.

_____ Beef cattle (1)

_____ Dairy cattle (2)

_____ Hogs (3)

_____ Poultry (chicken, turkeys) (4)

_____ Eggs (layer chickens) (8)

_____ Other livestock (goats, sheep) (5)

_____ Other (6)Display This Question:

If Do you currently work on a farm as part of an academic course at your institution? (e.g. school f... Yes Is Selected

And Do you currently work on a farm other than an academic course farm? (e.g. family farm, own farm,... Yes Is Selected

Q94 Which of the following agricultural activities have you participated in in the past year either in your academic setting or non-academic setting? Check all that apply.

- Cleaning grain bins (1)
- Unloading grain (2)
- Mixing and grinding feed (3)
- Unloading and feeding hay (4)
- Cleaning animal pens in a barn (5)
- Feeding confinement animals (6)
- Cleaning confinement buildings (7)
- Working with poultry (8)

- Working with large animals (9)
- Hand harvesting fruits and vegetables (10)
- Using an ATV for farm work (11)
- Applying, mixing, or handling pesticides (12)
- Planting field crops with tractor (13)
- Harvesting field crops with combine (14)
- Other (please specify): (15) _____

Q44 The following sections of questions inquire about your agricultural work practices.Q83 Do you work with grain handling equipment, bins, and/or augers?

Yes (1)

- No (2)

Display This Question:

If Do you work with grain handling equipment, bins, and/or augers? Yes Is Selected

Q38 How often do you perform the following safety checks or practices when working with and handling GRAIN?

	Never (1)	Rarely (2)	Sometimes (3)	Often (4)	Always (5)
Enter a grain bin or grain transport vehicle only if it is absolutely necessary (1)					
Use a body harness secured to the outside of the bin or vehicle when entering a grain bin or vehicle (7)					

Use inspection holes or grain bin level markers instead of entering a grain bin (2)

Use a pole to break up possible grain bridges from outside the bin (3)

Establish nonverbal communication with observers (hand signals) (4)

Work from the top to bottom when cleaning grain bin walls (5)

Lock-out/tag-out all auger controls before entering a bin (6)

Wear hearing protection when working around an auger, with a vacuum, etc. (13)

Always work with a partner when entering a grain bin (14)

Wear two strap dust mask or organic dust filter equipped respirator when working in dusty or moldy environments (15)

Q84 Do you operator or drive a tractor?

Yes (1)

No (2)

Display This Question:

If Do you operator or drive a tractor? Yes Is Selected

Q42 How often do you perform the following practices or safety checks when operating a TRACTOR?

	Never (1)	Rarely (3)	Sometimes (4)	Often (5)	Always (6)
Wear seat belt if the tractor has a rollover protective structure (ROPS) (1)					

Avoid operating or driving a tractor that does not have a rollover protective structure (ROPS) (12) □ □ □ □ □

Avoid operating the tractor near ditches, embankments, and holes (2) □ □ □ □ □

Reduce speed when turning, crossing slopes, and on rough, slick, or muddy surfaces (3) □ □ □ □ □

Stay off slopes too steep for safe operation (4) □ □ □ □ □

When tractor is stopped, set brakes securely and use park lock if available (5) □ □ □ □ □

Prohibit extra riders unless there is a designated passenger (buddy) seat (6) □ □ □ □ □

Avoid talking on a cell phone when driving or operating a tractor (7) □ □ □ □ □

Avoid texting, emailing, using the web or social media when operating a tractor (8) □ □ □ □ □

Avoid operating a tractor when under the influence of drugs or alcohol. (9) □ □ □ □ □

Avoid operating a tractor when excessively tired (10) □ □ □ □ □

Wear hearing protection when driving or operating a cableless tractor. (11) □ □ □ □ □

Q85 Do you operate or drive an ATV (4-wheeler) or UTV (Gator, Kabota)?

□ Yes (1)

□ No (2)

Display This Question:

If Do you operate or drive an ATV (4-wheeler) or UTV (Gator, Kabota)? Yes Is Selected

Q44 How often do you perform the following practices or safety checks when operating or riding an ATV or UTV?

	Never (1)	Rarely (3)	Sometimes (5)	Often (6)	Always (7)
Carry more passengers than the vehicle is designed to carry. (ATVs are designed for one rider, most UTVs are designed for two) (1)	□	□	□	□	□
Avoid driving an ATV/UTV on public roads (2)	□	□	□	□	□
Wear a helmet when operating an ATV (4)	□	□	□	□	□
Wear the seatbelt when operating a UTV (8)	□	□	□	□	□
Avoid talking on a cell phone when operating an ATV or UTV (5)	□	□	□	□	□
Avoid texting, surfing the web or using email or social media on a cell phone while operating an ATV or UTV (6)	□	□	□	□	□
Avoid operating an ATV or UTV while under the influence of alcohol or drugs (7)	□	□	□	□	□
Avoid operating an ATV or UTV when excessively tired (12)	□	□	□	□	□
Wear hearing protection when operating an ATV or UTV. (13)	□	□	□	□	□

Q86 Do you handle or apply chemicals or pesticides?

□ Yes (1)

□ No (2)

Display This Question:

If Do you handle or apply chemicals or pesticides? Yes Is Selected

Q46 How often do you perform the following practices or safety checks when working with and handling CHEMICALS and PESTICIDES?

	Never (1)	Rarely (3)	Sometimes (5)	Often (6)	Always (7)
Wear long pants and long sleeves, shoes or boots, and socks (1)	□	□	□	□	□
Wash hands after working with pesticides (2)	□	□	□	□	□
Wash work clothes before wearing them again (3)	□	□	□	□	□
Take a bath or shower as soon as you get home after working with pesticides or chemicals (4)	□	□	□	□	□
Lock up chemicals or pesticides after use (5)	□	□	□	□	□
Store chemicals in their original package or container (7)	□	□	□	□	□
Wear appropriate personal protective equipment such as gloves, apron, and goggles (8)	□	□	□	□	□
Undergo training on pesticides or chemicals before handling or applying them (9)	□	□	□	□	□

Display This Question:

If Do you handle or apply chemicals or pesticides? Yes Is Selected

Q102 Have you every participated in a private pesticide licensure class or taken an exam?

□ Yes (1)

□ No (2)

Q87 Do you work with livestock?

□ Yes (1)

□ No (2)

Display This Question:

If Do you work with livestock? Yes Is Selected

Q48 How often do you perform the following practices or safety checks when working with LIVESTOCK?

	Never (1)	Rarely (3)	Sometimes (5)	Often (6)	Always (7)
Avoid sudden movements (1)	□	□	□	□	□
Avoid animal blind spots and approach them from the front or side. (2)	□	□	□	□	□
Avoid using loud noises/machinery or yelling. (3)	□	□	□	□	□
Use proper restraining equipment when working with and moving livestock. (4)	□	□	□	□	□

Use caution when working with male farm animals (5) □ □ □ □ □

Use caution when working with livestock offspring in the presence of their mother. (6) □ □ □ □ □

Use proper personal protective equipment when working with livestock (steel toe shoes, gloves) (7) □ □ □ □ □

Q100 Do you work with livestock in a confinement (e.g. hogs or poultry)?

□ Yes (1)

□ No (2)

Display This Question:

If Do you work with livestock in a confinement (e.g. hogs or poultry)? Yes Is Selected

Q101 How often do you perform the following practices or safety checks when working with LIVESTOCK in CONFINEMENTS?

	Never (1)	Rarely (2)	Sometimes (3)	Often (4)	Always (5)
Wear hearing protection when working in a confinement (1)	□	□	□	□	□
Wear a two strap dust mask or organic dust filter equipped respirator when working in confinement (2)	□	□	□	□	□

Avoid entering confinement when manure pit is being agitated or emptied (3)
□ □ □ □ □

Wear hearing protection when operating a power washer/ pressure washer to clean confinement (4)□ □ □ □
□

Q105 Answer the following questions regarding workplace policies and procedures in reference to the non-academic farm you spend the most time on (family farm, farm you work as a hired worker) UNLESS you do not work on a farm besides a school farm, in which case answer in reference to the academic farm. Please indicate which type of farm you responding in reference to.

□ Non-academic farm I work on (e.g. family farm, my own farm) (1)

□ School farm (e.g. AgEds 450 farm, farm owned by Kirkwood or Hawkeye) (2)

Q51 Does the farm you work on have workplace policies regarding the following activities?

No (1) Yes (2) NA (4)

Entrance into a grain transport vehicle or bin is prohibited unless absolutely necessary (1) □ □ □

Lock-out tag-out of all controls is required before entering a bin (2) □
□ □

The use of ATVs or UTVs on public roads is prohibited (3) □ □
□

Helmet must be worn when using an ATV (4) □ □
□

Seatbelt must be worn when operating or driving a UTV (13) □
□ □

Seat belt be worn when operating a tractor (5) □ □ □

Passengers or extra riders on tractors are prohibited when there is not a designated passenger seat (buddy seat) (6) □ □ □

Pesticides must be kept in locked storage facility (7) □ □ □

Appropriate personal protective equipment (PPE) is required when handling pesticides or chemicals (8) □ □ □

Appropriate restraining equipment must be used when working with large livestock (9) □ □ □

Appropriate personal protective equipment (PPE) must be worn when working with livestock (hearing protection, steel toed shoes, etc) (10) □ □ □

A double strap dust mask or organic dust filter equipped respirator must be worn when working in dusty environments (11) □ □ □

All tractors are equipped with a cab or a rollover protective structure (ROPS) (12) □ □ □

Personal protective equipment is provided if required by employer (22) □ □ □

Q90 Please indicate which of the following agricultural safety and health activities you have participated in and the number of times (e.g. 0, 1, 2, etc.) you recall participating in each.

_____ Farm safety day camp (1)

_____ Farm safety presentation in elementary, middle, or high school (2)

_____ Safe tractor driving course (3)

_____ Farm safety presentation in 4-H or FFA (4)

_____ Helped host a farm safety day camp (5)

_____ Other (please specify): (6)

Q53 Have you ever received organized farm safety activity from any of the following? Select all that apply.

- Extension services (1)
- Farm commodity organization (e.g. Iowa Pork Producers) (2)
- 4-H program (3)
- FFA program (13)
- Farm safety organization (e.g. Farm Safety for Just Kids) (4)
- Insurance company (e.g. Farm Bureau) (6)
- Other farmers (10)
- Family members (11)
- Other (please specify) (12) _____

Q54 Were/are you a member of the National FFA Organization?

- Yes (1)
- No (2)

Q55 Were/are you a member of 4-H?

- Yes (1)

□ No (2)

Q104 Please indicate your level of agreement with the following statements.

	Strongly disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)
My boss does not allow me to take risks. (1)	□	□	□	□	□
I would be negatively evaluated if I took risks at work. (2)	□	□	□	□	□
Other people take risks at work. (3)	□	□	□	□	□
My coworkers take risks. (4)	□	□	□	□	□
My parents take risks. (5)	□	□	□	□	□
My parents could be considered risk takers. (6)	□	□	□	□	□
I would rather take risks than be overly cautious. (7)	□	□	□	□	□
In the past month, I've done some exciting things that other people think are dangerous. (8)	□	□	□	□	□
I love to take risks even when there is a small chance I could get hurt. (9)	□	□	□	□	□
I value having fun more than being safe. (10)	□	□	□	□	□

Sometimes people get on my nerves when they tell me how to act more safely. (11) □ □ □ □ □

Dangerous tasks have to get done at work. (12) □ □ □ □ □

There is a chance I will do something at work that could get me hurt. (13) □ □ □ □ □

I like taking risks at work. (14) □ □ □ □ □

I sometimes do things at work that may get me injured. (15) □ □ □ □ □

I get my job done faster by taking risks. (16) □ □ □ □ □

Q46 Did you DRIVE a motor vehicle (car, van, or truck) on a public road in the last 30 DAYS?

□ Yes (1)

□ No (2)

Display This Question:

If Did you DRIVE a motor vehicle (car, van, or truck) on a public road in the last 30 DAYS? Yes Is Selected

Q47 During the times that you DROVE in the last 30 days, how often did you....

	Never (1)	Less than half of the time (2)	Half of the time (3)	More than half of the time (4)	Always (5)
Wear a seatbelt (1)	□	□	□	□	□

Talk on a cell phone (2) □ □ □ □ □

Text, email, surf the web or social media on a cell phone (6) □ □ □ □ □

Operate a motor vehicle when excessively tired (7) □ □ □ □ □

Display This Question:

If During the last 30 days, did you DRIVE a car, van, or truck? Yes Is Selected

Q51 How many times did you DRIVE a motor vehicle (car, van, or truck) while under the influence of drugs or alcohol in the last 30 DAYS?

□ Zero/ none (2)

□ 1 (1) _____

□ 2 (3)

□ 3 (4)

□ 4 (5)

□ 5 (6)

□ 6 (7)

□ 7 (8)

□ 8 (9)

□ 9 (10)

□ 10 (11)

□ 11 (12)

□ 12 (13)

□ 13 (14)

- 14 (15)
- 15 (16)
- 16 (17)
- 17 (18)
- 18 (19)
- 19 (20)
- 20 (21)
- 21 (22)
- 22 (23)
- 23 (24)
- 24 (25)
- 25 (26)
- 26 (27)
- 27 (28)
- 28 (29)
- 29 (30)
- 30 (31)
- More than 30 (32)

Q52 Have you DRIVEN or RIDDEN a motorcycle, moped, or scooter in the past YEAR?

- Yes (1)

□ No (2)

Display This Question:

If Have you DRIVEN or RIDDEN a motorcycle, moped, or scooter in the past YEAR? Yes Is Selected

Q53 When RIDING or DRIVING a motorcycle, moped, or scooter, how often do you....

	Never (1)	Less than half of the time (2)	Half of the time (3)	More than half of the time (4)	Always (5)
Wear a helmet (1)	□	□	□	□	□
Talk on a cell phone (2)	□	□	□	□	□
Text, email, surf the web, or use social media on a cell phone (3)	□	□	□	□	□
Operate a motorcycle, moped, or scooter when excessively tired (4)	□	□	□	□	□

Q59 Have you smoked at least 100 cigarettes in your entire life? (100 cigarettes=5 packs)

□ Yes (1)

□ No (2)

Q61 In the past 30 DAYS, how many cigarettes have you smoked per day, on average?

- 0 (1)
- 1-10 (6)
- 11-19 (2)
- 20 (3)
- 21-39 (4)
- 40+ (5)

Q62 Why do you smoke cigarettes?

Q97 Have you used chewing tobacco and/or snuff at least 20 times in your life?

- Yes (1)
- No (2)
- I don't know (3)

Q98 In the past 30 DAYS, how many times per day do you use chewing tobacco and/or snuff, on average?

- 0 (1)
- 1-5 (2)
- 6-10 (3)
- 11-15 (4)
- 16-20 (5)
- 20+ (6)

Display This Question:

If What is your gender? Female Is Selected

Q105 During the last TWO WEEKS, how many times have you had 4 or more drinks on an occasion?

- More than once (enter number) (1) _____
- None (2)
- I don't know (3)

Display This Question:

If What is your gender? Male Is Selected

Q106 During the last TWO WEEKS, how many times have you had 5 or more drinks on an occasion?

- More than once (enter number) (1) _____
- None (2)
- I don't know (3)

Q67 In the past 30 days, on the occasions when you drank alcohol, how many drinks did you usually have?

- 0, did not drink in the past 30 days (1)
- 1 drink (2)
- 2 drinks (3)
- 3 drinks (4)

 4 drinks (5)

 5 drinks (6)

 6 drinks (7)

 7 drinks (8)

 8 drinks (9)

 9 or more drinks (10)Q69 Please rate your general health on the scale below.

 Excellent (1)

 Very good (2)

 Good (3)

 Fair (4)

 Poor (5)

Q70 Please rate your emotional health on the scale below.

 Excellent (1)

 Very good (2)

 Good (3)

 Fair (4)

 Poor (5)

Q95 What is your height

Feet (e.g. 5) (1)

Inches (e.g. 10) (2)

Q72 What is your weight in pounds?

Q76 Within the last 12 months, how would you rate the overall level of stress you have experienced?

- No Stress (1)
- Less than average stress (2)
- Average stress (3)
- More than average stress (4)
- Tremendous stress (5)

Q106 How many hours of sleep do you get EACH NIGHT during the week (Monday-Thursday), on average? (enter number of hours)

Q108 How many hours of sleep do you get EACH NIGHT during the weekend (Friday-Sunday), on average? (enter number of hours)

Q110 Do the number of hours of sleep you get each night vary depending on the agricultural season? (e.g. planting, harvesting, calving)

- Yes (1)
- No (2)

Q109 In the past 12 months, have you had any agricultural related injury or accident that made you....

No (1) Yes (2)

Use any type of first aid, such as a bandage to stop bleeding or antiseptic to clean an wound (or ice packs for a bruise, etc.) or seek medical attention at a clinic from a nurse or doctor? (1)

Unable to work as hard as you normally do for at least 4 hours? [or were assigned a different job (or different task) that was easier because the injury prevented you from doing the job (or task)] (2)

Unable to work for at least 4 hours? (3)

Take strong medicine, except asprin (or Tylenol or Ibuprofen), to allow you to keep working? (4)

Q77 In your lifetime, have you had an injury as a result performing agricultural work? (see definition for injury) Injury is defined as a wound or damage to the body resulting from an event or exposure in the agricultural work environment and required medical treatment beyond first aid, restricted work activity, resulted in days away from work, or resulted in loss of consciousness or awareness.

Yes (1)

No (2)

I don't know (3)

Display This Question:

If In your lifetime, have you had an injury as a result performing agricultural work? (see definition for injury) Injury is defined as an incident requiring basic first administered by self or someone... Yes Is Selected

Q78 In the last 12 months, have you an injury as a result of performing agricultural work? (see definition for injury)Injury is defined as a wound or damage to the body resulting from an event or exposure in the agricultural work environment and required medical treatment beyond first aid, restricted work activity, resulted in days away from work, or resulted in loss of consciousness or awareness.

- Yes (1)
- No (2)
- I don't know (3)

Display This Question:

If In the last 12 months, have you an injury as a result of performing agricultural work? (see definition for injury)Injury is defined as an incident requiring basic first administered by self or som... Yes Is Selected

Q79 How many times have you been injured in the last 12 months while performing agricultural tasks? (enter number of injuries)

Display This Question:

If In your lifetime, have you had an injury as a result performing agricultural work? (see definition for injury) Injury is defined as an incident requiring basic first administered by self or someone... Yes Is Selected

Q81 The following questions are in reference to the MOST SEVERE injury you have had in your lifetime as a result of agricultural work.

Display This Question:

If In your lifetime, have you had an injury as a result performing agricultural work? (see definition for injury) Injury is defined as an incident requiring basic first administered by self or someone... Yes Is Selected

Q82 What month did the MOST SEVERE injury occur?

Display This Question:

If In your lifetime, have you had an injury as a result performing agricultural work? (see definition for injury) Injury is defined as an incident requiring basic first administered by self or someone... Yes Is Selected

Q83 Describe your MOST SEVERE injury:

Display This Question:

If In your lifetime, have you had an injury as a result performing agricultural work? (see definition for injury) Injury is defined as an incident requiring basic first administered by self or someone... Yes Is Selected

Q84 What part of your body was injured?

- Skull (1)
- Face (including eyes) (2)
- Neck (3)
- Chest (including ribs and internal organs) (4)
- Back (including spine, spinal cord) (5)
- Abdomen (6)
- Pelvic region (7)
- Shoulder(s) (8)
- Arm(s) (9)
- Wrist(s) (10)
- Hand(s) (11)

- Leg(s) (12)
- Ankle(s) (13)
- Foot/feet (14)

Display This Question:

If In your lifetime, have you had an injury as a result performing agricultural work? (see definitio... Yes Is Selected

Q107 What type of injury was your MOST SEVERE? (You may select more than one)

- Traumatic injury to spinal cord (1)
- Injury to nerve (pinched nerve) (2)
- Dislocation (3)
- Cartilage fracture or tear (4)
- Sprain, torn ligament (5)
- Amputation (6)
- Cut, laceration (7)
- Puncture wound (8)
- Abrasion, scratch (9)
- Bruise, contusion (10)
- Chemical burn (11)
- Burn, blister (12)
- Head injury, TBI (13)
- Fracture (14)

 Concussion, loss of consciousness (15)

Display This Question:

If In your lifetime, have you had an injury as a result performing agricultural work? (see definition for injury) Injury is defined as an incident requiring basic first administered by self or someone... Yes Is Selected

Q86 What type of activity were you doing at the time your MOST SEVERE injury? (e.g. loading hay, driving a tractor)

Display This Question:

If In your lifetime, have you had an injury as a result performing agricultural work? (see definitio... Yes Is Selected

Q108 What was the source of the injury? (e.g. tractor, chainsaw, animal)

Display This Question:

If In your lifetime, have you had an injury as a result performing agricultural work? (see definition for injury) Injury is defined as an incident requiring basic first administered by self or someone... Yes Is Selected

Q87 Did you miss more than half of the day of work/school on the day your MOST SEVERE injury occurred?

 Yes (1)

 NO (2)

Display This Question:

If In your lifetime, have you had an injury as a result performing agricultural work? (see definition for injury) Injury is defined as an incident requiring basic first administered by self or someone... Yes Is Selected

Q88 How long were normal activities, the things you usually do, restricted after your MOST SEVERE injury? Normal activities are the things you would ordinarily do on that day.

- No restrictions of normal activity (1)
- Less than 4 hours (2)
- At least 4 hour but less than 1 day (3)
- 1 day (4)
- More than 1 day (enter number of days) (5) _____

Display This Question:

If In your lifetime, have you had an injury as a result performing agricultural work? (see definition for injury) Injury is defined as an incident requiring basic first administered by self or someone... Yes Is Selected

Q89 Did your most SEVERE INJURY result in any permanent disability?

- Yes, severe disability (require assistance with most daily activities) (1)
- Yes, moderate disability (capable of most activities, require assistance for those most demanding) (2)
- Yes, mild disability (fully independent but perform activities slower than others) (3)
- No permanent disability (fully recovered) (4)

Display This Question:

If In your lifetime, have you had an injury as a result performing agricultural work? (see definition for injury) Injury is defined as an incident requiring basic first administered by self or someone... Yes Is Selected

Q90 Were you seen by a health care professional for your MOST SEVERE injury?

- Yes (1)
- No (2)

Display This Question:

If In your lifetime, have you had an injury as a result performing agricultural work? (see definition for injury) Injury is defined as an incident requiring basic first administered by self or someone... Yes Is Selected

Q91 What treatment was administered for the MOST SEVERE injury? (select all that apply)

- Prescription medication (1)
- Surgery or an operation (2)
- Physical therapy (3)
- Stitches (4)
- Ice (5)
- Chiropractic treatment (6)
- First aid (7)
- Other (please specify) (8) _____

Q93 Has anyone in your immediate family (parents, siblings, children) died in an agricultural related incident?

- Yes (1)

□ No (2)

Display This Question:

If Has anyone in your immediate family been killed in an agricultural related incident? Yes Is Selected

Q94 How was this person related to you?

□ This was my mother (1)

□ This was my father (2)

□ This was my sister (3)

□ This was my brother (4)

□ This was my son (5)

□ This was my daugher (6)

□ Other (please specify) (7) _____

Display This Question:

If Has anyone in your immediate family been killed in an agricultural related incident? Yes Is Selected

Q95 What type of incident resulted in the fatality? (e.g. tractor overturn)

Q96 Have you ever had an immediate family member seriously injured (see definition for injury) in an agricultural related incident?Injury is defined as a wound or damage to the body resulting from an event or exposure in the agricultural work environment and required medical treatment beyond first aid, restricted work activity, resulted in days away from work, or resulted in loss of consciousness or awareness.

- Yes (1)
- No (2)

Display This Question:

If Have you ever had an immediate family member seriously injured (required medical attention beyond first aid) in an agricultural related incident? Yes Is Selected

Q96 How was this person related to you?

- This was my mother (1)
- This was my father (2)
- This was my sister (3)
- This was my brother (4)
- This was my son (5)
- This was my daugher (6)
- Other (please specify) (7) _____

Display This Question:

If Have you ever had an immediate family member injured (required medical attention beyond first aid) in an agricultural related incident? Yes Is Selected

Q99 What type of incident resulted in the injury? (e.g. tractor overturn)

Q104 Do you plan to be farming within the next 5 years? If so, which of the following best describes your career goals?

 I plan to be farming as a principal operator/owner FULL-TIME within the next 5 years. (1)

 I plan to be farming as the principal operator/owner PART-TIME within the next 5 years. (2)

 I plan to be working as a hired farm worker FULL-TIME within the next 5 years. (3)

 I plan to working as a hired farm worker PART-TIME within the next 5 years. (4)

 I do not plan to be farming in any capacity in the next 5 years. (5)

Q109 Thank you for participating in this research study and completing this survey! In order to be compensated $15, please provide your name and mailing address in the space below. You will be mailed a check.

Q110 Are you interested in participating in a focus group on your campus to identify barriers to safe agricultural work practices? If so, enter your email address. Focus groups will take place when it is convenient for students. Participants will receive a meal and a check for $30.

 Yes, please contact me at the following email address: (1)
_____

 No (2)

Hearing Protection RCT – Screening Survey

Q2 How old are you? (Enter age in years)

Q3 How many times do you enter a swine building each day? (Select one)

- None, I do not enter swine buildings (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- More than 4 (6)

Q17 If you do not enter every day, how many TIMES per WEEK do you enter a building? (Enter number of times per week and explain your circumstance-- for example: you work on the weekends or during the summer).

Q4 How much time do you spend in a swine building each day? (Select one)

- Less than 30 minutes (1)
- More than 30 minutes but less than 1 hour (2)
- More than 1 hour but less than 3 hours (3)
- More than 3 hours (4)

Q5 Which of the following tasks do you perform when you are in a swine building? (Check all that apply)

- Feeding pigs (1)
- Moving pigs (2)
- Inseminating (3)
- Processing piglets (4)

- Cleaning buildings (5)
- Inoculating swine (6)
- Heat checking (7)
- Ultrasound monitoring (8)
- Other (please specify) (9) _____
- I do not perform any of the above tasks (10)

Q6 Does the farm you work on require you to wear hearing protection (i.e. ear muffs, ear plugs)? when in a swine building?

- Yes (1)
- No (2)

Q7 How much of the time do you wear hearing protection when in a swine building (i.e. ear muffs, ear plugs)?

- Never (1)
- Less than 50% of the time (2)
- About 50% of the time (3)
- More than 50% of the time (4)
- Always (5)

Q8 Do you have a smartphone you use daily?

- Yes, I own and operate an Android smartphone (1)
- Yes, I own and operate an iPhone (2)
- No, I do not own or operate a smartphone (3)

Q9 Are you interested in participating in this research study?

- Yes (1)

 No (2)

Q15 If you are interested in participating in this research study, please provide your contact information below. The project PI will use this information to mail hearing protection and compensation.

Q11 What is your first and last name?

Q12 What is your email address?

Q13 What is your phone number? (Please include area code)

Q14 What is your mailing address? (Please include street address, city, state, and zip code). This will be the address your hearing protection and compensation checks will be sent to!)

Hearing Protection RCT – Pre-Intervention Survey

Q2 What is your first name?

Q3 What is your last name?

Q4 What is your age? (in years)

Q20 What is your gender?

- ❍ Male (1)
- ❍ Female (2)

Q7 Are you Spanish/Hispanic/Latino?

- ❍ No, I am NOT Hispanic or Latino (1)
- ❍ Yes, I am Hispanic or Latino (2)

Q8 What is your race?

- ❍ American Indian or Alaska Native (1)
- ❍ Asian (2)
- ❍ Native Hawaiian or Other Pacific Islander (3)
- ❍ Black or African American (4)
- ❍ White (5)
- ❍ More than one race (6)
- ❍ Other (7) _____

Q9 What is your marital status?

- ❍ Never married (1)
- ❍ Married (2)
- ❍ Divorced (3)

- ❍ Separated (4)
- ❍ Widowed (5)

Q6 What is the highest level of education you completed?

- ❍ Elementary to some high school (1)
- ❍ High school graduate (2)
- ❍ Tech training or trade school (3)
- ❍ Associate degree and/or some college (4)
- ❍ College graduate or beyond (5)

Q11 What is your role on the swine farm you work on?

- ❍ Owner/operator (1)
- ❍ Hired full-time worker (2)
- ❍ Hired part-time worker (3)
- ❍ Seasonal worker (4)
- ❍ Other (please specify) (5) _____

Q10 On average, how many hours a week do you work in a hog building? (enter number of hours)

Q22 On average, many hours a week do you work on a farm (total hours engaged in agricultural related tasks)? (enter number of hours)

Q23 On average. how many hours a week do you work in a non-agricultural production setting (off-farm), if any? (enter number of hours)

- ❍ Enter number of hours: (1) _____
- ❍ I do not work off-farm (10)

Q13 What type of swine operation do you work on? (Check all that apply)

- ❑ Farrow-to-wean (breeding and farrowing sows, weaning at approx. 21 days) (1)

- ❑ Farrow-to-feeder (breeding and farrowing sows and selling piglets at 30-60 lbs.) (2)
- ❑ Farrow-to-finish (breeding and farrowing sows, feeding hogs until market weight) (3)
- ❑ Wean-to-finish (buying wean pigs and feeding them until market weight) (4)
- ❑ Feeder-to-finish (buy feeder pigs at 30-60 lbs. and feeding them to market weight) (5)
- ❑ Other (please describe) (6) _____

Q14 What size of swine operation are you working on? (How many live hogs does the facility you work at have at one time? Do not include piglets under wean age)

- ❍ Less than 499 (1)
- ❍ 500 to 999 (2)
- ❍ 1000-1999 (3)
- ❍ 2000-4999 (4)
- ❍ 5000-9999 (5)
- ❍ 10,000 or more (6)

Q16 Complete the table below by indicating how many times in the past three days you have completed each activity and how many times you wore hearing protection when completing that activity. For example, if you enter a swine building to feed pigs twice a day, you would enter 6 in the first column. If you wore hearing protection half of the time when feeding pigs, you would enter 3 in the second column.

	Number of time you completed activity in a swine building in the past 3 working days. (1)	Number of times you wore hearing protection (i.e. ear plugs, ear muffs) for each activity in the past 3 working days. (2)
Feeding pigs (1)		
Walking pens, monitoring (2)		
Loading/unloading (9)		
Inseminating (3)		
Processing piglets (4)		

Cleaning buildings (5)

Inoculating swine (6)

Heat checking (7)

Ultrasound monitoring (8)

Moving pigs within the building (10)

Q26 Which of the following swine-related tasks have you completed in the PAST 6 MONTHS? (Check all that apply).

- ❑ Feeding pigs (1)
- ❑ Walking pens, monitoring (2)
- ❑ Loading/unloading (3)
- ❑ Inseminating (4)
- ❑ Processing piglets (5)
- ❑ Cleaning buildings (6)
- ❑ Inoculating swine (7)
- ❑ Heat checking (8)
- ❑ Ultrasound monitoring (9)
- ❑ Moving pigs within the building (10)
- ❑ Other (please specify): (11) _____

Q17 Have you purchased hearing protection devices (i.e. ear muffs, work tunes, foam ear plugs) in the past 60 days?

- ❍ No, and I do not intend to (1)
- ❍ No, but if I needed new hearing protection I would (2)
- ❍ Yes I have (3)

Q18 Complete the table below by indicating how many HOURS of sleep have you received each night in the past three weeknights. Please round to the nearest whole number.

	Hours of sleep (rounded to whole number) (1)
Past weeknight 1 (1)	
Past weeknight 2 (2)	
Past weeknight 3 (3)	

Q27 What type of smartphone do you own/operate?

- ❍ iPhone (1)
- ❍ Android (2)
- ❍ I do not own or operate a smartphone (3)

Q28 Please provide the address you would like your box of hearing protection sent to. (Please include your first and last name, street address, city, state, and zip code).

Q19 Thank you for completing this survey. In order to receive compensation for completing this survey, please provide your name and mailing address below. (Please include your first and last name, street address, city, state, and zip code)

Q24 What is your email address? (this is the address the next survey will be sent to).

Hearing Protection RCT – Immediate Post Intervention Survey (Intervention Groups)

Q2 What is your first name? (In order to link your responses from this survey with surveys in the future, please provide your first name. All identifying information will be removed before data are analyzed to maintain anonymity of participants).

Q3 What is your last name? (In order to link your responses from this survey with surveys in the future, please provide your first name. All identifying information will be removed before data are analyzed to maintain anonymity of participants).

Q4 What is your age? (in years)

Q16 Complete the table below by indicating how many times in the past three days you have completed each activity and how many times you wore hearing protection when completing that activity. For example, if you enter a swine building to feed pigs twice a day, you would enter 6 in the first column. If you wore hearing protection half of the time when feeding pigs, you would enter 3 in the second column.

Number of time you completed activity in a swine building in the past 3 working days. (1) Number of times you wore hearing protection (i.e. ear plugs, ear muffs) for each activity in the past 3 working days. (2)

Feeding pigs (1)

Moving pigs (2)

Inseminating (3)

Processing piglets (4)

Cleaning buildings (5)

Inoculating swine (6)

Heat checking (7)

Ultrasound monitoring (8)

Other/Additional activities (9)

Q18 Complete the table below by indicating how many HOURS of sleep have you received each night in the past three weeknights. Please round to the nearest whole number.

Hours of sleep (rounded to whole number) (1)

Past weeknight 1 (1)

Past weeknight 2 (2)

Past weeknight 3 (3)

Q27 On average, how many times each WEEK did you log your activities (number of times entered a swine barn, number of times wore hearing protection when entering swine barn, number of hours slept the night before) in Habitbull during the tracking period?

- Never- I did not log my activities (1)
- Less than once a week (2)
- 1-2 days a week (3)
- 3-4 days a week (4)
- 5-6 days a week (5)
- Every day (7 days a week) (6)

Q20 Please rate the following types of hearing protection based on your preference for each.

	Not at all desirable (1)	Somewhat desirable (2)	Very desirable (3)	Extremely desirable (4)
Ear muffs (1)				
Foam ear plugs (2)				
Other type: please specify (3)				
Other type: please specify (4)				

Q17 Have you purchased hearing protection devices (i.e. ear muffs, work tunes, foam ear plugs) in the past 60 days?

- No, and I do not intend to (1)
- No, but if I needed new hearing protection I would (2)
- Yes I have (3)

Q21 Please rate your level of agreement with the following statements regarding the smartphone app used to log your daily behaviors.

	Strongly disagree (1)	Disagree (2)	Neither disagree nor agree (3)	Agree (4)	Strongly Agree (5)
It helps me be more effective. (1)					

It helps me be more productive. (2) ☐ ☐ ☐ ☐ ☐

It is useful. (3) ☐ ☐ ☐ ☐ ☐

It gives me more control over the activities in my life. (4) ☐ ☐ ☐ ☐ ☐

It makes the things I want to accomplish easier to get done. (5) ☐ ☐ ☐ ☐ ☐

It saves me time when I use it. (6) ☐ ☐ ☐ ☐ ☐

It meets my needs. (7) ☐ ☐ ☐ ☐ ☐

It does everything I would expect it to do. (8) ☐ ☐ ☐ ☐ ☐

Q24 Please rate your level of agreement with the following statements regarding the smartphone app used to log your daily behaviors.

	Strongly disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)
It is easy to use. (1)	☐	☐	☐	☐	☐
It is simple to use. (2)	☐	☐	☐	☐	☐
It is user friendly. (3)	☐	☐	☐	☐	☐
It requires the fewest steps possible to accomplish what I want to do with it. (4)	☐	☐	☐	☐	☐
It is flexible. (5)	☐	☐	☐	☐	☐
Using it is effortless. (6)	☐	☐	☐	☐	☐
I can use it without written instructions. (7)	☐	☐	☐	☐	☐
I don't notice any inconsistencies as I use it. (8)	☐	☐	☐	☐	☐

Both occasional and regular users would like it. (9) □ □ □ □ □

I can recover from mistakes quickly and easily. (10) □ □ □ □ □

I can use it successfully every time. (11) □ □ □ □ □

Q25 Please rate your level of agreement with the following statements regarding the smartphone app used to log your daily behaviors.

	Strongly disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)
I learned to use it quickly. (1)	□	□	□	□	□
I easily remember how to use it. (2)	□	□	□	□	□
It is easy to learn to use it. (3)	□	□	□	□	□
I quickly became skillful with it. (4)	□	□	□	□	□

Q26 Please rate your level of agreement with the following statements regarding the smartphone app used to log your daily behaviors.

	Strongly disagree (1)	D (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)
I am satisfied with it. (1)	□	□	□	□	□
I would recommend it to a friend. (2)	□	□	□	□	□
It is fun to use. (3)	□	□	□	□	□
It works the way I want it to work. (4)	□	□	□	□	□

It is wonderful. (5) ☐ ☐ ☐ ☐ ☐

I feel I need to have it. (6) ☐ ☐ ☐ ☐ ☐

It is pleasant to use. (7) ☐ ☐ ☐ ☐ ☐

Q19 Thank you for completing this survey. In order to receive compensation for completing this survey, please provide your name and mailing address below. (Please include your first and last name, street address, city, state, and zip code)

Q28 What is your email address (please provide in the event a check is returned and the project coordinator needs to get a hold of you).

Q29 What is your phone number? (please provide in the event a check is returned and the project coordinator needs to get a hold of you).

Hearing Protection RCT – Immediate Post Intervention Survey (Control Group)

Q2 What is your first name? (In order to link your responses from this survey with surveys in the future, please provide your first name. All identifying information will be removed before data are analyzed to maintain anonymity of participants).

Q3 What is your last name? (In order to link your responses from this survey with surveys in the future, please provide your first name. All identifying information will be removed before data are analyzed to maintain anonymity of participants).

Q4 What is your age? (in years)

Q16 Complete the table below by indicating how many times in the past three days you have completed each activity and how many times you wore hearing protection when completing that activity. For example, if you enter a swine building to feed pigs twice a day, you would enter 6 in the first column. If you wore hearing protection half of the time when feeding pigs, you would enter 3 in the second column.

Number of time you completed activity in a swine building in the past 3 working days. (1) Number of times you wore hearing protection (i.e. ear plugs, ear muffs) for each activity in the past 3 working days. (2)

Feeding pigs (1)

Moving pigs (2)

Inseminating (3)

Processing piglets (4)

Cleaning buildings (5)

Inoculating swine (6)

Heat checking (7)

Ultrasound monitoring (8)

Other/additional tasks (9)

Q17 Have you purchased hearing protection devices (i.e. ear muffs, work tunes, foam ear plugs) in the past 60 days?

- No, and I do not intend to (1)
- No, but if I needed new hearing protection I would (2)
- Yes I have (3)

Q18 Complete the table below by indicating how many HOURS of sleep have you received each night in the past three weeknights. Please round to the nearest whole number.

	Hours of sleep (rounded to whole number) (1)
Past weeknight 1 (1)	
Past weeknight 2 (2)	
Past weeknight 3 (3)	

Q20 Please rate the following types of hearing protection based on your preference for each.

	Not at all desirable (1)	Somewhat desirable (2)	Very desirable (3)	Extremely desirable (4)
Ear muffs (1)				
Foam ear plugs (2)				
Other: please specify (3)				
Other: please specify (4)				

Q19 Thank you for completing this survey. In order to receive compensation for completing this survey, please provide your name and mailing address below. (Please include your first and last name, street address, city, state, and zip code)

Q27 What is your email address? (In the event a check is returned please provide your email address so the project coordinator can get a hold of you).

Q28 What is your phone number? (In the event a check is returned please provide your email address so the project coordinator can get a hold of you).

Hearing Protection RCT – 3-month Follow-up Survey

Q2 What is your first name? (In order to link your responses from this survey with surveys in the future, please provide your first name. All identifying information will be removed before data are analyzed to maintain anonymity of participants).

Q3 What is your last name? (In order to link your responses from this survey with surveys in the future, please provide your first name. All identifying information will be removed before data are analyzed to maintain anonymity of participants).

Q4 What is your age? (in years)

Q16 Complete the table below by indicating how many times in the past three days you have completed each activity and how many times you wore hearing protection when completing that activity. For example, if you enter a swine building to feed pigs twice a day, you would enter 6 in the first column. If you wore hearing protection half of the time when feeding pigs, you would enter 3 in the second column.

Number of time you completed activity in a swine building in the past 3 working days. (1) Number of times you wore hearing protection (i.e. ear plugs, ear muffs) for each activity in the past 3 working days. (2)

Feeding pigs (1)

Walking pens, monitoring (2)

Loading/unloading (9)

Inseminating (3)

Processing piglets (4)

Cleaning buildings (5)

Inoculating swine (6)

Heat checking (7)

Ultrasound monitoring (8)

Moving pigs within the buidling (10)

Q18 Complete the table below by indicating how many HOURS of sleep have you received each night in the past three weeknights. Please round to the nearest whole number.

Hours of sleep (rounded to whole number) (1)

Past weeknight 1 (1)

Past weeknight 2 (2)

Past weeknight 3 (3)

Q17 Have you purchased hearing protection devices (i.e. ear muffs, work tunes, foam ear plugs) in the past 90 days?

- No, and I do not intend to (1)
- No, but if I needed new hearing protection I would (2)
- Yes I have (3)

Q27 If you have purchased hearing protection in the past 90 days, which type of hearing protection did you purchase? (select all that apply)

- Ear muffs (1)
- Foam ear plugs (2)
- Work tunes (3)
- Other (please specify) (4) _____

Q28 If you have NOT purchased hearing protection in the past 90 days, why not? (select all that apply)

- Have not needed to purchase new hearing protection devices (i.e. ear muffs and ear plugs) (1)
- Do not know where to purchase hearing protection devices (i.e. ear muffs and ear plugs) (2)
- Do not know which kind of hearing protection devices (i.e. ear muffs and ear plugs) to purchase (3)
- Can not afford to purchase hearing protection devices (i.e. ear muffs and ear plugs) (4)
- I do not use hearing protection devices (i.e. ear muffs and ear plugs) (5)

Q33 Has your employer (including parent) or workplace purchased hearing protection devices (i.e. ear muffs, work tunes, foam ear plugs) in the past 90 days?

- No, and they do not intend to (1)

- No, but if the workplace needed new hearing protection my employer would (2)
- Yes then have (3)
- I do not have an employer (4)

Q37 If your employer or workplace has purchased hearing protection in the past 90 days, which type of hearing protection did they purchase? (Select all that apply)

- Ear muffs (1)
- Foam ear plugs (2)
- Work tunes (3)
- Other (please specify) (4) _____

Q34 Were you assigned to a study group that was instructed to log your daily use of hearing protection and daily amount of sleep using a smartphone app?

- Yes (1)
- No (2)

Display This Question:

If Were you assigned to a study group that was instructed to log your daily use of hearing protection and daily amount of sleep using a smartphone app? Yes Is Selected

Q29 Have you continued to track your hearing protection device (ear muff or ear plugs) use using the Habitbull smartphone app.

- Yes (1)
- No (2)

Display This Question:

If Have you continued to track your hearing protection device (ear muff or ear plugs) use using the Habitbull smartphone app. Yes Is Selected

Q31 How often do you use the app to track your use of hearing protection devices (ear muffs and ear plugs) in swine buildings?

- Less than once a week (1)
- 1-2 days a week (4)

- 3-4 days a week (5)
- 5-6 days a week (6)
- Everyday (7 days a week) (7)

Display This Question:

If Were you assigned to a study group that was instructed to log your daily use of hearing protection and daily amount of sleep using a smartphone app? Yes Is Selected

Q35 Have you continued to track your nightly hours of sleep using the Habitbull smartphone app.

- Yes (1)
- No (3)

Display This Question:

If Have you continued to track your nightly hours of sleep using the Habitbull smartphone app. Yes Is Selected

Q36 How often do you use the app to track the number of hours of sleep you receive each night?

- Less than once a week (1)
- 1-2 days a week (2)
- 3-4 days a week (3)
- 5-6 days a week (4)
- Everyday (7 days a week) (5)

Display This Question:

If Were you assigned to a study group that was instructed to log your daily use of hearing protection and daily amount of sleep using a smartphone app? Yes Is Selected

Q32 Have you started using the app to track other activities or daily events?

- Yes, (please specify) (1) _____
- No (2)

Display This Question:

If Were you assigned to a study group that was instructed to log your daily use of hearing protection and daily amount of sleep using a smartphone app? Yes Is Selected

Q38 Did you use the goal setting feature on the Habitbull app to set daily goal for hearing protection use and hours of sleep each night?

- Yes (1)
- No (2)

Display This Question:

If Did you use the goal setting feature on the Habitbull app to set daily goal for hearing protection use and hours of sleep each night? Yes Is Selected

Q39 Did you find the goal setting function useful?

- Yes (1)
- No (2)

Display This Question:

If Did you use the goal setting feature on the Habitbull app to set daily goal for hearing protection use and hours of sleep each night? Yes Is Selected

Q40 Why or why not did you find it useful?

Q19 Thank you for completing this survey. In order to receive compensation for completing this survey, please provide your name and mailing address below. (Please include your first and last name, street address, city, state, and zip code)