The Prevalence of Disabilities in the U.S. Farm Population

C. D. Miller, R. A. Aherin

ABSTRACT. *Health limitations and disabilities among farmers, farmworkers, and farm family members may have implications on their day-to-day activities and well-being as well as the farm business, but little is known about the extent of these limitations and disabilities. Using the U.S. Census Bureau's American Community Survey (ACS) Public Use Microdata Sample (PUMS) files from 2008 to 2016, the following questions were examined: what is the prevalence of disability in the overall farm population; what is the prevalence of health difficulties and disability among farmers, farmworkers, and farm family members; and do farmer and farmworker disability prevalence rates vary over time, by state, gender, or race/ethnicity. Finally, the effects of demographic factors were estimated on the likelihood that farmers and farmworkers might experience a disability. The findings of this study indicated that the disability rate in the farm population was 12.9%. On average, almost two out of ten farmers (19.2%) and nearly one out of ten farmworkers (9.0%) had a disability. One in 25 farm family children (4.2%, ages 6 to 17) and slightly more than two in 25 farm family adults (10.5%) had a disability.*

Keywords. *Cognitive difficulty, Disability, Farm children, Farmer, Farm household, Farmworker, Hearing difficulty, Independent living difficulty, Physical difficulty, Self-care difficulty, Vision difficulty.*

Health difficulties and disabilities among U.S. farmers, farm households, and farmworkers may impact their daily lives and well-being. According to Whelan et al. (2009), an Irish farmer with a disability affects not only the farmer but also the farm family, including the farm business. In addition to the health and disabling injury risks associated with farming, disabilities and health difficulties in the farm population may also be caused by a number of factors, such as genetics, aging, access to healthcare, and lifestyle choices. As the average age of U.S. farmers continues to increase and farmers work on the farm beyond the standard retirement age, more evidence of chronic diseases, health difficulties, and disabilities may be seen in this population (Brackbill et al., 1994; Von Essen and McCurdy, 1998; Cole et al., 2006).

Jackman et al. (2016) stated that disability in the farm population is considered a public health concern, but little is known about the extent of disabilities and health difficulties

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within this population (Mobed and Schenker, 1992; Gómez-Marín et al., 2004; Field and Jones, 2006; Villarejo et al., 2010). Deboy et al. (2008) produced a range of U.S. agriculture disability estimates of 490,000 to 2.23 million. This wide range of estimates came from the disability rates and national health surveys used, as well as different farm population counts, i.e., the agriculture workforce, agriculture households, or the total agriculture population. Deboy et al. (2008) used disability prevalence estimates from the general U.S. population (either 14.0% or 19.4%) and imposed those rates onto the farm population, assuming that farmers and non-farmers have the same (or similar) prevalence of disabilities.

Aside from Deboy et al. (2008), no other literature was found that estimated national disability prevalence rates within the U.S. farm population. No other study was found that used the U.S. Census Bureau's American Community Survey (ACS) Public Use Microdata Sample (PUMS) files from 2008 to 2016 to estimate health difficulties and disabilities within the farm population. The ACS PUMS files contain a nationally representative subsample of the yearly ACS files, which replaced the decennial Census long-form survey, and include both person record and housing unit questions. The person record files include health difficulty questions, detailed occupation codes, state identifiers, and household indicators for all members of the same household. Using the occupation codes and household identifiers, the first question in this study estimated the prevalence of disability within the overall farm population. The U.S. Census Bureau's definition of disability states that an individual is classified as disabled if he or she answers yes to at least one of six health difficulty questions, which focus on the following: vision, hearing, physical, cognitive, self-care, and independent living.

The second question in this study was what were the health difficulties and disability prevalence rates among farmers, farmworkers, and farm family adults (age 18 and older) (table 2) and farm children (ages 0 to 5 years and 6 to 17 years) (table 3). The third question was whether health difficulties and disability prevalence rates among farmers and farmworkers varied over time or by state, gender, or race and ethnicity. First, the change in disability rates over time was illustrated (fig. 1). Maps of the state-average farmer and farmworker disability rates were produced (figs. 2 and 3). Visualizations of health limitations and disability estimates for farmers (figs. 4 and 5) and farmworkers (figs. 6 and 7) by gender and race/ethnicity were provided with bar charts. Finally, estimates were provided through probit regression models for farmers, farm family adults, and farmworkers that included demographic characteristics, such as education, age, marital status, and farm type (crop production and animal production), to show the effects of those demographic factors on the likelihood that farmers, farm family adults, and farmworkers might experience a disability (table 5).

The findings indicated that the disability rate for the entire farm population was 12.9% (or 634,000 individuals out of 4.92 million). On average, 19.2% (or 395,000) of farmers and 9.0% (or 134,000) of farmworkers had a disability. For both farmers and farmworkers, physical difficulties and hearing difficulties had the highest prevalence rates. Through examination of the health difficulties and disabilities of farmers and farmworkers by gender and race/ethnicity, it was found that female farmers and farmworkers had lower hearing difficulty prevalence rates and higher physical difficulty prevalence rates than male farmers and farmworkers. Among farm family members, farm family adults (age 18 and older) had a 10.5% (or 90,000) disability rate, preschool-age farm children (ages 0 to 5) had a 0.7% (or 900) disability rate, and school-age farm children (ages 6 to 17) had a 4.2% (or 16,000) disability rate.

Background on the Farm Population

Workers face a variety of occupational risks due to hazards and exposures, and farming is no exception. The Bureau of Labor Statistics ranked farming as one of the most hazardous occupations (BLS, 2016; Gorucu et al., 2015). As a place of both work and residence, hazards (machinery, livestock, chemicals, confined spaces) on a farm or ranch could lead to an increased risk of health difficulties, disabling injuries, or even death (Sprince et al., 2002; Browning et al., 2013; Jawa et al., 2013; Fox et al., 2015). Additionally, health risks could be exacerbated by long working hours, seasonal fatigue, occupational tenure, and the stress of managing a farm or ranch (Brackbill et al., 1994; Von Essen and McCurdy, 1998; Cole, 2006; Lilley et al., 2011).

Occupational injuries may potentially have negative spillover effects for the worker, the worker's family, and the employer. According to Leigh (2011), the total estimated cost of all occupational injuries and illnesses in the U.S. in 2007 was $250 billion. The National Safety Council (NSC, 2013) found that the average cost of an injury across all industries was $37,000, and the average cost of a fatality was $1.4 million (Ryan et al., 2017). Farm-specific occupational injury or fatality estimates could be underestimated because most farms in the U.S. (total farms, not land in farming) are considered small family farms (farms with less than 11 paid employees) and are exempt from OSHA inspections. This means that accidents or deaths on these family farms are not included in OSHA data sets. Therefore, without the data, it is nearly impossible to accurately estimate the average cost of farm injuries and fatalities in the U.S. (Landsteiner et al., 2016).

A few studies have provided information on disabled farmers' quality of life and types of disabling injuries. Windon et al. (2016) found that farmers with disabilities tended to work fewer hours in a day, fewer months in a year, and earn less annual income. Ohio AgrAbility participants (farmers with disabilities) responded that they were at least somewhat satisfied with their quality of life (Windon et al., 2016). Additionally, Allen et al. (1995) found that 31% of the 552 disabled farmers in their study worked full-time (31 hours per week) as farm operators. The most common injury of the disabled farmers in their study was to the spinal cord (41% of respondents) and the top two causes of disability were farm work related injuries and motor vehicle related injuries (Allen et al., 1995).

Returning to work can pose a number of challenges for disabled farmers, although compared to other occupations, farmers had a high rate of returning to work after a disabling incident (Hamm et al., 2012). In order for a farmer to return to farming and continue to perform regular tasks, the farm may need to be adapted or the farmer may need to purchase assistive technologies. Meyer and Fetsch (2006) found that adapting the farm and purchasing assistive technologies could cost more than $100,000. On top of medical and rehabilitation bills (as well as farm operation and household bills), the additional costs of adapting the farm and purchasing assistive technologies can be a burden on the farmer.

Several organizations are aimed at helping disabled farmers continue farming. The National AgrAbility Project (NAP) is a unique program that connects farmers, ranchers, and their families with disability resources (rehabilitation and assistive technologies) to help disabled farmers continue to work on the farm and improve their daily living activities. Currently, 22 states are involved in NAP. Partially funded through a discretionary grant program at the USDA National Institute of Food and Agriculture (NIFA), NAP exploits the benefits of university extension services' abilities to connect farmers with information

and resources at nonprofit disability organizations such as Easter Seals, Goodwill Industries International, and the Arthritis Foundation (http://www.agrability.org/faqs/agrability.org; Kirkhorn, 2011).

Elderly and Farm Children

Within the farm household, the elderly and farm children may be at risk for disabling injuries or health difficulties due to the tasks they perform on the farm, potential exposure to hazards, and the places where farm children play (Brison et al., 2006; Molineri et al., 2015; Gross et al., 2015; Reed and Claunch, 2000). Studies show that occupational and non-occupational fatalities in agriculture tend to occur among those younger than 14 years and older than 65 (Gorucu et al., 2015; Swanton et al., 2015).

The 2012 Census of Agriculture showed that almost a third of farm operators were age 65 or older. Older farmers had higher probabilities of farm-related injuries (Amshoff and Reed, 2005). Due to strong emotional ties to the land, elderly farmers often continued to work on the farm despite passing the farm down to their children (Amshoff and Reed, 2005). Cole and Donovan (2008) stated that all older adults experience age-related deficits in vision, hearing, physical, and cognitive functioning, but older farmers seem to adapt to these deficits. Combined with their knowledge of the farm, older farmers' abilities to adapt to changes in their health may enable them to work safely on the farm well beyond normal retirement age (Cole and Donovan, 2008).

Farm children are at an elevated risk of injury and disability due to the areas where they play on the farm and the on-farm tasks they perform. In particular, preschool-age farm children (under the age of 6) are at a high risk of injury (Brison et al., 2006). A child dies in an agriculture-related accident every three days, and 45 children are injured on the farm every day (Wright et al., 2013). In a study by Hard et al. (2016), 27% of farm children between the ages of 4 and 10 were operating tractors on the farm. Despite recommendations by the Department of Labor that children under 13 not operate tractors, farm children's injury risk could be affected by the age-appropriateness of the tasks they perform and the equipment they use (Hard et al., 2016; Gerberich et al., 2001).

Farmworkers

Health difficulties and disabilities can potentially impact farmworkers' productivity and quality of life. Injury and disability risks to farmworkers include repetitive motions, high noise levels, livestock handling, exposure to toxic dust, and machinery vibrations. Hearing loss due to farm machinery has been found to increase the risk of agriculture injury and fatality (Choi et al., 2005). Using the National Health Interview Survey, Variyam and Mishra (2005) found that farmworkers had a higher prevalence of lower back pain compared to construction workers and all other occupations. Compared to construction workers, farmworkers had a higher prevalence of respiratory conditions, functional limitations, hypertension, and cardiovascular disease (Variyam and Mishra, 2005).

Description of the Data

The ACS PUMS one-year files from 2008 to 2016 provide a nationally representative subsample of the yearly ACS, which replaced the decennial Census long-form survey (collected every ten years). Because the ACS collected data on 3.5 million households in the U.S. on a yearly basis, this data set contains a rich source of information on demographics, occupations, and housing.

According to the USDA Census of Agriculture, a farm or ranch is any place from which $1,000 or more in agriculture products were produced and sold, or would have been sold, during the Census year. Thus, the industry and occupation codes were used along with employment type (hired, self-employed, unemployed, or not in the labor force) and the agricultural sales variable to define farmers. After farmers were located in the ACS data set, individuals within the farmer's household were classified as farm family members by using the household identifier variable. Industry and occupation codes were used as well as employment type (hired or self-employed) to define farmworkers. Specifically, the following farm populations were created:

- *Farmers* stated that their primary occupation was farm or ranch owner/operator or manager. Farmers were age 18 years or older and had positive agricultural sales. Farmers were either self-employed, employed, unemployed, or are not currently in the labor force.
- *Farmworkers* were either self-employed or hired in the labor force. Farmworkers were age 18 years or older; working as agriculture inspectors, graders, or sorters; or performing miscellaneous agricultural work. Farmworkers who were unemployed or not in the labor force were excluded.
- *Farm family adults* were either men or women, age 18 years or older, and living in the same household as a farmer. These household members did not list their primary occupations as farm owners or operators.
- *School-age children* were between the ages of 6 and 17 and living in the same household as a farmer.
- *Preschool-age children* were age 5 or younger and living in the same household as a farmer.

The ACS included six health difficulty questions related to activities of daily living. The yearly files from 2008 to 2016 were pooled together. Descriptions of the health difficulty questions on the survey are as follows:

- *Physical difficulty* refers to serious difficulty walking or climbing stairs.
- *Hearing difficulty* refers to deafness or serious difficulty hearing.
- *Vision difficulty* refers to blindness or serious difficulty seeing even when wearing glasses.
- *Cognitive difficulty* refers to serious difficulty concentrating, remembering, or making decisions.
- *Self-care difficulty* refers to difficulty dressing or bathing.
- *Independent living difficulty* refers to difficulty performing errands (i.e., visiting a doctor's office or shopping).

According to the Census and within the ACS PUMS, an individual was classified as disabled if he or she answered yes to at least one of the six health difficulty questions.

Descriptive Statistics of Farmers, Farm Family Adults, and Farmworkers

Using the ACS PUMS pooled data (2008-2016) with population weights, this study contained an average of 2.06 million farmers (table 1). The number of farmworkers averaged 1.5 million over 2008 to 2016. The number of farm family members averaged 1.4 million. On average, the total farm population was just under 5 million.

Farmers were, on average, 56.7 years old (table 1). The average age of farm family adults was 46.3 years. Farmworkers were, on average, 40 years old. Farmers were predominantly white (91.1%) and married of either gender. Farmworkers were mostly white or

Table 1. Descriptive statistics of farmers, farm family adults, and farmworkers, 2008-2016.

	Farmers		Farm Family Adults		Farmworkers	
	Mean	SE	Mean	SE	Mean	SE
Age (years)						
Average age	56.7	0.04	46.3	0.07	40.0	0.05
Age bracket (%)						
18 to 30 years	8.8	0.08	22.8	0.19	33.6	0.17
31 to 45 years	15.8	0.10	22.2	0.18	30.8	0.17
46 to 64 years	40.3	0.12	41.2	0.20	28.7	0.16
65 to 80 years	27.8	0.11	12.4	0.12	6.3	0.07
81 and above	7.3	0.06	1.4	0.04	0.6	0.02
Gender (%)						
Male	57.0	0.12	39.0	0.20	73.2	0.16
Female	43.0	0.12	61.0	0.20	26.8	0.16
Race (%)						
Non-Hispanic, white	91.1	0.08	84.5	0.16	43.3	0.17
Non-Hispanic, black/African-American	2.5	0.04	2.9	0.07	4.0	0.07
Non-Hispanic, other race	3.0	0.05	3.8	0.08	2.9	0.06
Latino	3.3	0.05	8.8	0.14	49.8	0.18
Marital status (%)						
Never married	11.9	0.09	22.3	0.19	36.5	0.18
Married	72.9	0.12	69.3	0.20	51.0	0.18
Divorced/widowed/separated	15.2	0.09	8.4	0.12	12.5	0.12
Education attainment (%)						
Less than high school diploma	13.1	0.09	11.6	0.14	45.2	0.18
High school diploma	34.8	0.12	31.2	0.19	28.3	0.16
Some college	27.6	0.11	34.2	0.20	18.9	0.14
College graduate	15.9	0.09	15.9	0.15	6.2	0.08
Advanced degree	8.6	0.07	7.1	0.10	1.4	0.04
Farm type (%)						
Crop	19.4	0.10	0.6	0.03	66.8	0.17
Livestock	12.9	0.08	0.3	0.02	27.3	0.16
Not reported	67.7	0.12	99.1	0.04	5.8	0.09
Health insurance (%)						
Employer-sponsored only	28.0	0.11	48.4	0.21	30.8	0.15
Direct purchase only	16.7	0.09	12.3	0.13	6.9	0.09
Medicare	36.7	0.11	14.9	0.13	7.6	0.08
Medicaid only	3.2	0.05	4.8	0.10	10.8	0.10
Multiple sources (excluding Medicare)	11.6	0.08	7.3	0.10	4.2	0.06
Uninsured	10.5	0.09	13.9	0.16	40.2	0.18
Number of observations	275,834		103,129		141,294	
Average population size	2,059,149		841,032		1,491,218	

Hispanic/Latino males, who were either married or single. Nearly 67% of farmworkers worked on crop farms. For some reason, most farmers did not specify their type of farm. This could have been due to farmers producing both livestock and crops.

Health insurance is an indicator of access to healthcare and a mechanism to protect against medical debt in the case of illness or injury. Having health insurance means that individuals may have access medical care at a reduced cost and therefore may have a higher probability of seeking medical care when a problem arises. A large percentage of farmers had health insurance coverage from either Medicare (36.7%), employer-sponsored health insurance (28.0%), or direct purchase (16.7%) insurance (purchased insurance directly from a broker or the Health Insurance Marketplace), while 10.5% were uninsured. Farm family adults were mostly covered by employer-sponsored health insurance (49.4%) or

Table 2. Descriptive statistics of farm family children, 2008-2016.

	Preschool-Age Children		School-Age Children	
	Mean	SE	Mean	SE
Age (years)				
Average age	2.6	0.2	11.8	0.02
Age bracket (%)				
0 to 5 years	100.0	-	-	-
6 to 9 years	-	-	30.0	0.3
10 to 14 years	-	-	42.0	0.3
15 to 18 years	-	-	28.0	0.3
Gender (%)				
Male	52.1	0.5	51.6	0.3
Female	47.9	0.5	48.3	0.3
Race (%)				
Non-Hispanic, white	75.3	0.5	78.7	0.3
Non-Hispanic, black/African-American	2.8	0.2	2.8	0.1
Non-Hispanic, other race	3.9	0.2	4.7	0.1
Hispanic/Latino	17.9	0.4	13.8	0.2
Health insurance (%)				
Employer-sponsored only	37.2	0.5	47.2	0.3
Direct purchase only	13.6	0.3	14.6	0.2
Medicare	0.5	0.1	0.5	0.1
Medicaid only	30.6	0.5	20.2	0.3
Multiple sources (excluding Medicare)	5.0	0.2	5.8	0.1
Uninsured	12.2	0.3	10.7	0.2
Number of observations	17,207		45,577	
Average population size	148,442		377,893	

direct purchase insurance (12.3%), but nearly 15% (14.9%) of farm family adults were uninsured. While over 40% of farmworkers were uninsured, nearly 31% had insurance coverage through an employer, and 7% had direct purchase insurance.

Descriptive Statistics of Farm Children

For preschool-age farm children (under 5 years old), the average age was 2.6 (table 2). School-age farm children (ages 6 to 17) had an average age of 11.8. While most of the farm children were white (75.3% and 78.7%, respectively), the next largest racial/ethnic group was Hispanic/Latino (13.8% and 17.9%, respectively). Regarding health insurance, 37.2% of preschool-age children and 47.2% of school-age children were covered by employer-sponsored health insurance plans. Almost 31% (30.6%) of preschool-age children and 20.2% of school-age children had Medicaid coverage. Roughly 14% and 15% of preschool-age and school-age children, respectively, were covered by direct purchase health insurance plans. Finally, 12% of preschool-age farm children and 11% of school-age children were uninsured.

Methods

The ACS PUMS files from 2008 to 2016 were pooled. Using the population weights provided in the ACS PUMS files enabled calculation of estimates of health difficulty and disability for the U.S. farm population and subpopulations. National means of disability prevalence in the farm population for 2008-2016 were produced. In addition, national disability prevalence rates (yearly and overall) for farmers, farmworkers, farm family adults, school-age farm children, and preschool-age farm children as well as prevalence rates of the six health difficulties (vision, hearing, physical, cognitive, self-care, and independent

living) were provided.

Using Stata software (ver. 15) and the maximum likelihood probit command with Huber-White robust standard errors and population weights, the probabilities of demographic factors on the likelihood that farmers, farm family adults, and farmworkers might experience a disability were estimated (Wooldridge, 2009). The roles of age, gender, race/ethnicity, education, marital status, farm type, and employment status in the probability of a disability among farmers, farm family adults, and farmworkers were examined.

Results

National disability prevalence estimates were calculated for the entire farm population: farmers, farmworkers, and farm family adults (table 3), as well as preschool-age farm children and school-age farm children (table 4). The disability prevalence for the farm population was found to be 12.9% (or 634,000 individuals out of 4.92 million). On average, 19.2% (or 395,000) of farmers and 9.0% (or 134,000) of farmworkers had a disability. Farm family adults had, on average, a 10.5% disability rate (roughly 90,000 individuals). In simpler terms, nearly two in ten farmers, one in ten farmworkers, and two in 25 farm family adults had a disability.

Health Difficulties and Disabilities of Farmers, Farm Family Adults, and Farmworkers

Physical and hearing difficulties were high for farmers (10.1% and 8.2%, respectively). Independent living difficulties had the next highest prevalence rate among farmers at 6.6%. Cognitive difficulties had a prevalence rate of 5.1. More than 3.0% of farmers had difficulty with self-care tasks, such as bathing or dressing.

Table 3. Average health difficulties and disability prevalence among farmers, farm family adults, and farmworkers, 2008-2016.

	Farmers		Farm Family Adults		Farmworkers	
	Mean	SE	Mean	SE	Mean	SE
Health difficulty (%)						
Vision	3.1	0.04	1.7	0.05	2.1	0.05
Hearing	8.2	0.04	3.6	0.07	2.8	0.05
Physical	10.1	0.08	5.0	0.09	3.6	0.06
Cognitive	5.1	0.06	3.2	0.07	2.9	0.06
Self-care	3.7	0.05	1.7	0.05	1.0	0.03
Independent living	6.6	0.06	3.3	0.08	1.9	0.05
Disabled (%)	19.2	0.10	10.5	0.12	9.0	0.10
Number of observations	275,834		103,129		141,294	
Average population size	2,059,149		841,032		1,491,218	

Table 4. Average health difficulties and disability prevalence among farm children, 2008-2016.

	Preschool-Age Children		School-Age Children	
	Mean	SE	Mean	SE
Health difficulty (%)				
Vision	0.5	0.07	0.7	0.06
Hearing	0.4	0.05	0.6	0.05
Physical	-	-	0.6	0.05
Cognitive	-	-	3.1	0.11
Self-care	-	-	0.9	0.06
Disabled (%)	0.7	0.09	4.3	0.15
Number of observations	17,207		45,577	
Average population size	148,442		377,893	

Farmworkers experienced fewer reported health difficulties and disabilities than farmers. Physical and hearing difficulties were high for farmworkers (3.6% and 2.8%, respectively), and 2% of farmworkers had vision difficulties. Nearly 3% had cognitive difficulties, nearly 2.0% had independent living difficulties, and 1.0% had self-care difficulties.

Farm family adults also reported fewer difficulties. Physical and hearing difficulties (5.0% and 3.6%, respectively) were the most prevalent. Slightly more than 3.0% of farm family adults experienced independent living difficulties and cognitive difficulties. Self-care difficulties among farm family adults were, on average, 1.7%.

Health Difficulty and Disabilities of Farm Children

Roughly 0.7% (or 900) of preschool-age farm children and 4.3% (or 16,000) of school-age farm children were disabled (table 4). Preschool-age children reported the fewest health difficulties (0.5% had a vision difficulty and 0.4% had a hearing difficulty). Among school-age children, 3.1% reported a cognitive difficulty. Less than 1% of school-age children had self-care difficulties, vision difficulties, physical difficulties, or hearing difficulties.

Variations in Disability over Time

The yearly disability prevalence rates were calculated for farmers, farmworkers, farm family adults, preschool-age farm children, and school-age farm children over time (2008-2016; fig. 1). While there was a slight increase in the disability prevalence of farmers between 2008 and 2016, the disability prevalence rates for the other population groups appeared to be relatively constant.

State-Level Variations in Disability for Farmers and Farmworkers

Since farming varied by state or region in terms of crops planted, livestock raised, farm size, topography, and climate, the average disability rates (2008-2016) for farmers (fig. 2) and farmworkers (fig. 3) within each state were calculated. Among both farmers and farmworkers, Appalachia and parts of the lower Mississippi River region had some of the highest disability rates.

Between 12.3% and 27.1% of the farmer population within each state was disabled. The Great Plains and parts of the Midwest and New England were in the lowest quintile, with 12.3% to 16.3% of the farmers in those states having a disability (fig. 2). West Virginia, Kentucky, Tennessee, Mississippi, South Carolina, Alabama, Louisiana, and Oklahoma were in the highest quintile, with 24.0% to 27.1% of the farmers in those states having

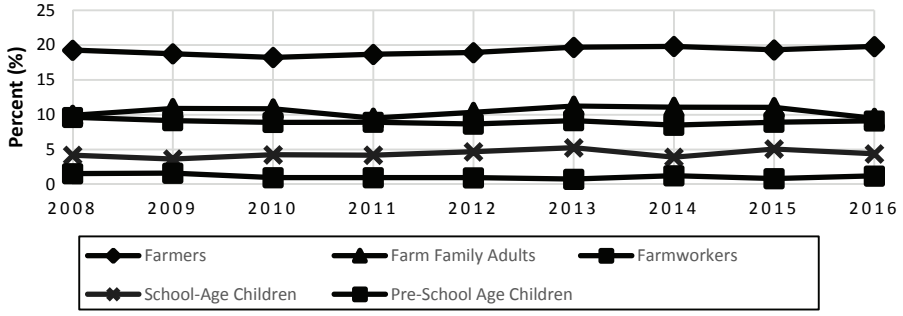

Figure 1. Prevalence of disability by farm population type and year.

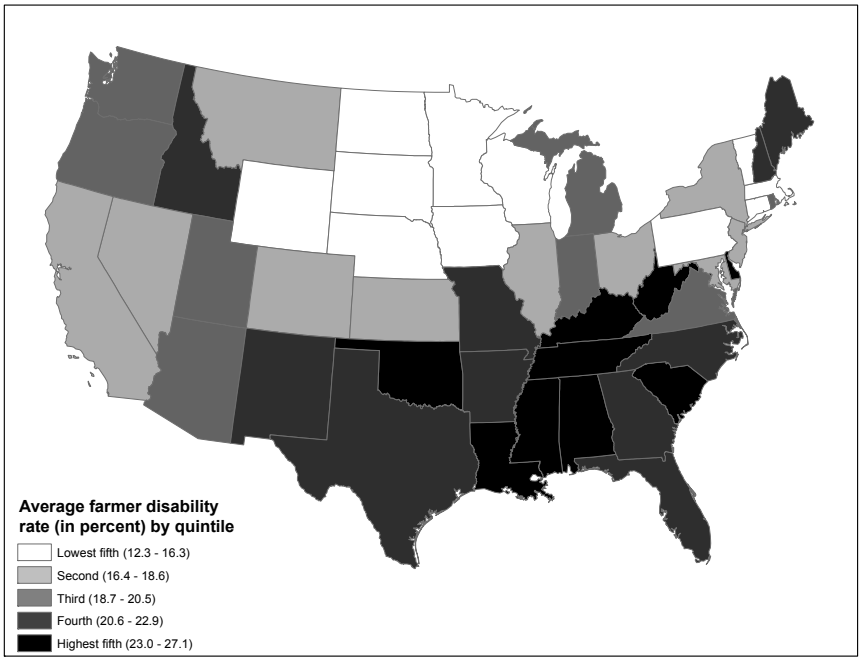

Figure 2. Percentages of farmers with disabilities by state, 2008-2016.

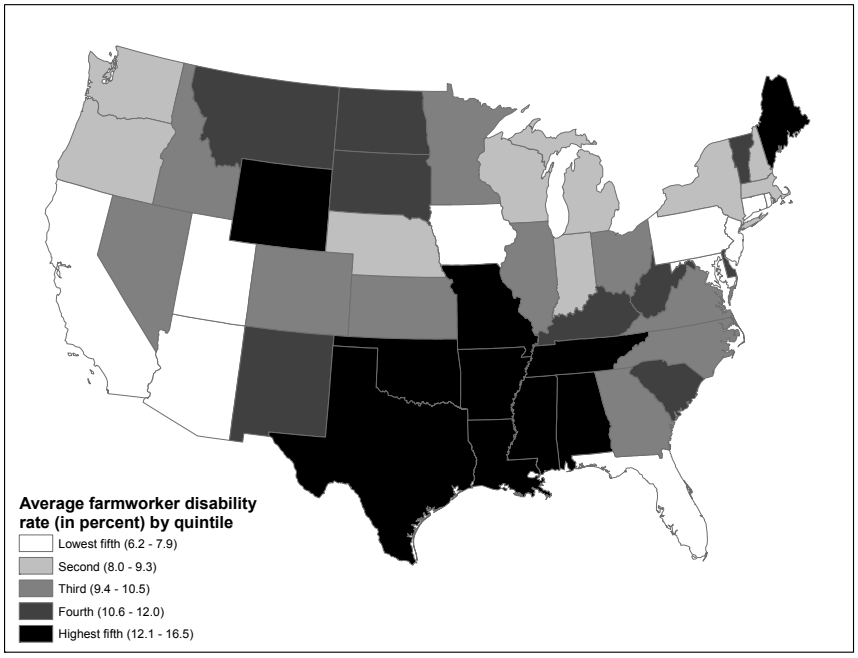

Figure 3. Percentages of farmworkers with disabilities by state, 2008-2016.

some form of disability. Farmworkers reported a lower percentage of disabilities by state, with a range of 6.1% to 16.5% of the state farmworker population. Parts of the West, Midwest, and New England were in the lowest quintile for farmworkers, while parts of the South, Wyoming, and Maine were in the highest quintile (fig. 3).

Variations in Farmer Difficulties and Disability by Race/Ethnicity

Gender and race/ethnicity differences in health difficulties and disabilities (averaged over 2008 to 2016) within the farmer population (figs. 4 and 5) were examined. The average disability rate among female farmers was 18.7% (or 166,000). The average disability rate among male farmers was 19.5% (or 230,000). Female farmers had higher rates of physical difficulties (among all races/ethnicities) compared to male farmers. Male farmers had higher rates of hearing difficulties than female farmers.

Among male farmers by race/ethnicity, non-Hispanic black or African-American male farmers had the highest disability rate (30.0%, or 7,600 farmers). Non-Hispanic other-race

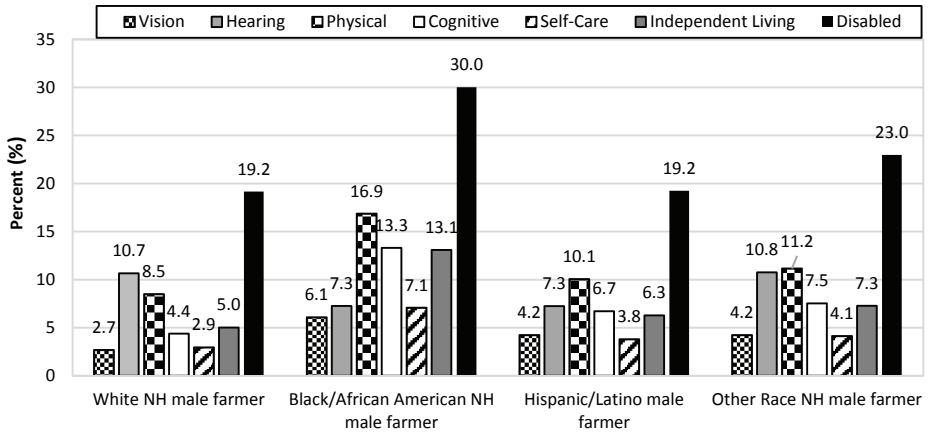

Figure 4. Health limitations and disability among male farmers by race/ethnicity, 2008-2016.

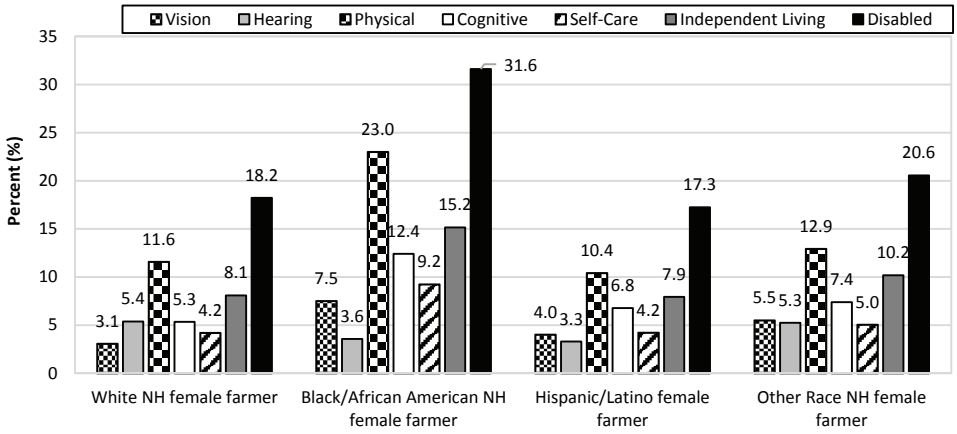

Figure 5. Health limitations and disability among female farmers by race/ethnicity, 2008-2016.

male farmers (including Asian-American, American Indian, Alaskan native, and Hawaiian/Pacific Islander) had the second highest disability rate among male farmers (23.0%, or 7,400 farmers). Non-Hispanic white male farmers and Hispanic/Latino male farmers had a disability rate of 19.2% (or 210,000 and 7,200 farmers, respectively).

Female farmers also showed variations in disability rates by race/ethnicity. Non-Hispanic black or African-American female farmers had the highest disability prevalence rate at 31.6% (or 8,600 farmers). Non-Hispanic other-race female farmers (including Asian-American, American Indian, Alaskan native, and Hawaiian/Pacific Islander) had the second highest disability prevalence rate at 20.6% (or 6,200 farmers). Non-Hispanic white female farmers had a disability prevalence rate of 18.3% (or 145,000 farmers). Hispanic/Latino female farmers had a disability prevalence rate of 17.3%, or 6,100 farmers.

Variations in Farmworker Difficulties and Disability by Race/Ethnicity

Gender and race/ethnicity differences in health difficulties and disabilities (averaged over 2008 to 2016) within the farmworker population (figs. 6 and 7) were examined. The average disability rate among female farmworkers was 8.0% (or 32,000 female farmworkers). The average disability rate among male farmworkers was 9.3% (or 101,473 male farmworkers). Female farmworkers had higher rates of physical difficulties (among all races/ethnicities) compared to male farmworkers. Male farmworkers had higher rates of

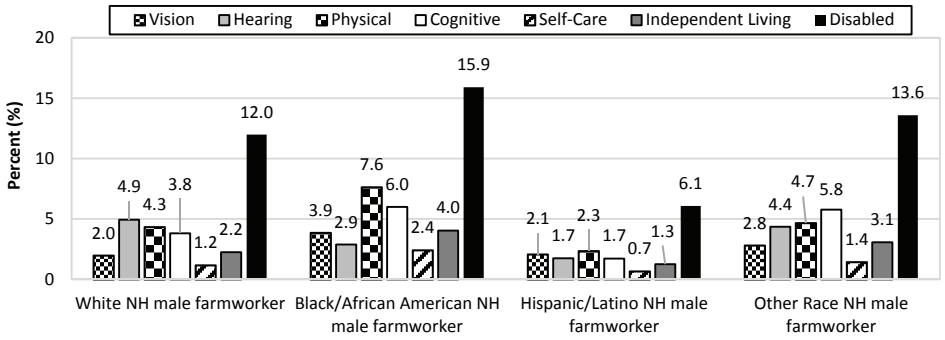

Figure 6. Health limitations and disability among male farmworkers by race/ethnicity, 2008-2016.

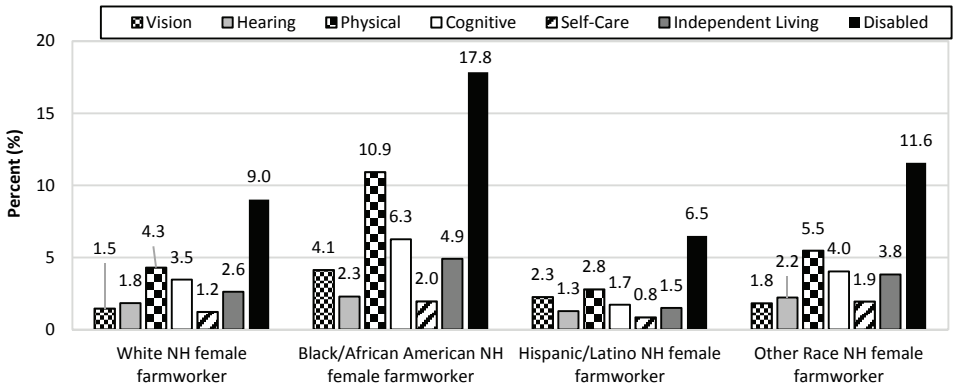

Figure 7. Health limitations and disability among female farmworkers by race/ethnicity, 2008-2016.

hearing difficulties than female farmworkers.

Among male farmworkers by race/ethnicity, non-Hispanic black or African-American farmworkers had the highest rate of disability (15.9%, or 7,656 farmworkers). Non-Hispanic other-race farmworkers had the second highest rate of disability (13.6%, or 4,073 farmworkers). Non-Hispanic white farmworkers had a disability rate of 12.0% (or 57,965 farmworkers). Latino male farmworkers had a disability rate of 6.1% (or 32,350 farmworkers).

Among female farmworkers by race/ethnicity, non-Hispanic black or African-American female farmworkers had the highest rate of disability (17.8%, or 2,106 farmworkers). Non-Hispanic other-race female farmworkers had the second highest rates of disability (11.6%, or 1,594 farmworkers). Non-Hispanic white female farmworkers had a disability rate of 9.0% (or 14,580 farmworkers). Latino female farmworkers had a disability rate of 6.5% (or 13,809 farmworkers).

Probit Regression Estimates

The effects of demographic characteristics on the likelihood of disability among farmers, farm family adults, and farmworkers were calculated using three probit regression models. In table 5, M1 represents the probit regression results for farmers, M2 represents the probit regression results for farm family adults, and M3 represents the probit regression results for farmworkers. The dependent variable in the models was the U.S. Census Bureau's definition of disability. Year fixed effects were included in each model to account for any aggregate time effects.

The relationship of the observable factors (age, gender, education, work status, farm type, marital status, and race) and the likelihood of having a disability within the farm population were better understood by this type of model. Farmers, farm family adults, and farmworkers have different roles and responsibilities on the farm that could expose them to potential health risks. In addition, a number of unobservable characteristics, such as genetics, exposure to pesticides, and machinery/livestock handling could play a role in the likelihood of disability. Unobservable characteristics could be correlated with the variables included in the models and could bias the results.

In regression M1, as farmers aged the probability of disability increased. Farmers age 31 to 45 were 7.9 percentage points more likely to have a disability. Farmers age 46 to 64 had a 16.6 percentage point higher likelihood of a disability. Farmers age 64 to 80 were 23.7 percentage points more likely to have a disability. Finally, farmers over 80 years old had a 38.9 percentage point higher likelihood of a disability. Female farmers were 5.9 percentage points less likely to have a disability. Employed or hired farmers (not self-employed) had a higher likelihood of disability by 1.9 percentage points, whereas unemployed and farmers not in the labor force had higher likelihoods of disability by 9.9 and 13.2 percentage points, respectively. A married farmer was almost eight percentage points less likely to have a disability. A farmer with less than a high school diploma was five percentage points more likely to have a disability. As education increased, the likelihood of a disability decreased. Non-Hispanic black or African-American farmers were nearly seven percentage points more likely to have a disability. Non-Hispanic other-race farmers were almost five percentage points more likely to have a disability. Latino farmers were roughly two percentage points more likely to have a disability.

In regression M2, farm family adults experienced higher probabilities of disability as

Table 5. Marginal effects results of Probit regressions (dependent variable is likelihood of a disability).

Variable	Farmers (M1)	Farm Family Adults (M2)	Farmworkers (M3)
Age 31 to 45	0.079***	0.058***	0.033***
	(0.0056)	(0.0047)	(0.0028)
Age 46 to 64	0.166***	0.107***	0.092***
	(0.0049)	(0.0040)	(0.0025)
Age 65 to 80	0.237***	0.164***	0.157***
	(0.0048)	(0.0045)	(0.0032)
Age 81 and older	0.389***	0.278***	0.227***
	(0.0048)	(0.0074)	(0.0032)
Female	-0.059***	-0.037***	-0.006***
	(0.0021)	(0.0024)	(0.0021)
Employed	0.019***	0.016***	-0.022***
	(0.0038)	(0.0066)	(0.0040)
Unemployed	0.099***	0.043***	-
	(0.0144)	(0.0214)	
Not in labor force	0.132***	0.094***	-
	(0.0032)	(0.0071)	
Farm type not reported	0.009***	0.018	0.012***
	(0.0035)	(0.0157)	(0.0040)
Livestock farm	0.008***	0.018	0.004***
	(0.0035)	(0.0235)	(0.0020)
Married	-0.078***	-0.050***	-0.029***
	(0.0022)	(0.0030)	(0.0019)
Less than high school	0.052***	0.033***	0.022***
	(0.0029)	(0.0037)	(0.0025)
Some college	-0.008***	-0.012***	-0.008***
	(0.0024)	(0.0028)	(0.0026)
College	-0.053***	-0.046***	-0.051***
	(0.0030)	(0.0037)	(0.0043)
Advanced degree	-0.059***	-0.051***	-0.049***
	(0.0038)	(0.0048)	(0.0065)
Non-Hispanic, black/African-American	0.068***	0.027***	0.013***
	(0.0055)	(0.0065)	(0.0040)
Non-Hispanic, other race	0.045***	0.015***	0.010***
	(0.0057)	(0.0059)	(0.0046)
Hispanic/Latino	0.016***	-0.019***	-0.048***
	(0.0058)	(0.0049)	(0.0026)
Year fixed effects	Yes	Yes	Yes
Number of observations	275,834	103,129	141,294
Average population size	2,059,149	841,032	1,491,218
Pseudo R^2	0.16	0.12	0.09

age increased. Farm family adults age 31 to 45 were 5.8 percentage points more likely to have a disability. Farm family adults age 46 to 64 had a 10.7 percentage point higher likelihood of a disability. Farm family adults age 64 to 80 were 16.4 percentage points more likely to have a disability. Finally, farm family adults over 80 years old had a 27.8 percentage point higher likelihood of a disability. Females were almost four percentage points less likely to have a disability. Employed farm family adults were almost two percentage points more likely to have a disability. Those who were unemployed or not in the labor force were roughly five or nine percentage points, respectively, more likely to have a disability. Among farm family adults, the coefficients on type of farm (livestock and not reported type) were not statistically significantly different from zero. Married farm family adults were five percentage points less likely to report a disability. Farm family adults with less

than a high school education were three percentage points more likely to report a disability, whereas those with more education were less likely. Non-Hispanic black/African-American and non-Hispanic other-race farm family adults were nearly three and two percentage points more likely to have a disability, whereas Latino farm family adults were nearly two percentage points less likely to have a disability.

In regression M3, farmworker results showed increases in the probability of disability as age increased. Farmworkers age 31 to 45 were 3.3 percentage points more likely to have a disability. Farmworkers age 46 to 64 had a 9.2 percentage point higher likelihood of a disability. Farmworkers age 64 to 80 were 15.7 percentage points more likely to have a disability. Finally, farmworkers over 80 years old had a 22.7 percentage point higher likelihood of a disability. Female farmworkers were less than one percentage point less likely to have a disability. Relative to self-employed farmworkers, employed or hired farmworkers were 2.2 percentage points less likely to have a disability. Married farmworkers were three percentage points less likely to have a disability. Education also played a similar role with farmworkers. Farmworkers with less than a high school education were two percentage points more likely to report a disability, whereas those with more education were less likely to have a disability. Non-Hispanic black/African-American and non-Hispanic other-race farmworkers had a one percentage point higher likelihood of a disability, whereas Latino farmworkers were almost five percentage points less likely to have a disability.

The models were run with and without year fixed effects, which are typically included to control for aggregate time effects. The probit regression model coefficients did not change when the year fixed effects were added; thus, the confidence level is high for the results shown in table 5. While it is standard practice to include year fixed effects in these types of models, they were insignificant and did not affect the model coefficients when removed.

Discussion and Conclusion

It is difficult to gauge the financial implications of health difficulties and disabilities for farms without having more data on farm income or farmer productivity. Nevertheless, health difficulties and disabilities are present and have potential to influence the decisions made on farms. These health difficulties and disabilities impact the daily lives and well-being of farmers, farm family members, and farmworkers.

This study aimed to fill a gap in the literature on the health of the farm population, particularly to estimate the prevalence of disability among farmers, farmworkers, farm family adults, and farm children. The ACS PUMS files (2008-2016) were used to calculate disability prevalence rates within the farm population and compare these rates to the range of estimates provided by Deboy et al. (2008). The assumption made by Deboy et al. (2008), which imposed the disability rate of the general population onto the farm population, was not far off from the disability estimates calculated in this study. The estimates they used (14.0% and 19.4) could be applied to the farm population for rough disability estimates.

The findings in this study indicated that the disability prevalence rate for the farm population was 12.9% (or 634,000 individuals out of 4.92 million). On average, 19.2% (or 395,000) of farmers and 9.0% (or 134,000) of farmworkers had a disability. By gender and race/ethnicity, it was found that female farmers and farmworkers had lower hearing difficulty prevalence rates and higher physical difficulty prevalence rates than male farmers and farmworkers. Among farm family members, farm family adults (age 18 and older)

had a 10.5% (or 90,000) disability rate, preschool-age farm children (age 5 and younger) had a 0.7% (or 900) disability rate, and school-age farm children (ages 6 to 17) had a 4.2% (or 16,000) disability rate.

The information provided in this study could potentially help with the education of AgrAbility extension agents, and other health practitioners involved in aiding disabled farmers to target the areas of greatest need, such as states with high percentages of disability or specific health difficulties. Focusing on the areas of greatest need or primary causes of disabilities could also aid in prevention efforts. This study could also help migrant-focused clinics understand the health issues in the migrant farmworker population. Finally, this study may help protect the health of farm children by providing information on the health difficulties and disabilities faced by farm children. The results of this study may help injury prevention efforts to ensure that farm youth perform age-appropriate tasks and provide information for farm parents to understand the level of risks for their children.

As is the case in most econometric models based on observational data, as opposed to controlled experiments, the possibility exists that the results presented in the probit regression models may be biased by the omission of important unobserved factors that are correlated with the variables included in the model. Another limitation of this study is the vagueness of the health limitation questions in the ACS. The health limitation questions are self-reported, not doctor-diagnosed, and are broad in scope. No health-related questions on national farm-specific surveys were found. No national agriculture injury data have been collected since NIOSH discontinued the Agriculture Injury Surveillance Study in 2015. Other than the Keokuk County Rural Health Study and the Agricultural Health Study, which are both small area studies, it is difficult to find data to answer questions about chronic health, health limitations, or disabilities among members of the farm population. Most national health surveys have small sample sizes and tend to lump the occupation of farming with forestry and fishing, while other national health surveys with robust health data tend to exclude the occupation codes.

Baseline estimates of disability in the farm population were provided in this study, but there are more questions to explore, such as conducting a study using longitudinal health survey data to follow the health of farmers over time to examine potential causal effects of increases in the likelihood of a disability.

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