

Methodologic Issues in Farm Injury Research

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Abstract

The hazards associated with farming have been well described for over 50 years in terms of the number of injuries. Despite this, there continue to be problems with interpretation of the patterns of injury and risk due to methodologic problems with the reported work. Specifically, use of denominators to clarify risk patterns are rare and sometimes not appropriate, definitions of farm work are usually absent, and coding on death certificate data is not adequate to identify farm work related injuries. Therefore, results of research cannot necessarily be compared. A number of researchers have worked to develop standard techniques for identification of farm or agricultural production work related injuries and to ensure use of appropriate denominators in the calculation of rates. The purpose of this paper is to discuss the methodologic issues, consequences of the choices researchers have made, and present information which will be useful in identifying methods which will allow comparisons of study results.

Introduction

The hazards associated with farming have been well described for over 50 years in terms of the number of injuries (Cogbill et al., 1985; Gordon et al., 1988; Simpson, 1984; Jones, 1990; McDermott et al., 1990; Demers et al., 1991; Saariet al., 1984; Hopkins, 1989; Cogbill et al., 1991; Calandruccio et al., 1949; Carlson et al., 1978; Cooper, 1969; Delzell et al., 1985; Gadalla, 1984; Goodman et al., 1985; Hatch et al., 1956; Hoskin et al., 1979; Huston et al., 1969; Jackson, 1983; Karlson et al., 1979; Kay, 1971; Knapp, 1966; Powers, 1939; Stallones et al., 1986). Farm injury research has been hampered by the lack of uniform definitions and classification schemes. Farms are places of business and residence (Murphy et al., 1990). Agriculture as an industry includes farm production work, agricultural services, and forestry. As an occupation, agriculture includes workers, owner/operators, managers and a host of other codes. Therefore, farm-related injuries and agricultural injuries are two overlapping, but not completely similar categories as occupational injuries. In addition, farms are places of residence and recreation. The farm-related home injuries and recreational injuries must be separated from the farm-work related injuries in order to present an accurate picture of the risks associated with working and living on a farm (Murphy et al., 1993). There is the additional complication of visitors and part time employees (Stallones, 1990). All of these issues give rise to a wide array of estimates of farm related injuries. Murphy et al. (1993) have published a detailed classification system to address these issues. The researchers must begin to clarify what is being presented when farm injuries are studied, in fact if work related injuries are the study interest, a different approach is needed from the assessment of all injuries which occur in a farm setting (Murphy, 1992). The classification of an "at work" injury death is done by coroners or medical examiners (Runyan et al., 1994). There are not consistent, standard definition which apply to worker, a job or being on the job (Runyan, et al., 1994). In fact, Runyan et al. (1994) found that among medical examiners, only 52 percent would classify the death of a 16 year old who suffocated in a grain bin while loading grain on a family farm as a work-related death. In addition, a man who worked part time as a house painter killed by a tractor roll-over on his farm while harvesting hay was only classified as a work-related death by 36 percent of the North Carolina medical examiners surveyed (Runyan et al., 1994).

Denominators

Estimates of the number of agricultural workers there are in the United States vary drastically. In 1980, Bureau of Labor Statistics estimate was 943,000 agricultural workers while the National Safety Council estimate was 3,300,000 (Kraus, 1985). In 1984, the census estimate of the farm population was 3,435,000 persons aged 14 years or older employed in agriculture (US Department of Commerce, 1984). The differences in estimates of the number of agricultural workers has a direct effect on the estimated rates of injuries occurring on farms. Care in the selection of numerators and denominators which have been collected by different agencies is required to avoid artificially high or artificially low estimates of farm related injury rates.

Large discrepancies with regard to denominators is in part the result of different definitions used for farmers and farmworkers. National Safety Council does not apply an age category to the definition of workers, nor is it clear what is the source of the denominator (NSC, 1993). US Census data are based on Census Occupational codes and include farming, forestry and fishery workers 16 years of age and older (US Census, 1990). Whitener (1984) identified the additional problem of the large proportion of seasonal and migrant workers involved. A significant proportion of farm workers were not involved in farm work during the month of March. Farm work was defined as on-farm wage or salary work associated with producing, harvesting, and delivering agricultural commodities or managing a farm but excluding work by farm operators, unpaid family members, machine custom work, nonfarm work done on a farm or work performed for pay-in-kind (Whitener, 1984). The 1980 Decennial Census data indicated 792,000 wage and salary workers from five agricultural occupations (managers of farms and horticultural specialty farms, supervisors of farm workers, farm workers, and nursery workers) (Whitener, 1984). The 1981 Hired Farm Working Survey indicated 818,000 hired farm workers employed in March, but a total of 2,210,000 total farm workers (Whitener, 1984). The seasonal nature of farm work influences the accuracy of the count of farm workers, with only one third of all workers employed between January and March when the census is taken (Whitener, 1984). In addition, those workers who are on the farm in March work significantly more days than the workers who are not employed that month (average 105 days for all workers, 218 days for March workers) (Whitener, 1984). These differences have implications for the estimates of risk of farm work related injuries as well, particularly when using number of people as a denominator. The inclusion of only those who worked exceptional hours in the estimate of risk will give a different pattern of injury risk when compared with using the person hours worked as a denominator.

Finally, the United States Census of the Population does count the number of farm residents. In 1980, detailed tables of the age-race-gender information were not made available for states by county and had to be purchased as a special tabulation (Stallones, 1990). Availability of data from the 1990 Census on CD-ROM alleviates this problem, but the information is difficult to extract and requires a special program because the detail is not available on the summary files. This is the only source of data for the farm population who are under 16 years of age. A great deal of interest is evident in the literature, given the number of published articles on farm injuries among children (Pollack, 1992; Tormoehlen, 1986; No author, 1988; Field et al., 1982; Doyle et al., 1989; Weiser, 1968; Grand; 1985; Rivara, 1985; Salmi et al., 1989; Stallones, 1989; Waller et al., 1989; Cogbill et al., 1985; Lucas, et al. 1963; Swanson et al., 1987; Stueland et al., 1991; Davies et al., 1988; Edmonson, 1987; Anderson et al., 1980; Brennan et al., 1990; Purschwitz, 1990; Stallones et al., 1993). Use of an inappropriate denominator will influence the estimate of rates per 100,000 for farm related boys injuries as well, as indicated by the results reported by Salmi et al. (1989) (2.3 among 0-4 years; 2.2 among 5-9 years) compared to others (Rivara, 1985) (14.9 for 0-4 years; 13.9 for 5-9 years) (Stallones, 1989) (14.8 for 0-4 years; 27.4 for 5-9 years). Salmi et al. (1989) used the rural resident population as the denominator for the injury rates. The rural resident population is much larger than the rural farm population and will consistently give an underestimate of injuries (Table 1).

Table 1 contains estimates of the number of farm workers from differing sources. Clearly the selection of a denominator will influence the rate of injury estimated for the population. In addition, the inclusion or exclusion of operators and family members has an influence on the actual counts of the agricultural working population. Also included in the table are the counts for the rural farm population and the rural nonfarm population. The use of rural farm and nonfarm combined as a denominator will lead to a gross underestimate of the risk of injuries among farm residents.

Numerators

Another issue in the evaluation of farm related injuries is the definitions which are used to identify the farm relatedness of an event. Based on death certificates only, there are several useful fields which may or may not be coded within a state. A place of occurrence code can be used with the ICDA external cause of death codes (E-codes) using a fifth digit sub-classification. There is also a field on the death certificate which may be coded separately. The choices are shown in Table 2. When the information is not detailed, coding can be ambiguous and the ability to determine the farm-relatedness of an injury is affected. For example, if a drowning occurs in a farm pond, but the information obtained is not specific for farm, than the death would be coded to the other specified places rather than a farm. Another example would be a death occurring while mowing the hedge row near the farm house. This might be coded as occurring on the home premises rather than on the farm. This may or may not be

viewed as a farm work related injury. Depending on the direction of the decisions, the rate of farm injuries can be increased or decreased.

Occupation and industry codes are also potentially useful in identifying farm related injuries, however are not uniformly available from state computer files. Since the occupation and industry which are coded are the usual occupation and industry, in areas where there is a large percentage of part-time farmers who have another primary occupation, this field will not give an accurate assessment of the magnitude of the problem.

The National Traumatic Occupational Fatality (NTOF) system was developed by the National Institute for Occupational Safety and Health (NIOSH) to monitor occupational fatalities (Murphy et al., 1990). The method for classification which is used to identify injuries is based on being coded as an at work injury, then the usual occupation and industry of the decedent (Murphy et al., 1990). Murphy et al. (1990) compared this classification scheme with one based on death certificates, a newspaper clipping service database and supplemental information obtained from next of kin in Pennsylvania. The investigators provided evidence of a 30 percent error in the NTOF method which resulted in a 20 percent undercount of agricultural work injury deaths and an overcount by the National Safety Council's system of approximately 35 percent (Murphy et al. 1990).

Results of such comparisons may differ from one state to another, being dependent on the proportion of part time farm operators within a state. For example, in Kentucky, a high percentage of farmers work at other occupations. In a detailed search of death certificates, a large percentage were not classified as at work (43 percent of farmers, 47 percent of farm workers, 61 percent of those with other occupations on the death certificate and 70 percent of students and family members) despite the fact that the description of the injury on the death certificate indicated a farm work related injury had occurred (Stallones, 1990). The error then will lead to an underestimate of the number of farm work related injuries which will be more significant in states where farm operators have multiple occupations. The most useful source of information in this study was the field which described how the injury occurred, but this information is not usually available from computer files and is only accessible through the hard copy of death certificates in most states.

Issues related to the definition of farm-relatedness are as similar when using medical records data as when using death certificates. The detailed information needed for assessing the injury episode rather than the type and significance of the injury may not be well documented. For this reason, the use of newspaper clippings, a traditional approach used by agricultural safety specialists, has been adopted by some investigators (Gunderson et al., 1990). Farm related trauma was defined as any injury occurring to individuals on any farm in Minnesota or any injury on a public road where farm equipment was involved (Gunderson et al., 1990). Limitations noted included the fact that only severe or catastrophic events were reported and data needed for research were not always included in the newspaper report (Gunderson et al., 1990). Not included in the discussion, but also a potential problem is the fact that two newspaper clipping services may actually obtain information on different groups of injuries, that is not all injuries found by one service will also be found by a different service.

Gunderson et al. (1990) reported that in Olmsted County, fewer than 5 percent of all farming-related injuries involved hospitalization, however 87 percent involved contact with a health care provider. These data indicate the need for surveillance mechanisms beyond hospital records to accurately count the number of nonfatal injuries which occur. Gunderson et al. (1990) reviewed reports based on data from the Occupational Safety and Health Administration (OSHA) and Workers' Compensation records and concluded that due to the fact that farmers are self-employed and frequently hire fewer than 11 employees, the majority of US farms would be excluded from a count of these records.

The Ninth Revision of the International Classification of Diseases-Adapted (ICDA) codes offer little assistance in the classification of farm related injuries. Codes are available for injuries where agricultural machines are involved, but these are only identifiable when the E-codes are used. In fact, many E-codes are involved when an injury occurs on a farm including the codes for falls, slips and trips, burn, drowning, fractures, carbon monoxide or other utility gas, excessive heat or cold, being struck by objects, injuries from electrical current, and injuries from firearms. In order for the injury to be identified as farm-related other information must be available (e.g., where the injury occurred, details about circumstances of the injury). In Kentucky, all death certificates which contained an E-code were hand searched to identify farm-related and farm-work related deaths (Stallones, 1990). A total of 17,821 records were searched for the period 1979-1985 (Stallones, 1990). In that survey, the distribution of ICDA Ninth

Revision codes was as shown in Table 3. Table 4 contains the same distribution for children under age 15 years of age who died from unintentional injuries on farms in Kentucky from 1979–1985 (Stallones, 1989). Table 5 contains the same ICDA code distribution for nonfatal work related injuries which occurred on farms in Colorado in 1993 based on a telephone survey being conducted among farm families in that state. While differences in the overall distributions are evident comparing fatal and nonfatal injuries and injuries occurring to children and adults, overall a wide variation in the ICDA codes is represented and the selection of the most important codes to identify farm injuries is complex.

Conclusions

Perhaps the most important issues to resolve in farm related injury research are those of definitions. The most critical are the separation of injuries to family members and operators who are injured in the course of daily activities unrelated to agricultural production. This will help in the selection of an appropriate denominator for a given study. The separation of farm residents from workers is critical for the evaluation of occupational related farm injuries as compared to injuries which occur on a farm related to home or leisure activities. Children at young ages (5–6 years) do work on farms and therefore should be included in evaluating work related injuries when appropriate. They can also be injured bystanders in the work setting and this also needs to be evaluated, but separated from those injuries which occur while a child is actually doing the work. These same circumstances apply to visitors to farms who may have an injury but will never be counted in the available denominators. The inclusion of this group will tend to inflate the estimates of injury risk to workers.

Finally, a uniform definition of a farm needs to be developed and applied by researchers. Census farm resident populations are self defined. The Census of Agriculture defines a farm as a place where in a normal year, \$1,000 in agricultural produce is sold. If there are major discrepancies in the self defined farm population and the specific definition used by the Census of Agriculture enumerators, there is no valid way to compare the results of studies using the two data sources. This has not been examined in detail and has implications for expanding to international comparisons of farm injuries. This issue has particular significance for countries where subsistence agriculture is the norm and \$1,000 in sales is not a normal year, but rather an abnormally high sales year for a small farmer.

The separation of farm workers from other workers who have been included in the classification (forest and fishery workers) will help in the clarification of the population at risk. The identification of individuals who live on farm separately from those who are employed on farms will also improve the estimate of the risk of farm work as distinct from farm living injury risk. This applies to the classification of both numerators and denominators. The use of person hours worked as a denominator may assist researchers in better understanding the magnitude of risk on farms, since the work hours vary widely from one season to another. In addition, a pressing question is whether there are different risks with different types of farming, as has been shown in a few studies (Gadalla, 1962; Stallones, 1990). The collection and presentation of injuries by type of agricultural production is important for evaluating injury risk.

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Table 1: Number of Agricultural Workers by Source of Data

<u>Source of Data</u>	<u>Year</u>	<u>Number</u>
National Safety Council ¹	1992	3,200,000
Census of Agriculture ²	1982*	4,855,857
Bureau of Labor Statistics ³	1992	3,207,000
US Census Summary ⁴	1990	2,839,010
Hired Farm Worker Survey ⁵	1981	2,210,000
Rural farm residents ⁶	1990	3,871,583
Rural nonfarm residents ⁶	1990	57,786,747

¹Includes all persons gainfully employed, including owners, managers, other paid employees, the self-employed, and unpaid family workers, but excludes private household workers (NSC, 1993).

²Most recent estimate available because 1987 Census of Agriculture eliminated the number of hired farm and ranch workers (Census of Agriculture, 1987, A-2 Appendix A).

³Employed civilians 16 years of age and older (BLS, 1993).

⁴Available on CD-ROM 1990 Census Summary, includes farming, forestry and fishing occupations, employed persons 16 years and over.

⁵Interim Census of workers age not specified, not operators of farms (Whitener, 1984).

⁶Available on CD-ROM 1990 Census Summary Tape File 3C

Table 2: Place of Occurrence of Injury Codes

Home	Apartment, Boarding house, Farm house Home premises, House, Noninstitutional place of residence, Private (driveway to home, garage, garden to home, walk to home), swimming pool in private house or yard, yard to home Excludes: home under construction but not yet occupied; institutional place of residence
Farm	Buildings, land under cultivation Excludes: farm house and home premises of farm
Mine and quarry	Gravel pit, sand pit, tunnel under construction
Industrial place and premises	Building under construction, dockyard, factory, garage etc.
Place of recreation/sport etc.	Amusement park, Baseball field, Basketball court, Beach resort
Street/highway	
Public building	Airport, bank, cafe, post office etc. Excludes: home garage, industrial building or workplace
Residential Institution	Children's home, dormitory, hospital, prison, old people's home, orphanage, prison, reform school
Other specified places	Beach, canal, caravan site, derelict house, desert, dock, forest, pond or pool (natural), prairie, river, stream, sea, lake, mountain, parking lot, parking place etc.

Table 3: On-farm unintentional injury deaths in Kentucky by ICDA code, 1979–1985*

<u>ICDA Ninth Revision</u>	<u>Number</u>	<u>Percent</u>
E810–E819: Motor Vehicle Traffic	35	6.5
E820–E825: Motor Vehicle Nontraffic	15	2.8
E826–E829: Other Road Vehicle	5	0.9
E830–E838: Water Transport	3	0.5
E860–E869: Accidental poisoning by other solid and liquid substances, gases and vapors	9	1.7
E880–E888: Accidental falls	25	4.7
E890–E899: Accidents caused by fire and flames	65	12.1
E900–E909: Accidents due to natural and environmental factors	20	3.7
E910–E915: Accidents caused by submersion, suffocation and foreign bodies	51	9.5
E919.0: Agricultural equipment	198	37.0
E916–E928: Other accidents, excluding E919.0	109	20.4
TOTAL	535	99.8

*Note: this includes all deaths on Kentucky farms without regard to work-relatedness. This also represents unintentional deaths and those for which intent had not been determined.

Table 4: On-farm unintentional injury deaths among children under 15 years of age in Kentucky by ICDA code, 1979–1985*

<u>ICDA Ninth Revision</u>	<u>Number</u>	<u>Percent</u>
E810–E819: Motor Vehicle Traffic	1	2.1
E820–E825: Motor Vehicle Nontraffic	5	10.4
E826–E829: Other Road Vehicle	2	4.2
E830–E838: Water Transport	1	2.1
E860–E869: Accidental poisoning by other solid and liquid substances, gases and vapors	0	0.0
E880–E888: Accidental falls	0	0.0
E890–E899: Accidents caused by fire and flames	1	2.1
E900–E909: Accidents due to natural and environmental factors	0	0.0
E910–E915: Accidents caused by submersion, suffocation and foreign bodies	14	29.2
E916–E928: Other accidents	24	50.0
TOTAL	48	100.1

*Note: this includes all deaths on Kentucky farms without regard to work-relatedness. This also represents unintentional deaths and those for which intent had not been determined.

Table 5: On-farm unintentional work related injuries in Colorado by ICDA code, 1993

<u>ICDA Ninth Revision</u>	<u>Number</u>	<u>Percent</u>
E810–E819: Motor Vehicle Traffic	0	0.0
E820–E825: Motor Vehicle Nontraffic	1	1.3
E826–E829: Other Road Vehicle	5	6.3
E830–E838: Water Transport	0	0.0
E860–E869: Accidental poisoning by other solid and liquid substances, gases and vapors	2	2.6
E880–E888: Accidental falls	14	17.5
E890–E899: Accidents caused by fire and flames	0	0.0
E900–E909: Accidents due to natural and environmental factors	11	13.7
E910–E915: Accidents caused by submersion, suffocation and foreign bodies	0	0.0
E919.0: Agricultural equipment	5	6.2
E916–E928: Other accidents, excluding E919.0	42	52.5
TOTAL	80	100.1