
Chronic Disease and Injury in an Agricultural County: The Keokuk County Rural Health Cohort Study

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ABSTRACT: *The Keokuk County Rural Health Study (KCRHS) was designed as a 20-year, prospective cohort study focusing on chronic disease and injury in an agricultural southeastern Iowa county. The goals of the KCRHS are to prospectively describe, measure, and analyze prevalent rural and agriculturally related adverse health outcomes and their respective risk factors and to provide the basis for future community-based intervention programs to reduce disease and injury incidence. Methods of data collection included in-person interviews, medical screenings, and environmental assessments of homes and farms. All households studied were rural; comparisons were made among farm, rural nonfarm, and town households, between men and women, and between smokers and nonsmokers. The present paper reports selected adult baseline data from Round 1 of this study. Residents of farm households were somewhat younger and better educated than residents of rural nonfarm and town households; smoked less; were more likely to have ridden an all-terrain vehicle; and were more likely to report firearms in the home. Eighty-nine percent of the men and 66% of the women engaged in farming or did so in the past. Men more often reported hearing loss, were more often overweight and obese, more often reported an injury, less often reported asthma, and less often saw a medical practitioner. Women reported poorer emotional health and higher rates of depression symptoms. The KCRHS has identified several modifiable health outcomes and risk factors as candidates for further analysis and targets for community-based prevention and intervention programs.*

Geographically defined community-based cohort studies have greatly advanced our understanding of chronic disease (Berkman & Syme, 1979; Dawber, 1980; Heyden et al., 1971; Higgins & Keller, 1970; Menkes et al., 1986; Pearson & Lewis, 1998; Samet & Muñoz, 1998). They have also provided epidemiological models upon which community-based prevention programs can be built. However, no previous commu-

nity-based cohort study has focused exclusively on farming in a rural community.

There are numerous compelling reasons to study the health of rural populations. A quarter of the U.S. population lives in rural areas (Hewitt, 1992). A higher proportion of poor people live in rural areas (Rowland & Lyons, 1989); they are more often Medicare-dependent but otherwise less often have health insurance (Straub & Walzer, 1992). Rural residents also

have less access to education, social services, and health care than nonrural residents (Gesler et al., 1992; Hicks, 1992; Mansfield et al., 1999).

Rural residents are at higher risk for a number of preventable injuries, with a 50% higher mortality rate for unintentional injuries than residents in large urban areas (Baker et al., 1992), two-thirds of which are related to motor vehicle crashes (Baker et al., 1992; Maio et al., 1992). Rural residents also face increased injury risk from residential fires, suicide, unintentional firearm deaths, and occupational injuries (Baker et al., 1992). They more often work in small businesses and in mining and agriculture, all recognized to have higher rates of traumatic injuries (Myers, 1990). Although farming-related injury mortality rates have decreased over the last decade, farming, mining, and construction remain the most dangerous occupations (Institute of Medicine Committee to Assess Training Needs for Occupational Safety and Health Personnel in the United States, 2000).

Rural residents, especially women, suffer from high rates of depression (Coryell et al., 1992), and farmers have higher rates of depression and suicide, especially firearm-related suicide (Armstrong & Schulman, 1990; Gunderson et al., 1993; Lorenz et al., 1993; Zwerling et al., 1993). Farmers are at increased risk for chronic respiratory disease (American Thoracic Society, 1998); noise-induced hearing loss (Beckett et al., 2000); degenerative joint disease (Thelin, 1990); and dermatoses (Susitaival et al., 1995). Higher rates of selected cancers, birth defects, and Parkinson's disease associated with agricultural work and rural living have also been observed (Blair & Zahm, 1991; Engel et al., 2000; Gorell et al., 1998). However, these multiple studies relating agricultural work and adverse health effects have been mainly cross-sectional in design and have examined male farmers almost exclusively. There is little health outcome or risk factor information regarding rural cohorts, especially for farm women and children who share farm work and its risks (Rivara, 1997).

The Keokuk County Rural Health Study (KCRHS) was designed with three primary goals: (a) to measure rural and agricultural adverse health and injury outcomes and their respective risk factors; (b) to design and conduct nested case-control studies and multivariable analyses to define determinants of health and injury outcomes; and (c) to provide a basis for the future design, implementation, and evaluation of community-based intervention programs to reduce disease and injury incidence. Health outcomes of particular interest include injury, respiratory disease, mental

health, and hearing loss and their respective environmental and other risk factors.

Methods

The present paper reports the methodology used and selected adult baseline data collected in Round 1, which began in June 1994 and ended in February 1998. Between the end of Round 1 and the present, investigators verified the data, conducted data analyses, reported selected results to the community, and began Round 2 data collection, which is ongoing.

Population. Keokuk County was chosen because it is entirely rural (no town over 2,500); is agriculturally typical of the state of Iowa; has no history of other university studies; and because the community responded to inquiries and visits with enthusiasm. The county's population was 11,624 (Goudy & Burke, 1991). The largest town and county seat, Sigourney, had a population of 2,111. Twenty-eight percent of county residents were age 19 and under, whereas nearly 21% were age 65 and over. The median age was 37.2 years. Nearly 77% of adults over the age of 25 were high school graduates. Per capita income in 1990 was \$15,373, and 71% of the housing units were owner-occupied. Of the families with children under 18 years of age, 14.9% met the poverty level. The minority population of the county was less than 1%. The county covers 579.2 square miles, or 370,688 acres, of which 87% was farmland. In 1990, there were 1,060 farms in the county, averaging 336 acres per farm and worth \$1,065 per acre (United States Department of Agriculture, 2000). Types of farms included those individually or family-operated (82.1%), partnership (11.7%), and other (6.2%). Principal crops were corn, soybeans, oats, and hay; livestock included mainly hogs, cattle, and sheep.

Response Rate and External Validity. The University of Iowa Institutional Review Board expressed concern about the burden this comprehensive, prospective study would place on participating households. Households were, therefore, sent an initial letter with options of participating immediately, participating at a later date, or declining to participate at any time. Those not responding by mail were subsequently telephoned (a few were visited by staff) to ascertain whether the household members would participate in the study. Of the 2,496 eligible households, 67.1% agreed to participate immediately or be contacted to

participate at a later date, 31.3% refused to participate, and 1.6% were undecided. We stopped enrolling households in the study when we had obtained the sample of 1,000 households that was our goal, although up to that time 1,052 had agreed to participate. To evaluate whether there were any systematic differences between participant and nonparticipant households, 200 randomly selected households that had refused to participate in the study (100 with rural addresses and 100 with town addresses) were given a telephone-administered questionnaire and compared with the households that did participate (see Selected Results). Although the entire county is "rural" by the U.S. Census definition—no town with a population greater than 2,500—some county residents live in small towns.

Sampling. Because assessment of health outcomes and their relationships with agricultural and rural environmental exposures was a major goal of the study, the household was determined to be the most appropriate sampling unit. Every person, related or unrelated, living in a randomly selected household was defined as eligible for the study. Since the primary interest was in agriculturally related health outcomes, farm households were oversampled. Of the 4,573 households in Keokuk County, 1,030 (23%) were farm; 2,947 (64%) were town; and 596 (13%) were rural nonfarm households. The prestudy goal was to choose a stratified random sample of 400 farm households, 300 town households, and 300 rural nonfarm households: 22% of all households in the county. The stratum-specific sample sizes were based on detection of anticipated differences between farmers and nonfarmers, divided into those living in towns and those living in rural (nontown) areas. The sample size computations reduced the usual alpha of 0.05 to 0.01 to accommodate multiple comparisons, with a power to detect assumed differences to be at least 0.80. The sample size computation was based on the assumption that the prevalence of bronchitis (a primary health outcome of interest) in farmers is 20% compared to 10% in nonfarmers. If so, the sample of 374 individuals in each group would allow detection of this difference with a power of 0.80. The number was increased to 400 farm families and decreased to 300 in the other two strata to allow an oversampling of farm families.

Individuals living within the same household are not independent with respect to living (and farm) environment, health beliefs, and practices. Hence the effective sample size may be somewhat larger than 300 or 400 per stratum, but such an increase cannot be as-

sumed until within-household correlation coefficients are computed to estimate the design effect. Importantly, the above sample-size computations were based on the household as the sampling unit, as several analyses were based on only one individual per household, who, for example, reported household income and educational level. Other analyses used the individual as the unit of analysis. Each individual household member, for example, reported on their own health status. In the end, the sample consisted of 341 farm households (34%), 202 rural nonfarm households (20%), and 461 town households (46%).

Constructing a Sampling Frame. A sampling frame of the county was compiled using the following sources: a state Department of Transportation listing of all registered owners of motor vehicles; a purchased list of heads of households compiled from 19 sources, including voter registration lists, birth records, telephone directories, and county records; area telephone directories; and the county plat book. After merging the lists and deleting duplicates, we interviewed postmasters, town clerks, town and county officials, volunteer firefighters, grain elevator operators, and local school officials to identify individuals who had recently moved into or out of the county. This resulted in a substantially complete census of county households. A computer-generated list of random numbers was then used to select households to recruit for participation.

Research Facility. To collect and secure survey data, to increase the project's visibility, to encourage a sense of ownership and loyalty among county residents, and to convey a long-term commitment, a storefront on

This research was supported by grant U07/CCU 706145 from the National Institute for Occupational Safety and Health to the Great Plains Center for Agricultural Health, College of Public Health, The University of Iowa. The authors thank Beth Henning, Diana Serterth, Jill Moore, Ann Yeoman, Craig Taylor, LaMar Grafft, Mary Lewis, Erik Svendsen, Matt Nonnemann, and Beth Croteau for their assistance with data collection and management; Naomi Tucker and Sarah Merchant for their assistance with recruitment of subjects and numerous other tasks; Fang Qian for her assistance with data analysis; Evie Richardson for her secretarial help; and Kathryn Andrews for her assistance in preparing the manuscript. We thank Craig Downing and the KCRHS Community Advisory Committee for their support, advice, and wisdom. For further information, contact: Ann M. Stromquist, Ph.D., Department of Occupational and Environmental Health, College of Public Health, 208 IREH, The University of Iowa, Iowa City, IA 52242. e-mail ann-stromquist@uiowa.edu. More information about the Keokuk County Rural Health Study also can be found on our web site: www.kcrhs.org.

the town square of the county seat was leased and renovated. The facility consists of four soundproof interview and exam rooms, a medical laboratory, an office, a staff break room, a restroom, and a reception area. The facility accommodates four to five staff members and two to three research subjects at one time.

Partnership With the Community—Community Advisory Committee. A countywide community advisory committee (CAC), broadly representative of the townships and occupations in the county, was formed at the time the study was being designed. This 32-person CAC, which meets two to four times a year, participated in designing the approach to the community, the content of the research protocol, recruitment of subjects, a strategy for communicating with subject families and their health care providers, and provided community feedback on results. The CAC helped ensure ongoing positive relationships among all involved in the study and contributed to a sense of ownership by community residents.

Human Subjects Review. The University of Iowa Institutional Review Board approved the study, including all instruments and procedures, initially and annually for the duration of the study. Adult participants gave their informed consent, and children ages 8 to 17 years gave their assent. In addition, a legally authorized representative (usually a parent) of each child participant gave informed consent.

Incentives. For their time and to offset their travel expenses, households were offered \$50 if all members of the household completed all parts of the study and \$30 if not all household members participated or if not all parts of the study were completed. A "Certificate of Participation," documenting each household member's date of participation, was given to each participating household.

Study Protocol and Instruments. Medical protocols and all questionnaires were pretested, revised, and documented in protocol notebooks, together with quality assurance and control measures for each (see our web site, www.kcrhs.org, for a complete list of data modules).

Questionnaires. Questionnaires were developed primarily from well-documented national surveys including the National Health Interview Survey, the Third National Health and Nutrition Examination Survey, the American Thoracic Society respiratory question-

naire, the Centers for Disease Control and Prevention (CDC) Behavioral Risk Factor Surveillance System, the CDC Injury Control and Risk Survey, and other published questionnaires. Utilizing direct computer entry, in-person interviews with adults, adolescents, and a parent or guardian of each child participant were completed by a single trained interviewer, except when absent because of vacation or illness. (See definitions of selected health outcomes on our Web site, www.kcrhs.org.)

Environmental Assessments. To the extent possible, environmental assessment questionnaires and protocols utilized previously evaluated items and procedures. All instruments were peer reviewed, pilot tested, and revised and then pilot tested again before adoption. Questionnaires were administered in person by an industrial hygienist to an adult, usually the head of household, followed by environmental observations and measurements using direct reading instruments. (See a complete list of environmental measures, included in the list of types of data collected by the study, on our web site, www.kcrhs.org.)

Job History and Occupational Survey. Adult participants listed all full or part-time jobs held since the age of 12 and completed a more detailed questionnaire about job tasks, hobbies, and agricultural and occupational exposures.

Data Collection. Baseline data collection (Round 1) began in June 1994 and ended in February 1998. Round 2 data collection began April 1999 and is ongoing.

Statistical Methods and Analyses. As stratified random sampling was utilized in the study, all statistical analyses were consistent with this sample design. All countywide estimates and standard errors incorporated stratum weights. To account for the complex sampling design, Survey Data Analysis (SUDAAN; Shah et al., 1997) was utilized for all estimates based on more than one individual per sampled household. Statistical Analysis System (SAS Institute, Inc., 1989) procedures were utilized for analyses of characteristics based on only one individual per household, such as head of household. Variables were defined to assess the influence of residential strata (town, rural non-farm, or farm household); farming (currently farming or ever farmed); gender; and smoking, ever smoked, and never smoked, on several health outcomes. Age-adjusted odds ratios and their confidence intervals were computed using multiple logistic regression within the SUDAAN program.

Selected Results

Survey of Nonparticipant Households. To assess whether this sample was representative of the county, a postenumeration survey of 200 randomly selected nonparticipant households (100 town and 100 rural non-town) was conducted, and nonparticipant households were compared to participant households. The KCRHS and the nonparticipant samples were similar with the exception of a higher level of education in the KCRHS households (92.9% had at least one person who was a high school graduate compared with 88.5% of the nonparticipant households). The KCRHS sample contained slightly fewer persons (2.5 vs. 2.8) and slightly fewer adults per household. The KCRHS sample contained adult women who were somewhat younger (52.3 vs. 54.3 years). Some of these statistically significant differences are likely attributable to oversampling of farms in the KCRHS cohort. The results of this comparison show substantial concordance between the study participant and nonparticipant households.

Household Demographics. In general, farm households had higher incomes and their members had a higher level of education than did rural nonfarm and town households. More town households (24.7%) had household incomes below \$20,000 than did rural nonfarm (15.0%) or farm (8.8%) households. Rural nonfarm households more often rented their homes (13.6% compared to 6.5% of farm and 7.0% of town households) and less often reported having any health insurance (90.9%, compared to 94.9% of farm and 95.6% of town households). Farm household members (48.6%) more often had some college education than rural nonfarm (46.7%) or town (45.7%) households.

The following results are for adults in the sample only.

Individual Demographics. Nearly 90% of farm household women currently (57.6%) or previously (31.4%) farmed, and nearly all farm household men currently (94.8%) or previously (4.8%) farmed (Table 1). Importantly, nearly 60% of rural nonfarm women and 88.8% of rural nonfarm men and 46.9% of town women and 77% of town men currently farmed or had previously farmed. Farm men and women were somewhat younger, whereas town men and women were both older than their counterparts. Farm women were more often college graduates (21.1%), whereas farm men (9.8%) were less often college graduates than their rural nonfarm and town counterparts. (Other sociodemo-

graphic characteristics such as marital status, religious preference, and ethnicity are listed in Table 1.)

Smoking and Alcohol Use. The rates of current smoking among farm women (10.2%) and men (11.4%) were low (Table 2). Few differences among household groups were reported in rates of ever drinking alcohol, but significant differences were observed for men (CAGE score 2 to 4, odds ratio [OR] = 2.52; CAGE score 3 to 4, OR = 3.85) and those who had ever smoked (CAGE score 2 to 4; OR = 3.26; CAGE score 3 to 4, OR = 6.37). Men (OR = 2.79) and those who ever smoked (OR = 2.46) were more likely to be binge drinkers.

General Health. High proportions (above 85%) of all three household groups reported their general health to be good to excellent (Table 3). However, those who ever smoked were less likely to report good to excellent health (OR = 0.51). Similarly, high proportions of all household groups reported their eyesight was good to excellent, but those who had ever smoked were less likely to report good to excellent vision (OR = 0.54). Differences were reported between men and women regarding perceived hearing loss, with men in all three residential groups less likely to report good to excellent hearing than women (OR = 0.30), and those who ever smoked also less likely to report good to excellent hearing (OR = 0.81). Men were more likely to be overweight and obese (OR = 1.65), whereas those who had ever smoked were less likely to be obese (OR = 0.71) but were more likely to have a health problem that limited work (OR = 1.42). Fewer men than women in all residential groups reported seeing a medical practitioner in the last year (OR = 0.58).

Respiratory Symptoms. In general, smoking history and gender were more closely associated with respiratory symptoms than was place of residence (Table 4). Those who had ever smoked were more likely to have respiratory symptoms: usual cough (OR = 2.0), usual phlegm (OR = 2.07), and wheeze with a cold (OR = 2.10) or without a cold (OR = 2.54). Men in all three residential groups were more likely to have higher rates of respiratory symptoms than women, significantly so for usual phlegm (OR = 1.68). However, men in all three residential groups were less likely than women to report attacks of wheezing with shortness of breath (OR = 0.56), a history of asthma (OR = 0.52), and a doctor diagnosis of asthma (OR = 0.50).

Table 1. Sociodemographic Characteristics of Study Subjects by Residence Type and Gender, Keokuk County, Iowa, Keokuk County Rural Health Study, 1994–1998.

	Farm		Rural/Nonfarm		Town	
	Women	Men	Women	Men	Women	Men
History of farming						
Sample sizes	283	290	168	133	388	287
Never (%)	10.9	0.3	40.5	11.3	53.1	23.0
In the past (%)	31.4	4.8	43.5	45.9	42.5	56.2
Current (%)	57.6	94.8	16.1	42.9	4.4	20.8
Age cohorts						
Sample sizes	287	291	184	143	417	317
18–39 (%)	27.2	24.0	29.4	25.2	23.5	24.0
40–64 (%)	50.8	53.0	45.7	49.7	44.8	44.2
65+ (%)	22.0	23.0	25.0	25.2	31.6	31.9
Highest Educational level						
Sample sizes	284	290	182	140	415	315
High school graduate (%)	96.1	93.4	92.9	84.3	88.7	86.7
College graduate (%)	21.1	9.8	14.8	12.1	15.4	12.7
Aggregated marital status						
Sample sizes	285	290	182	141	417	315
Married now (%)	86.7	79.0	79.1	82.3	67.2	79.0
Widowed (%)	7.0	3.4	11.5	2.1	17.8	4.8
Divorced/separated (%)	0.4	7.0	4.4	7.1	7.7	3.2
Other (%)	6.0	10.1	5.0	8.5	7.4	13.0
Self-reported ethnicity						
Sample sizes	284	287	181	139	414	313
Central Europe (%)	57.4	62.4	48.1	51.8	48.8	52.1
British Isles (%)	22.2	18.5	24.9	28.1	27.5	24.6
American Indian (%)	1.8	1.4	5.5	2.2	3.9	1.6
Other (%)	11.3	8.0	12.2	8.6	11.1	9.5
Don't know (%)	7.4	9.8	9.4	9.4	8.7	12.8
Religious preference						
Sample sizes	285	290	182	141	471	315
None (%)	1.4	3.8	5.0	8.5	4.1	6.0
Protestant (%)	60.7	56.6	69.8	61.0	69.3	65.7
Catholic (%)	35.4	36.4	23.1	27.0	22.3	22.9
Other (%)	2.5	3.1	2.2	3.5	4.3	5.4

Injury and Risk Behaviors for Injury. Residents of farm households and men reported more risk behaviors associated with injury (Table 5). Men were more likely than women to report an injury in the last year (OR = 1.16). Farm household members were less likely to always wear seat belts (OR = 0.75), accounted for entirely by farm men (OR = 0.30). Farm household residents (OR = 3.87), rural household residents (OR = 1.72), those who had ever farmed (OR = 2.39), and

men (OR = 3.21) were more likely to have ridden an all-terrain vehicle in the last year. Farm residents (OR = 2.98), rural nonfarm residents (OR = 2.43), and men (OR = 1.79) were more likely to report any firearms in their home or vehicles.

Mental Health. Although few differences were observed among residential groups on all measures of mental health, gender differences were marked

Table 2. Smoking and Alcohol Use by Residence Type and Gender, Odds Ratios (ORs), and 95% Confidence Intervals (CIs) for Potential Risk Factors Associated With Smoking and Alcohol Use, Keokuk County, Iowa, Keokuk County Rural Health Study, 1994–1998.

	Rural/Nonfarm				Town		Logistic Regression: OR (95% CI)					
	Farm		Men		Women	Men	Ever Smoked	Ever Farmed	Farm Residence	Rural Residence	Men	
	Women	Men	Women	Men	Women	Men	Age					
Ever smoked cigarettes?												
Sample sizes	285	289	182	141	417	316						
Yes (%)	21.0	38.8	31.9	61.0	36.0	59.5	1.01 (1.00, 1.01)	0.63 (0.46, 0.84)	0.51 (0.39, 0.67)	0.98 (0.72, 1.33)	3.06 (2.42, 3.87)	
Smoking history												
Sample sizes	285	289	182	140	417	315						
Never (%)	79.0	61.2	68.1	39.3	64.0	40.6						
In the past (%)	10.9	27.3	13.7	37.9	19.9	39.0						
Current (%)	10.2	11.4	18.1	22.9	16.1	20.3						
Ever drink alcoholic beverages												
Sample sizes	285	290	182	140	417	317						
Yes (%)	60.7	78.6	63.7	72.9	58.8	69.1	0.95 (0.94, 0.96)	1.17 (0.85, 1.62)	1.21 (0.89, 1.65)	1.12 (0.77, 1.64)	1.50 (1.17, 1.92)	
CAGE* score of 2, 3, or 4												
Sample sizes	283	287	178	139	413	314						
Yes (%)	6.4	13.9	8.4	20.9	8.7	19.8	0.97 (0.95, 0.98)	0.74 (0.48, 1.13)	0.88 (0.58, 1.34)	1.09 (0.70, 1.72)	2.52 (1.77, 3.59)	
CAGE* score of 3 or 4												
Sample sizes	283	287	178	139	413	314						
Yes (%)	0.7	3.8	2.2	10.8	2.2	7.6	0.97 (0.95, 0.99)	0.60 (0.31, 1.14)	0.64 (0.31, 1.32)	1.33 (0.70, 2.52)	3.85 (1.96, 7.58)	
Binge drinking?												
Sample sizes	285	290	182	138	417	316						
Yes (%)	9.1	28.0	9.9	22.5	11.0	24.7	0.93 (0.92, 0.94)	1.53 (0.98, 2.38)	1.00 (0.69, 1.47)	0.81 (0.51, 1.29)	2.79 (2.06, 3.78)	

* CAGE (Mayfield et al., 1974).

Table 3. Health Status by Residence Type and Gender, Odds Ratios (ORs), and 95% Confidence Intervals (CIs) for Potential Risk Factors Associated With Health Status, Keokuk County, Iowa, Keokuk County Rural Health Study, 1994–1998.

	Farm						Rural/Nonfarm			Town			Logistic Regression: OR (95% CI)					
	Women		Men		Women		Men		Women		Men		Age	Ever Smoked	Ever Farmed	Farm Residence	Rural Residence	Men
	Sample sizes	%	Sample sizes	%	Sample sizes	%	Sample sizes	%	Sample sizes	%	OR	95% CI						
Health in general?																		
Sample sizes	284	290	181	141	417	316												
Fair/poor (%)	10.6	8.6	11.6	13.5	14.9	13.6												
Excellent to good (%)	89.4	91.4	88.4	86.5	85.1	86.4						0.96	0.51	1.21	1.10	1.00	1.19	(0.82, 1.73)
Eyesight?																		
Sample sizes	285	290	181	141	417	316												
Fair/poor (%)	5.3	7.9	9.4	9.2	10.3	12.7						0.96	0.54	1.32	1.30	1.18	0.77	(0.50, 1.21)
Excellent to good (%)	94.7	92.1	90.6	90.8	89.7	87.3						(0.95, 0.98)	(0.36, 0.80)	(0.81, 2.14)	(0.85, 2.00)	(0.72, 1.93)	(0.50, 1.21)	
Hearing?																		
Sample sizes	285	290	181	141	416	316												
Fair/poor (%)	9.5	31.0	12.7	27.7	14.7	33.2						0.96	0.81	1.19	1.04	1.22	0.30	(0.21, 0.41)
Excellent to good (%)	90.5	69.0	87.3	72.3	85.3	66.8						(0.96, 0.97)	(0.60, 1.09)	(0.82, 1.72)	(0.75, 1.42)	(0.85, 1.75)	(0.21, 0.41)	
Body Mass Index																		
Sample sizes	281	290	178	138	401	304												
<25 BMI	32.4	25.0	30.9	16.7	29.9	21.4												
25.9 to <30 BMI (overweight)	32.4	39.2	30.9	44.2	34.4	42.8												
30 and over BMI (obese)	35.2	35.8	38.2	39.1	35.7	35.9						1.01	0.87	0.97	0.88	1.18	1.65	(1.25, 2.16)
Overweight + obese												(1.01, 1.02)	(0.66, 1.14)	(0.71, 1.32)	(0.66, 1.17)	(0.83, 1.69)	(1.25, 2.16)	
Obese only												1.00	0.71	1.03	0.90	1.18	1.11	(0.88, 1.40)
Obese only																		
Obese only												(0.99, 1.01)	(0.56, 0.90)	(0.77, 1.39)	(0.77, 1.39)	(0.86, 1.61)	(0.88, 1.40)	
Health problem that limits work?																		
Sample sizes	283	290	179	139	412	314												
Yes (%)	26.5	29.3	23.5	25.9	33.5	34.1						1.05	1.42	0.81	1.01	0.73	1.04	(0.80, 1.36)
												(1.04, 1.06)	(1.08, 1.88)	(0.59, 1.12)	(0.76, 1.35)	(0.51, 1.04)	(0.80, 1.36)	
Seen medical practitioner in last year?																		
Sample sizes	285	290	181	141	417	316												
Yes (%)	91.2	83.1	89.0	85.1	91.4	85.4						1.02	0.91	1.08	0.89	0.85	0.58	(0.41, 0.84)
												(1.01, 1.03)	(0.64, 1.29)	(0.70, 1.66)	(0.60, 1.32)	(0.56, 1.30)	(0.41, 0.84)	

Table 4. Respiratory Symptoms by Residence Type and Gender, Odds Ratios (ORs), and 95% Confidence Intervals (CIs) for Potential Risk Factors Associated With Respiratory Symptoms, Keokuk County, Iowa, Keokuk County Rural Health Study, 1994–1998.

	Farm				Rural/Nonfarm				Town				Logistic Regression: OR (95% CI)									
	Women		Men		Women		Men		Women		Men		Ever Smoked		Ever Farmed		Farm Residence		Rural Residence		Men	
	Sample sizes	Yes (%)	Sample sizes	Yes (%)	Sample sizes	Yes (%)	Sample sizes	Yes (%)	Sample sizes	Yes (%)	Sample sizes	Yes (%)	Sample sizes	Yes (%)	Sample sizes	Yes (%)	Sample sizes	Yes (%)	Sample sizes	Yes (%)	Sample sizes	Yes (%)
Usually have a cough?																						
Sample sizes																						
Yes (%)																						
Usually bring up phlegm from chest?																						
Sample sizes																						
Yes (%)																						
Chest wheeze with cold?																						
Sample sizes																						
Yes (%)																						
Chest wheeze without cold?																						
Sample sizes																						
Yes (%)																						
Attack of wheezing/short of breath?																						
Sample sizes																						
Yes (%)																						
Ever had asthma?																						
Sample sizes																						
Yes (%)																						
Asthma confirmed by doctor?																						
Sample sizes																						
Yes (%)																						

Table 5. Injury and Injury Risk Behaviors by Residence Type and Gender, Odds Ratios (ORs), and 95% Confidence Intervals (CIs) for Potential Risk Factors Associated With Injury and Injury Risk Behaviors, Keokuk County, Iowa, Keokuk County Rural Health Study, 1994-1998.

	Farm		Rural/Nonfarm		Town		Logistic Regression: OR (95% CI)					
	Women	Men	Women	Men	Women	Men	Age	Ever Smoked	Ever Farmed	Farm Residence	Rural Residence	Men
	Sample sizes Yes (%)											
Injury past year?												
Sample sizes	284	290	182	141	418	316						
Yes (%)	19.7	29.7	22.0	27.7	21.8	23.1	0.97 (0.97, 0.98)	1.13 (0.86, 1.49)	1.14 (0.80, 1.62)	1.06 (0.79, 1.42)	0.98 (0.70, 1.38)	1.16 (0.89, 1.52)
Ridden bike outside in the past 12 months?												
Sample sizes	284	290	182	141	413	316						
Yes (%)	32.2	31.7	37.0	34.8	38.5	44.0	0.96 (0.95, 0.97)	0.77 (0.57, 1.00)	1.02 (0.75, 1.38)	0.53 (0.39, 0.72)	0.72 (0.51, 1.01)	1.30 (1.02, 1.64)
Always use seat belts?												
Sample sizes	277	287	173	139	400	311						
Yes (%)	70.0	74.4	70.5	67.4	56.3	43.7	1.02 (1.01, 1.03)	0.94 (0.69, 1.21)	0.94 (0.69, 1.28)	0.75 (0.57, 0.99)	0.97 (0.71, 1.32)	0.30 (0.24, 0.38)
Ridden motorcycle/moped in the past year?												
Sample sizes	283	298	182	141	416	317						
Yes (%)	7.8	18.8	6.0	15.0	9.2	17.4	0.96 (0.94, 0.97)	1.14 (0.80, 1.63)	0.86 (0.55, 1.36)	0.99 (0.65, 1.51)	0.80 (0.49, 1.32)	2.30 (1.70, 3.10)
Ridden ATV in the past year?												
Sample sizes	282	286	182	139	416	317						
Yes (%)	31.6	54.9	15.9	28.8	6.2	23.0	0.95 (0.94, 0.96)	0.94 (0.70, 1.26)	2.39 (1.56, 3.67)	3.87 (2.71, 5.54)	1.72 (1.10, 2.70)	3.21 (2.51, 4.10)
Any firearms in home, on your property, or in your vehicle?												
Sample sizes	280	287	181	141	413	316						
Yes (%)	86.10	87.15	79.00	84.40	59.10	73.70	0.99 (0.98, 1.00)	0.88 (0.66, 1.18)	1.01 (0.74, 1.39)	2.98 (2.07, 4.32)	2.43 (1.60, 3.70)	1.79 (1.38, 2.32)

(Table 6). Men were more likely than women to report excellent to good emotional health (OR = 2.08), whereas those men and women who had ever smoked were less likely to report good to excellent emotional health (OR = 0.42). Women reported higher rates of depression symptoms, with men less likely to report depression symptoms (OR = 0.55) and having less often been treated for depression (OR = 0.46). Those who had ever smoked were more likely to have been treated for depression (OR = 1.47) and had more often reported thoughts of taking their own life (OR = 1.72).

Discussion

A very high proportion of men and a substantial proportion of women in all household groups were found to be currently engaged in farming or had done so in the past. Therefore, systematic assessment of the role of farm living and farmwork is highly relevant in this rural cohort. In addition, several adverse health and injury outcomes and risk factors were observed in this study. Evidence of excesses in injury and chronic disease mortality in rural areas has been documented over the last three decades, as have clear excesses in agriculturally related injuries and diseases (American Thoracic Society, 1998; Armstrong & Schulman, 1990; Beckett et al., 2000; Blair & Zahm, 1991; Engel et al., 2000; Gorell et al. 1998; Gunderson et al., 1993; Lorenz et al., 1993; Thelin, 1990; Susitaival et al., 1995; Zwerling et al., 1993). Although the number of farmers has declined over time, agriculture continues to play a dominant role in rural America. It is, therefore, surprising that there are no prospective cohort studies that have examined the role of agricultural and other rural risk factors in prevalent injury and disease outcomes.

The KCRHS was designed to study a large, representative sample of rural households in order to assess agricultural and rural risk factors and injury and health outcomes common on farms and in rural communities. Limitations of the study include a participation rate that was less than hoped for; however, the sample was large and differed little from a sample of nonparticipating households. Therefore, selection is not believed to be a limitation in this study. Although the study was designed to compare farm, rural nonfarm, and town households, it became clear that a very high proportion of all household groups (especially men) had current or past farming exposures.

The pervasiveness of farm exposures, therefore, diminished the opportunity to detect differences among household groups for chronic health outcomes related to farming. The finding of such differences was likely further limited by the movement of older and more infirm residents from the farm into rural or town households, a phenomenon suggested by the fact that farm residents were younger and in better general health than rural nonfarm and town residents. For some health outcomes, a third limitation is the confounding effect of a lower rate of cigarette smoking among farm households, probably due to a tradition of less smoking in farm households, but also to the selection of smokers with adverse health outcomes away from the rigors and respiratory exposures of farming.

As documented in numerous other population-based studies, a history of cigarette smoking has been found to be highly associated with a perception of poor general health (Gold et al., 1996; Kind et al., 1998). Of interest, smoking was also associated with perception of poor eyesight, a finding consistent with studies that have documented higher rates of cataract and macular degeneration among those who have smoked (Christen et al., 1992; Klein et al., 1998). Men, especially those with a history of smoking, were also much more likely to drink alcohol to excess, a finding consistent with other population-based studies (Cruickshanks et al., 1998; Dawson, 2000).

Noise-induced hearing loss among farmers with exposures to multiple types of farm machinery, livestock, and firearms is well documented (Beckett et al., 2000). Given the pervasive history of farm exposures among the men in the KCRHS, it is therefore not surprising that men reported fair to poor hearing two to three times as often as women. As reported elsewhere, a history of smoking also appears to contribute to hearing loss (Cruickshanks et al., 1998).

Measured body mass index (BMI) in this rural cohort found both men and women to be more obese than statewide self-reported rates of obese adults (Mokdad et al., 1999). Using data from NHANES II, Sobal et al. (1996) found that rural White men and women were more often overweight and extremely overweight than their urban counterparts and demonstrated that these differences can be largely explained by differences in demographic factors such as age and education (for women) and age and marital status (for men). A study of 965 rural Wisconsin residents found that between 1992 and 1997 the percentage of overweight and obesity increased from 51% to 75% for women and from 75% to 92% for men (Rothacker & Blackburn, 2000). There is a need to further investigate

Table 6. Mental Health Status by Residence Type and Gender, Odds Ratios (ORs), and 95% Confidence Intervals (CIs) for Potential Risk Factors Associated With Mental Health Status, Keokuk County, Iowa, Keokuk County Rural Health Study, 1994–1998.

	Farm				Rural/Nonfarm				Town				Logistic Regression: OR (95% CI)										
	Women		Men		Women		Men		Women		Men		Ever Smoked		Ever Farmed		Farm Residence		Rural Residence		Men		
	Sample sizes	Yes (%)	Sample sizes	Yes (%)	Sample sizes	Yes (%)	Sample sizes	Yes (%)	Sample sizes	Yes (%)	Sample sizes	Yes (%)	Sample sizes	Yes (%)	Sample sizes	Yes (%)	Sample sizes	Yes (%)	Sample sizes	Yes (%)	Sample sizes	Yes (%)	
Emotional health?																							
Sample sizes	285	290	180	141	417	315																	
Fair/poor (%)	10.5	8.6	13.9	12.8	14.2	7.8																	
Excellent to good (%)	89.5	91.4	86.1	87.2	86.8	92.2																	
Depression score* ≥8																							
Sample sizes	283	286	182	140	413	311																	
Yes (%)	19.8	15.4	26.9	17.9	28.3	18.3																	
Ever treated by a doctor for depression?																							
Sample sizes	285	290	182	141	415	316																	
Yes (%)	19.0	8.6	22.5	11.4	18.5	10.7																	
Thoughts of taking own life during the past year?																							
Sample sizes	285	290	182	141	415	316																	
Yes (%)	6.7	7.6	8.8	8.5	9.2	8.2																	

* From abbreviated (11-item) CES-D scale (Radloff, 1977; Wallace & O'Hara, 1992).

this striking phenomenon of obesity and its effect on the health and well-being of rural Americans. We have added a new module on dietary history to Round 2 in order to do this.

The increase in respiratory symptoms, especially bronchitis (chronic phlegm), among men and smokers in this study is consistent with findings from studies of farmers exposed to grain dust, livestock facilities, and agricultural chemicals—all common exposures among farmers in Keokuk County. Despite a large number of studies documenting increased prevalence of bronchitis, airway obstruction, and progressive declines in lung function among farmers, relatively few farmers have adopted prevention measures involving improved ventilation and the use of personal protective equipment (Reynolds et al., 1998). An interesting finding, especially because of the high proportion of men who had current or past farming exposures, was the significantly lower prevalence of asthma among men in all household groups. It has been observed that men who develop asthma on the farm often select themselves out of farming and other agricultural jobs that involve exposure to organic dusts and other respiratory irritants (Merchant & Reynolds, 1999). As there are very few jobs in Keokuk County that do not involve such exposures, one possible explanation for this finding is that there may have been a systematic selection of asthmatic men out of this agricultural county. Differential use of health care between men and women, and thus a possible reporting bias, is another possible explanation for the lower prevalence of asthma among men.

Although Cole (1993) noted the high prevalence of injury-related behavioral risk factors among rural populations, to our knowledge the KCRHS is the first study to describe the distribution of risky behaviors across different segments of a rural population. We found that some high-risk behaviors were unequally distributed across the community. For example, farm men, especially older farm men, were much less likely to use seatbelts all of the time than other members of the rural community (Zwerling et al., 2001). Farmers were also more than twice as likely as other community members to have ridden all-terrain vehicles in the last year, a pattern suggesting that farmers use all-terrain vehicles for farm work while other rural residents use them for recreation. We found that farm and non-farm residents were more likely than town residents to have firearms in their homes and, as reported elsewhere (Nordstrom et al., 2001), farmers were about twice as likely as townspeople to have loaded guns in their homes. These loaded firearms are a particular

concern because farmers have been reported to have high rates of depression (Roberts & Lee, 1993; Scarth et al., 2000) and because of the association between suicide and the presence of firearms in the home (Brent et al., 1991; Cummings et al., 1997; Kellermann et al., 1992).

Rates of depression, the major risk factor for suicide, are increasing worldwide (Weissman et al., 1996). Typically, high levels of depressive symptomatology (20%) and lower levels of depressive disorders (3% for men, 4 to 9% among women) are found in population-based studies (Wagenfeld et al., 1994). There is little agreement, however, about the relative risk of depression between urban and rural residents, in part because the definition of "rural" is not consistent across studies (Robins & Regier, 1991). However, studies conducted since the farm crisis of the 1980s indicate that farmers have higher levels of depression than non-farmers, particularly those farmers who report a higher debt-to-asset ratio and economic hardship (Armstrong & Schulman, 1990; Lorenz et al., 1993). Most prevalence studies have found that rates of depression among women are twice as high as among men (Coryell 1992; Leon et al., 1993; Weissman et al., 1996). We found that household type and history of farming were not associated with depressive symptoms or lifetime history of treatment for depression. However, women were much more likely than men to report symptoms of depression, and twice as many women as men reported having been treated for depression. Rates of suicidal ideation were high (about 8% overall), but no differences were observed among household types or by gender.

The KCRHS has identified several modifiable health outcomes (injuries, respiratory disease, depression, obesity, hearing loss) and risk factors (smoking, alcohol abuse, firearm access, seat belt and all-terrain vehicle use) as candidates for further analysis and targets for community-based prevention programs. These results document significant differences in prevalent adverse health and injury outcomes and risk factors in a single rural county and underscore both the importance of and opportunity for developing community-based intervention models in rural America.

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