Diagnosed Skin Diseases Among Migrant Farmworkers in North Carolina: Prevalence and Risk Factors

T. A. Arcury, S. R. Feldman, M. R. Schulz, Q. Vallejos, A. Verma, A. B. Fleischer, Jr., S. R. Rapp, S. F. Davis, J. S. Preisser, S. A. Quandt

ABSTRACT. *Skin diseases are common among farmworkers, yet little research documents their prevalence and risk factors. This analysis documents the prevalence of skin diseases among farmworkers in North Carolina, examines variation in the prevalence across the agricultural season, and delineates factors associated with skin disease. Data are from a longitudinal surveillance study with assessments at approximately three-week intervals from May through October 2005. The sample included 304 farmworkers from 45 camps with 1048 data points. Data collection included a structured interview and a standard set of ten digital photographs. A board-certified dermatologist reviewed the photographs and made specific diagnoses in five categories: inflammatory disease, infection, pigmentary disorder, tumor, and trauma. The prevalences of the five skin disease categories and specific diagnoses are described with counts and frequencies for the entire season and for six time periods. The inflammatory disease and infectious disease categories are modeled with an extension of logistic regression that accounts for repeated measures and clustering of farmworkers within camps. Farmworkers experience high levels of inflammatory skin disease (57.2%) including acne, folliculitis, and contact dermatitis; infectious skin disease (73.8%) including tinea pedis, onychomycosis, and warts; pigmentary disorders (19.1%); and trauma (34.5%). The odds of inflammatory skin disease decreased with age, while those for infectious skin disease increased with age. The odds of inflammatory skin disease increased with pesticide exposure and decreasing housing quality. Skin diseases are highly prevalent among farmworkers. Research is needed to delineate specific factors causing high levels of infection and inflammation in this population.*

Keywords. *Farmworkers, Latino, Migrant and seasonal, Prevalence, Skin disease.*

Submitted for review in February 2007 as manuscript number JASH 6876; approved for publication by the Journal of Agricultural Safety and Health of ASABE in June 2007.

The authors are **Thomas A. Arcury,** PhD, Professor and Research Director, Department of Family and Community Medicine, and **Steven R. Feldman,** MD, PhD, Professor, Department of Dermatology, Wake Forest University School of Medicine, Winston-Salem, North Carolina; **Mark R. Schulz,** PhD, Assistant Professor, Department of Public Health Education, University of North Carolina, Greensboro, North Carolina; **Quirina Vallejos,** MPH, Research Associate, Department of Family and Community Medicine, Wake Forest University School of Medicine, Winston-Salem, North Carolina; **Amit Verma,** MPH, Research Assistant, Department of Public Health Education, University of North Carolina, Greensboro, North Carolina; **Alan B. Fleischer, Jr.,** MD, Professor, Departments of Dermatology and Pathology, and **Stephen R. Rapp,** PhD, Professor, Department of Psychiatry and Behavioral Medicine, Wake Forest University School of Medicine, Winston-Salem, North Carolina; **Steven F. Davis,** BS, Farmworker Outreach Director, East Carolina Community Health Centers, Greene County Health Care, Inc., Snow Hill, North Carolina; **John S Preisser,** PhD, Associate Professor, Department of Biostatistics, School of Public Health, University of North Carolina, Chapel Hill, North Carolina; and **Sara A. Quandt,** PhD, Professor, Department of Epidemiology and Prevention, Division of Public Health, Wake Forest University School of Medicine, Winston-Salem, North Carolina. **Corresponding author:** Thomas A. Arcury, Department of Family and Community Medicine, Wake Forest University School of Medicine, Medical Center Blvd., Winston-Salem, NC 27157-1084; phone: 336-716-9438; fax: 336-716-3206; e-mail: tarcury@wfubmc.edu.

Skin diseases are common among all agricultural workers, particularly migrant and seasonal farmworkers (Hogan and Lane, 1986; O'Malley and Mathias, 1988; Villarejo and Baron, 1999; Krejci-Manwaring et al., 2006). The Bureau of Labor Statistics (2006) reported that while the 2005 incidence of skin disease among all private industry workers was 4.4 per 10,000, it was 16.5 per 10,000 workers employed in crop production. Suspected causes of skin diseases among agricultural workers include physical hazards; exposure to pesticides, fertilizers, and other chemicals; exposure to sun, sensitivity to plant materials, and infectious agents (Hogan and Lane, 1986; Villarejo and Baron, 1999). In addition to being one component of poor health, skin disease reduces general quality of life and affects the ability of farmworkers to work (Quandt et al., in press). However, epidemiological research on the prevalence of skin disease or its risk factors among agricultural workers is rare (Villarejo and Baron, 1999).

Four published epidemiological studies document dermatological disorders among farmworkers. McCurdy et al. (1989) found that 46% of a sample of 226 California farmworkers reported a skin rash within the previous three months. When performing "waist-up" exams, 2% of the farmworkers had irritant or contact dermatitis. Gamsky et al. (1992) found that 12% of 759 California farmworkers reported a skin rash in the past year, with "waist-up" exams showing that 2% had contact dermatitis and 13% had lichenified hand dermatitis. Arcury et al. (2003) found that 24% of 293 North Carolina farmworkers in early season and 37% in late season reported itching or burning skin or skin rash during the previous two months. For a sample of 59 North Carolina farmworkers who were examined by a dermatologist during the 2004 agricultural season, Krejci-Manwaring et al. (2006) reported that 42 of 54 men (77.7%) and all five women examined had a diagnosed skin disease. For the men, 31.5% had onychomycosis, 27.8% had tinea pedis, 24.1% had acne, and 5.6 % had contact dermatitis. Of these analyses, only Arcury et al. (2003) found predictors significantly associated with a skin disorder, including harvesting blueberries, not having a work contract, not showering after work, and age 25-34 years (vs. age >34 years).

This analysis first documents the prevalence of skin diseases common among migrant farmworkers in North Carolina. Second, it examines variations in the prevalence of common skin diseases among migrant farmworkers across the agricultural season. Third, it delineates occupational and environmental factors associated with skin diseases common among migrant farmworkers.

Methods

Data are from a longitudinal surveillance study of skin disease prevalence and risk factors among migrant farmworkers in eastern North Carolina. Data collection included baseline and up to four follow-up assessments at approximately three-week intervals from May through October 2005.

Sample

The sample was selected from among farmworkers employed in a nine-county area of eastern North Carolina served by two migrant clinics and one farmworker service agency. Counties included Edgecombe, Greene, Harnett, Johnston, Lenoir, Sampson, Nash, Pitt, and Wilson. Sample selection proceeded in two stages. First, farmworker residential sites (camps) served by each clinic/agency were randomly listed. Interviewers visited residential sites for each clinic/agency in random order until 15 inhabited sites were found in which the residents agreed to participate (total of 45 sites). Thirty-three residential sites were uninhabited at the recruitment visit, and the residents at one

inhabited site refused to participate. A census was taken at all sites where residents gave preliminary consent to participate in the study. Second, farmworkers residing in each site were recruited from the census lists; up to seven participants were recruited at each site (sites often had fewer than seven residents).

Initially, 242 farmworkers were recruited (table 1). Individual participants were replaced at the first through third follow-up interviews if other site residents indicated that the workers had permanently left the area. Participants who were not available for a specific follow-up interview, but who had not left the area, were maintained in the sample and contacted at the next follow-up interview. Substantial effort was made to maintain the participation of all farmworkers recruited to the study. Follow-up interviews could be completed within a five-day window that included the period of two days before and two days after the three-week anniversary of the previous interview. Interviewers made several visits to each site, if needed, to contact a participant for a follow-up interview.

The total sample included 304 farmworkers (300 Latino men, 4 Latina women) from 45 camps with a total of 1048 data points (table 1). Loss to follow-up across the data collection period is consistent with other longitudinal research with migrant farmworker populations (Quandt et al., 2002).

Data Collection

Data collection included an interviewer-administered questionnaire and a standard set of ten digital photographs. The questionnaire was developed in English and translated into Spanish by a professional translator who was a native Spanish speaker familiar with Mexican Spanish. The questionnaire was reviewed by three other native Mexican Spanish speakers familiar with farmworkers and pre-tested with five Latino farmworkers. Based on the review and pretest, the questionnaire wording was modified. The interview questionnaire included items addressing demographic and background information, as well as current work and living conditions. The ten digital photographs taken of each participant included one view of the face with the participant holding an ID number, one frontal view of the face, two profiles of the face, frontal and dorsal views of the torso and arms, palmar and dorsal surfaces of the hands, and plantar and dorsal surfaces of the feet. Photos were taken with an image size of 2592 × 1944 pixels and a FINE image quality setting (compression to 1/4 of the original size). Images were stored as JPEG files on a secure HIPAA-compliant server housed at Wake Forest University Baptist Medical Center. Participants received a cash incentive of $10 at each interview and a hat with an occupational health message at their initial interview. Data collection procedures were reviewed and approved by the Wake Forest University School of Medicine Institutional Review Board.

Measures

The outcome measures for this analysis were the presence of diagnosed skin diseases. A single board-certified dermatologist (SRF) viewed and rated the photo sets, recording

Table 1. Number of participants and number of data points in sample.

	Number of Data Points					
Participants	1	2	3	4	5	Total
Initial participants	57	19	34	13	119	242
Replacement participants	11	14	5	10	22	62
Total participants	68	33	39	23	141	304
Total data points	68	66	117	92	705	1048

diagnoses and severity scores on a standardized form. The form listed diagnoses, which were grouped into five categories: inflammatory disease, infection, pigmentary disorder, tumor, and trauma. While this process is consistent with standard telemedicine diagnostic procedures (Krupinski et al., 1999; Tang et al., 2005), it is limited due the lack of standardized case definitions or laboratory tests to confirm and differentiate dermatologic diagnoses.

Dichotomous measures of each major category of skin disease (inflammatory disease, infection, pigmentary disorder, tumor, and trauma) and each specific skin disease or injury were constructed for each participant over the entire data collection period and at each interview. Specific skin disease by major category included the inflammatory diseases acne and folliculitis, contact dermatitis, and other inflammatory diseases; the infectious diseases tinea pedis, onychomycosis, warts, pitted keratolysis, and other infectious diseases; the pigmentary disorders post-inflammatory changes, melasma, and other pigmentary disorders; tumors; and traumatic skin lesion, traumatic nail lesion, scars, bug bites, callus, and other trauma. Two measures of the trauma category were constructed: the first measure, used only for descriptive analysis, included diagnoses of scars and calluses, and the second, used in descriptive and multivariate analysis, excluded these diagnoses. The severity of trauma was not assessed, although it had to be sufficiently severe to be detectable by examination of the digital images.

Predictors included time period as well as personal, work, hygiene, camp, and environmental characteristics. The growing season was divided into six periods of approximately three weeks each (period 1 = 29 May to 19 June, period 2 = 20 June to 10 July, period 3 = 11 July to 31 July, period 4 = 1 Aug. to 21 Aug., period 5 = 22 Aug. to 10 Sept., period 6 = 11 Sept. to 12 Oct.). Defining the periods in this way did not result in any farmworker having two interviews within a single period. Personal characteristics were age (18-24 years, 25-30 years, 31-40 years, 41 years and older), highest level of education completed (0-6 years, 7-9 years, 10 years or higher), history of asthma or hay fever (dichotomous), and possession of an H2A visa (dichotomous). An H2A visa allows an individual to enter the U.S. to work in agriculture for a specified period of time for a particular farmer.

Work, hygiene, camp, and environmental characteristics were based on participants' self-reports for the week before each interview and could vary for each time period. The first work characteristic (hours worked in tobacco) was categorized into three levels (0 hours, 1-40 hours, greater than 40 hours). The other work characteristics (worked in wet shoes or clothes, wore a rain suit, sat in fencerows, worked in or adjacent to fields with a pesticide application) are dichotomous measures indicating whether each behavior or event occurred at least once in the week before the interview. The two hygiene characteristics were the average time the participant waited to shower after work (0-10, 10.1-20, 20.1-30, 30.1-60, and greater than 60 minutes) and whether there was a clothes washing machine in the camp (dichotomous). The camp characteristic was a housing index based on adding the scores of three variables: persons per showerhead (1, 2, 3, 4 or more), persons per sleeping room (1, 2, 3, 4 or more), and an air conditioner in the sleeping room (yes = 1, no = 4). Air conditioning was given a weight of 4 so that the absence of air conditioning in the sleeping room was weighted equal to the worst crowding categories for bathing and sleeping. The housing index could have a value of 3 (best condition) to 12 (worst condition) and was divided into four categories (3-6, 7-8, 9-10, 11-12). The environmental characteristic was the average temperature (°C) for the previous seven days divided into three categories ($\leq$25 °C, >25.01 °C and <26.5 °C, and >26.5 °C); temperature data were obtained from regional weather stations.

Table 2. Personal characteristics of farmworkers, eastern North Carolina, 2005 (n = 304).

Personal Characteristics		N	%
Age	18 to 24 years	79	26.0
	25 to 30 years	69	22.7
	31 to 40 years	104	34.2
	41 years and older	52	17.1
Educational attainment	0 to 6 years	184	60.5
	7 to 9 years	85	28.0
	10 or more years	35	11.5
Seasons in U.S. agriculture	1 year or less	69	22.7
	2 to 3 years	82	27.1
	4 to 7 years	77	25.4
	8 or more years	75	24.8
H2A visa	Yes	191	62.8
	No	113	37.2
Hay fever or asthma		44	14.5

Analysis

The prevalences of the five skin disease categories and specific diagnoses within each category were described with counts and frequencies for the season as a whole (per the 304 farmworkers in the sample) and for each time period (per the number of farmworkers interviewed in the respective period). Dichotomous outcomes for any inflammatory disease and any infection were analyzed as a function of independent variables for personal, work, hygiene, camp, and environmental characteristics with logistic models (tumors and pigmentary disorders were not modeled because of the small number of diagnoses). The modeling process for inflammatory and infectious diseases included examining bivariate associations for categorical variables and checking linear associations for continuous variables. Next, an initial model was constructed that included period and age of covariates, as reported in table 2. Since age was the dominant predictor in the initial models for inflammatory and infectious skin diseases, the initial models were reduced by eliminating one by one the covariates whose subtraction from the model did not change the association between age and outcome by more than 20%. The regression coefficients (and their standard errors) in these multivariate logistic regression models were determined with the alternating logistic regressions estimation procedure (Carey et al., 1993) to account for the typically correlated multiple observations from the same farmworker, as well as possibly correlated multiple observations from farmworkers employed at the same camp. Multivariate adjusted prevalence odds ratios (OR) and their 95% confidence intervals (CI) were determined in the usual way, by exponentiation of the log odds ratios from the multivariate logistic regressions. The magnitude of the clustering of the skin disorder outcomes within farmworkers and between farmworkers within camps was estimated with pairwise odds ratios (Preisser et al., 2003). The descriptive analyses used SPSS version 14.0 (SPSS, Inc., Chicago, Ill.), and the alternating logistic regressions used SAS version 9.1 (SAS Institute, Inc., Cary, N.C.).

Results

Participant personal characteristics are described in table 2. Participant work, hygiene, camp and environment characteristics across the six periods of the agricultural season are described in table 3.

Table 3. Work, hygiene, camp, and environment characteristics of farmworkers by data collection period, eastern North Carolina, 2005.

	Period[a]											
	1 (*N* =141)		2 (*N* = 187)		3 (*N* = 226)		4 (*N* = 199)		5 (*N* = 187)		6 (*N* = 95)	
Characteristics	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Work												
Hours worked in tobacco												
0 hours	99	70.2	73	39.0	19	8.4	14	7.0	10	5.3	20	21.0
1 to 40 hours	29	20.6	37	19.8	59	26.1	71	35.7	42	22.5	17	17.9
>40 hours	13	9.2	77	41.2	148	65.5	114	57.3	135	72.2	58	61.1
Work in wet shoes or clothes	46	32.6	72	38.5	133	58.8	119	59.8	98	52.4	45	47.4
Wore rain suit	6	4.3	14	7.5	36	15.9	37	18.6	38	20.3	17	17.9
Wore gloves	23	16.3	53	28.3	50	22.1	30	15.1	32	17.1	28	29.5
Sat in fencerows	52	36.9	101	54.0	130	57.5	83	41.7	80	42.8	24	25.3
Worked in or next to fields with pesticide application	27	19.1	64	34.2	93	41.2	32	16.1	10	5.3	5	5.3
Hygiene												
Average time waited to shower after work												
0-10 minutes	28	19.9	40	21.4	43	19.0	35	17.6	36	19.3	16	16.8
10.1-20 minutes	35	24.8	46	24.6	53	23.5	47	23.6	50	26.7	26	27.4
20.1-30 minutes	25	17.7	34	18.2	51	22.6	47	23.6	31	16.6	22	23.2
30.1-60 minutes	30	21.3	46	24.6	54	23.9	49	24.6	45	24.1	20	21.1
>60 minutes	19	13.5	21	11.2	24	10.6	20	10.1	23	12.3	10	10.5
Missing	4	2.8			1	0.4	1	0.5	2	1.1	1	1.0
Machine wash in camp	75	53.2	107	57.2	131	58.0	119	59.8	125	66.8	48	50.5
Camp (housing index)												
6 or less (best)	33	23.4	23	12.6	13	5.8	13	6.5	13	7.0	11	11.6
7-8	46	32.6	58	31.7	88	38.9	89	44.7	91	48.7	33	34.7
9-10	29	20.6	50	27.3	34	15.0	38	19.1	23	12.3	19	20.0
11-12 (worst)	33	23.4	52	28.4	91	40.3	59	29.6	60	32.1	32	33.7
Environment (average temp.)												
25°C or lower	57	45.6	20	10.7	0	0	0	0	53	28.3	46	48.4
25.01°C to 26.49°C	68	54.4	147	78.6	118	52.2	179	89.9	119	63.6	44	46.3
26.5°C or higher	0	0	20	10.7	108	47.8	20	10.1	15	8.0	5	5.3

[a] Period 1 = 29 May to 19 June, period 2 = 20 June to 10 July, period 3 = 11 July to 31 July, period 4 = 1 Aug. to 21 Aug., period 5 = 22 Aug. to 10 Sept., period 6 = 11 Sept. to 12 Oct.

Almost three-fifths (57.2%) of the farmworkers had an inflammatory skin disease during the agricultural season (table 4). This ranged from 29.1% during period 1 to 36.8% during period 6. Acne and folliculitis was the most common inflammatory diagnosis; 47.7% of the farmworkers had this diagnosis during the agricultural season. Acne and folliculitis were diagnosed for 25% to 30% of workers at each time period. Contact dermatitis was diagnosed for 12.2% of the farmworkers, and increased from 2.1% in period 1 to 5.3% in periods 5 and 6. No individual with psoriasis was identified in this population.

Over three-quarters (78.3%) of the farmworkers had a diagnosed infectious skin disease during the agricultural season. Tinea pedis (67.8%) was the most common infectious disease diagnosis, followed by onychomycosis (46.1%). The prevalence of tinea pedis varied slightly across the agricultural season, from 48.9% during period 1, to

Table 4. Season-wide and period prevalence of major categories and specific types of skin diseases among migrant farmworkers, eastern North Carolina, 2005.

			Period[a]											
	Total[b] (*N* = 304)		1 (*N* = 141)		2 (*N* = 187)		3 (*N* = 226)		4 (*N* = 199)		5 (*N* = 187)		6 (*N* = 95)	
Skin Diseases	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Inflammatory diseases	174	57.2	41	29.1	58	31.0	74	32.7	60	30.2	66	35.3	35	36.8
Acne and folliculitis	145	47.7	39	27.7	47	25.1	63	27.9	52	26.1	58	31.0	28	29.5
Contact dermatitis	37	12.2	3	2.1	7	3.7	8	3.5	6	3.0	10	5.3	5	5.3
Other[c]	20	6.6	0	0	6	3.2	5	2.2	4	2.0	2	1.1	4	4.2
Infectious diseases	238	78.3	82	58.2	105	56.1	129	57.1	116	58.3	112	59.9	64	67.4
Tinea pedis	206	67.8	69	48.9	80	42.8	93	41.2	86	43.2	86	46.0	50	52.6
Onychomycosis	140	46.1	38	27.0	58	31.0	71	31.4	64	32.2	67	35.8	38	40.0
Warts	33	10.9	6	4.3	9	4.8	13	5.8	8	4.0	5	2.7	3	3.2
Pitted keratolysis	15	4.9	1	0.7	2	1.1	10	4.4	5	2.5	1	0.5	0	0
Other[d]	12	3.8	4	2.8	2	1.1	4	1.8	3	1.5	5	2.7	1	1.1
Pigmentary disorders	58	19.1	11	7.8	25	13.4	34	15.0	17	8.5	16	8.6	6	6.3
Post-inflammatory changes	15	4.9	1	0.7	3	1.6	8	3.5	2	1.0	2	1.1	0	0
Melasma	43	14.1	9	6.4	22	11.8	26	11.5	14	7.0	14	7.5	6	6.3
Other[e]	3	1.0	1	0.7	1	0.5	2	0.9	3	1.5	1	0.5	0	0
Tumors[f]	7	2.3	0	0	1	0.5	2	0.9	2	1.0	1	0.5	1	1.1
Trauma	187	61.5	59	41.8	70	37.4	79	35.0	80	40.2	74	39.6	48	50.5
Trauma, excluding scars and callus	105	34.5	24	17.0	27	14.4	26	11.5	36	18.1	34	18.2	22	23.2
Traumatic skin lesions	51	16.8	10	7.1	11	5.9	6	2.7	12	6.0	12	6.4	7	7.4
Traumatic nail lesions	54	17.8	15	10.6	12	6.4	19	8.4	23	11.6	23	12.3	14	14.7
Scars	137	45.1	44	31.2	54	28.9	57	25.2	51	25.6	44	23.5	31	32.6
Bug bites	14	4.6	0	0	4	2.1	2	0.9	4	2.0	1	0.5	3	3.2
Callus	15	4.9	1	0.7	4	2.1	5	2.2	4	2.0	7	3.7	1	1.1
Other[g]	7	2.3	1	0.7	3	1.6	2	0.9	1	0.5	1	0.5	0	0

[a] Period 1 = 29 May to 19 June, period 2 = 20 June to 10 July, period 3 = 11 July to 31 July, period 4 = 1 Aug. to 21 Aug., period 5 = 22 Aug. to 10 Sept., period 6 = 11 Sept. to 12 Oct.
[b] Participants diagnosed with the same skin disease in different periods are only counted once.
[c] Includes atopic dermatitis, seborrheic dermatitis, stasis dermatitis, psoriasis, and keratoderma.
[d] Includes tinea versicolor, molluscum, impetigo, and scabies.
[e] Includes vitiligo.
[f] Includes melanoma, non-melanoma skin cancer, and other malignancy or premalignancy.
[g] Includes sunburn and other burns.

about 43% in periods 2 through 4, to 46.0% in period 5 and 52.6% in period 6. The prevalence of onychomycosis increased across the season, from 27.0% in period 1 to 40.0% in period 6. Diagnoses of warts (10.9%) and pitted keratolysis (4.9%) were common among farmworkers across the agricultural season. Three or four percent of the workers had warts in each period. Pitted keratolysis increased from 0.7% in period 1 to 4.4% in period 3 and decreased to none in period 6.

Pigmentary disorders were diagnosed for 19.1% of the farmworkers, with the percentage increasing from 7.8% in period 1 to 15.0% in period 3 and decreasing to 6.3% in period 6. Melasma was the most prevalent pigmentary disorder, being diagnosed in 14.1% of the farmworkers, while post-inflammatory changes were diagnosed for 4.9% of the workers. Prevalence for each of the specific pigmentary disorders increased from period 1 to periods 2 and 3, and then declined over periods 4 to 6.

Tumors were rare among the participants. Seven participants (2.3%) were diagnosed with any type of tumor across the agricultural season, and only one or two farmworkers were diagnosed with a tumor for any period.

Over one-third (34.5%) of the farmworkers were diagnosed with a skin trauma across the agricultural season when scars and calluses were excluded, and 61.5% were diagnosed with a skin trauma when scars and calluses were included. Traumatic skin lesions (16.8%) and nail lesions (17.8%) were commonly diagnosed. Traumatic skin lesions decreased from being diagnosed for 7.1% of farmworkers in period 1 to 2.7% in period 3 but increased to 7.4% in period 6. Similarly, traumatic nail lesions decreased from being diagnosed for 10.6% of farmworkers in period 1 to 6.4% in period 2 and increased to 14.7% in period 6. Many (45.1%) of the participants had scars, and the percentage with scars remained between 25% and 32% in each of the periods. Bug bites were diagnosed for 4.6% of the participants, and calluses were diagnosed for 4.9%.

Table 5. Multivariate (logistic regression) models of predictors of inflammatory and infectious skin diseases among migrant farmworkers, eastern North Carolina, 2005.

	Inflammatory Diseases		Infectious Diseases	
Characteristics	OR	95% CI	OR	95% CI
Time period				
Period 1 (29 May to 19 June)	1.00	--	1.00	--
Period 2 (20 June to 10 July)	1.24	0.93, 1.64	0.92	0.66, 1.28
Period 3 (11 July to 31 July)	1.25	0.89, 2.10	0.91	0.62, 1.33
Period 4 (1 Aug. to 21 Aug.)	1.29	0.94, 1.78	1.09	0.66, 1.81
Period 5 (22 Aug. to 10 Sept.)	1.76	1.16, 2.66	1.10	0.70, 1.71
Period 6 (11 Sept. to 12 Oct.)	1.70	0.92, 3.13	1.38	0.80, 2.40
Personal characteristics				
Age				
18 to 24 years	1.00	--	1.00	--
25 to 30 years	0.32	0.19, 0.53	1.63	0.96, 2.76
31 to 40 years	0.19	0.11, 0.30	2.15	1.48, 3.13
41 years and older	0.09	0.05, 0.15	3.11	1.89, 5.12
H2A visa[a]	--	--	0.68	0.46, 1.02
Work characteristics				
Work in wet shoes or clothes[a]	--	--	0.68	0.98, 1.52
Sat in hedgerows	0.81	0.63, 1.05	1.20	0.98, 1.47
Work in or next to fields with pesticide application[b]	1.33	1.02, 1.75	--	--
Camp characteristics (housing index)				
6 or less	1.00	--	1.00	--
7-8	1.17	0.77, 1.79	1.05	0.76, 1.45
9-10	1.57	1.03, 2.39	1.22	0.85, 1.74
11-12	2.04	1.28, 3.26	0.76	0.50, 1.16

[a] Not included in the final inflammatory diseases model.
[b] Not included in the final infectious diseases model.

Farmworkers had greater odds of an inflammatory skin disease diagnosis in the final periods of the season compared to the earliest period; the OR for inflammatory diseases was 1.76 (95% CI = 1.16 to 2.66) in period 5 and 1.70 (95% CI = 0.92 to 3.13) in period 6 (table 5). Age was inversely related to a diagnosis of inflammatory disease among the farmworkers. The OR for having an inflammatory disease diagnosis decreased with each age group such that, compared to those aged 18 to 24 years, those aged 25 to 30 years had an OR of 0.32 (95% CI = 0.19 to 0.53), those aged 31 to 40 years had an OR of 0.19 (95% CI = 0.11 to 0.30), and those aged 41 years and older had an OR of 0.09 (95% CI = 0.05 to 0.15). Farmworkers reporting that they worked in or next to fields with pesticide application had an OR of 1.33 (95% CI = 1.02 to 1.75). Farmworkers for whom the housing index was 9-10 had an OR of 1.57 (95% CI = 1.03 to 2.39), and those for whom the housing index was 11-12 had an OR of 2.04 (95% CI = 1.28 to 3.26) compared to those for whom the housing index was 6 or less.

Age was positively related to a diagnosis of infectious disease among the farmworkers. Compared to those aged 18 to 24 years, those aged 31 to 40 years had an OR of 2.15 (95% CI = 1.48 to 3.13) and those aged 41 years and older had an OR of 3.11 (95% CI = 1.89 to 5.12) for an infectious disease diagnosis.

Discussion

Skin diseases are common among the North Carolina farmworkers who participated in this study. Most have an inflammatory or infectious skin disease, many have a trauma, and several have pigmentary changes. Few have tumors. Common inflammatory diseases include acne, folliculitis, and contact dermatitis, while common infectious diseases include tinea pedis, onychomycosis, and warts. Both traumatic skin lesions and traumatic nail lesions are common. Melasma is the most common pigmentary disorder. Many of these diseases could be related to the work and living conditions of migrant farmworkers.

Skin disease causation is complex. Some inflammatory diseases, such as acne, are related to age and their occurrence decreases as individuals age. Other inflammatory diseases, such as contact dermatitis, are transitory, making them difficult to observe or diagnose. Chronic infections, such as tinea pedis and onychomycosis, are difficult and expensive to cure and therefore are more common among older members of a population. Multivariate analyses of the presence of inflammatory and infectious skin diseases indicated that age is associated with skin disease among farmworkers. The odds of having an inflammatory disease decrease with age, so that farmworkers over age 40 have almost no odds of having an inflammatory disease. On the other hand, the odds of having an infectious disease increase with age, so that farmworkers over age 40 are almost assured to have one of these disorders. However, age does not cause an infectious disease, and the specific environmental pathways leading to the high levels of infection in this population require further research.

Two environmental factors independently affect the odds of having an inflammatory condition in addition to age. Working in or near fields in which participants report pesticides have been applied and living in poor housing both increase the odds of having an inflammatory condition. The processes by which these environmental factors result in inflammation need to be delineated with additional research.

Trauma is also widespread among the farmworkers who participated in this study. However, specific factors associated with these injuries were not identified. Further research needs to examine the occupational factors that cause the high levels of injuries experienced by farmworkers.

studies (McCurdy et al., 1989; Gamsky et al., 1992; Krejci-Manwaring et al., 2006) provide comparable information on the prevalence of diagnosed skin disease among farmworkers. These comparable studies collected data at a single point, while our analysis is based on longitudinal data from across an agricultural season and for six periods. Diagnoses of skin disorders in these studies are based on in-person examination, whereas diagnosis for our study is based on a review of digital images. Two of the studies (McCurdy et al., 1989; Gamsky et al., 1992) conducted "waist-up" exams of the torso, arms, and head but did not collect data on the feet and legs, as did this study. Comparison with the McCurdy et al. (1989) and Gamsky et al. (1992) studies is problematic due to differences in terminology. The analysis by Krejci-Manwaring et al. (2006) uses the same terminology and the same body areas as our study.

Levels of inflammatory disease documented in this study are similar to those reported by McCurdy et al. (1989) and Krejci-Manwaring et al. (2006). Compared to our 30% to 35% prevalence of any inflammatory disease for each of the six periods, 25% to 30% prevalence of acne and folliculitis, and 2% to 5% of contact dermatitis, Krejci-Manwaring et al. (2006) report 38.9% for inflammatory disease, 24.1% for acne and folliculitis, and 5.6% for contact dermatitis, while McCurdy et al. (1989) report 30% for pustular eruptions, 30% for acne, and 2% for contact dermatitis. Gamsky et al. (1992) report facial acne in 17.4% of their participants but also report 21.7% of their participants with pustular eruptions. Gamsky et al. (1992) report 2% of their participants with contact dermatitis, but 13.6% with lichenified hand dermatitis.

Infectious diseases are not reported by McCurdy et al. (1989) or Gamsky et al. (1992). Most of the infectious disease diagnoses (tinea pedis and onychomycosis) occur on the feet, and McCurdy et al. (1989) and Gamsky et al. (1992) did waist-up exams. Krejci-Manwaring et al. (2006) report 48.1% of their participants with an infectious disease diagnosis, with 27.8% having tinea pedis and 31.5% having onychomycosis. Among our participants, about 60% had an infectious disease in any of the six periods, with 40% to 50% having tinea pedis and 30% to 40% having onychomycosis.

Pigmentary disorders are not reported by McCurdy et al. (1989) or Gamsky et al. (1992). The prevalence of 14.8% reported by Krejci-Manwaring et al. (2006) is similar to the overall rate of 19.1% in our study. Tumors are not reported by any of the three comparable studies and were very rare among farmworkers in our sample. Trauma is not reported by Gamsky et al. (1992). Excluding scars and calluses, we found that 34.5% of our participants had a trauma diagnosis, with most of these being skin and nail lesions. McCurdy et al. (1989) report an overall prevalence of 10%, with most of this (8%) being accounted for by bug bites. Krejci-Manwaring et al. (2006) report fewer trauma cases, with an overall prevalence of 3.7%. Gamsky et al. (1992) report several disorders with high prevalence that are not reported by other studies: keratosis pilaris (13.2%), conjunctival erythema (10.0%), and paronychia (8.4%).

An analysis of 25 Latino poultry workers provides another comparison (Quandt et al., 2005). Dermatologist-diagnosed skin disease among these Latino workers included 68% with any inflammatory disease; among these, 64% were diagnosed with acne or folliculitis and 8% with atopic dermatitis. None were diagnosed with contact dermatitis. Most (92%) had an infectious disease, 72% with tinea pedis and 76% with onychomycosis. Forty percent had pigmentary disorders, 36% with melasma and 4% with post-inflammatory pigment change. Finally, 28% had a skin trauma, 16% had scars, 8% had a traumatic skin lesion, and 8% had a traumatic nail lesion.

Comparison with these other studies indicates that inflammatory and infectious skin diseases are highly prevalent among Latino farmworkers on the east and west coasts, as well as among other Latino poultry processing workers. Farmworkers are a largely young

population, and tumors are fairly rare. Comparison across studies will be improved if consistent categories and terminology for reporting skin problems are used.

Like other analyses of cross-sectional or prospective data, we have limited ability to predict specific categories of skin disease. For any inflammatory and any infectious skin disease, age has the strongest association. These diseases are so widespread, and the environmental and occupational conditions across farmworkers are so similar, that it is difficult to differentiate associations other than age.

This study should be evaluated in light of its limitations. Assessments were based on digital images rather than direct examinations, and the images were not full-body images. This may have led to some bias against observing certain conditions. Further, while diagnosis was consistent with standard telemedicine, it was limited due to the lack of formal definitions for skin disease or laboratory tests to confirm and differentiate some diagnoses. Therefore, some detailed differential diagnoses (e.g., between specific types of dermatitis or between onychomycosis and psoriatic nails) cannot be made with a high level of certainty. Measures of covariates, such as working in or next to fields with pesticide application, were based on self-reported data. These measures were therefore subject to subjective evaluation and recall bias. This study was limited to farmworkers in North Carolina. All of the participants worked in tobacco for some portion of the summer. This may have led to different skin diseases than might have been found in workers in other locations working in other crops. Further, a high percentage of the farmworkers participating in this study had H2A visas. These workers may be in better health than the larger migrant farmworker population in North Carolina and the U.S.: our estimates of skin disease may therefore be lower than those for the larger farmworker population. Finally, the observational design of this study limits its ability for statistical inference of causation.

Strengths of this analysis include a sizable sample from a substantial number of residential camps across nine counties with very large farmworker populations. Access to the farmworkers was facilitated by working with local clinic and agency outreach programs. The repeated measures design allowed contacting most participants several times across the season. Finally, the skin disease diagnosis used standard telemedicine procedures.

Skin diseases are highly prevalent among farmworkers in North Carolina and elsewhere. The presence of high levels of infectious disease among farmworkers is a concern because of the effects of these diseases on the well-being of this population. Farmworkers experience significant environmental exposures from substandard housing (Early et al., 2006; HAC, 2001), as well as from pesticides and other chemicals (Quandt et al., 2006). Greater effort is needed to document the specific factors causing high levels of infection and inflammation among farmworkers.

Acknowledgements

This research was supported by the National Institute of Environmental Health Sciences (Grant No. R01-ES012358). The authors greatly appreciate the assistance of Will Willner, Department of Creative Communications, Wake Forest University Health Sciences, for technical support in collecting the digital images, and Josh Tan, Department of Biomedical Engineering, Wake Forest University Health Sciences, for technical support in archiving the digital images. The authors also appreciate the help of the North Carolina Farmworkers Project (Benson, N.C.), East Carolina Community Health Centers, Greene County Health Care, Inc. (Snow Hill, N.C.), and Harvest Family Clinic, Carolina Family Health Centers, Inc. (Wilson, N.C.) with sample recruitment and data collection.

References

Arcury, T. A., S. A. Quandt, and B. G. Mellen. 2003. An exploratory analysis of occupational skin disease among Latino migrant and seasonal farmworkers in North Carolina. *J. Agric. Safety Health* 9(3): 221-232.

Bureau of Labor Statistics. 2006. Illness rates by category of illness - Detailed industry - 2005. Washington, D.C.: U.S. Department of Labor. Available at: www.bls.gov/iif/oshom.htm.

Carey, V. J., S. L. Zeger, and P. Diggle. 1993. Modeling multivariate binary data with alternating logistic regressions. *Biometrika* 80(3): 517-526.

Early, J., S. W. Davis, S. A. Quandt, P. Rao, B. M. Snively, and T. A. Arcury. 2006. Housing characteristics of farmworker families in North Carolina. *J. Immigr. Health* 8(2): 173-184.

Gamsky, T. E., S. A. McCurdy, P. Wiggins, S. J. Samuels, B. Berman, and M. B. Schenker. 1992. Epidemiology of dermatitis among California farm workers. *J. Occup. Med.* 34(3): 304-310.

HAC. 2001. No refuge from the fields: Findings from a survey of farmworker housing conditions in the United States. Washington, D.C.: Housing Assistance Council.

Hogan, D. J., and P. Lane. 1986. Dermatologic disorders in agriculture. *Occup. Med.: State of the Art Reviews* 1(2): 285-300.

Krejci-Manwaring, J., M. R. Schulz, S. R. Feldman, Q. Vallejos, S. A. Quandt, S. R. Rapp, and T. A. Arcury. 2006. Skin disease among Latino farmworkers in North Carolina. *J. Agric. Safety Health* 12(2): 155-163.

Krupinski, E. A., B. LeSueur, L. Ellsworth, N. Levine, R. Hansen, N. Silvis, P. Sarantopoulos, P. Hite, J. Wurzel, R. S. Weinstein, and A. M. Lopez. 1999. Diagnostic accuracy and image quality using a digital camera for teledermatology. *Telemed. J.* 5(3): 257-263.

McCurdy, S. A., P. Wiggins, M. B. Schenker, J. Munn, A. M. Shaieb, C. Weinbaum, D. Goldim, S. T. McGillis, B. Berman and S. Samuels. 1989. Assessing dermatitis in epidemiologic studies: Occupational skin disease among California grape and tomato harvesters. *American J. Ind. Med.* 16(2): 147-57.

O'Malley, M. A., and T. Mathias. 1988. Distribution of lost-work-time claims for skin disease in California agriculture: 1978-1983. *American J. Ind. Med.* 14(6): 715-20.

Preisser, J. S., Arcury, T. A., and S. A. Quandt. 2003. Detecting patterns of occupational illness clustering with alternating logistic regressions applied to longitudinal data. *American J. Epidemiol.* 158(5): 495-501.

Quandt, S. A., J. S. Preisser, and T. A. Arcury. 2002. Mobility patterns of migrant farmworkers in North Carolina: Implications for occupational health research and policy. *Human Org.* 61(1): 21-29.

Quandt, S. A., M. R. Schulz, S. R. Feldman, Q. Vallejos, A. Marín, L. Carrillo, and T. A. Arcury. 2005. Dermatological illnesses and injuries among immigrant poultry processing workers in North Carolina. *Arch. Environ. Occup. Health* 60(3): 165-169.

Quandt, S. A., M. A. Hernández-Valero, J. G. Grzywacz, J. D. Hovey, M. Gonzales, and T. A. Arcury. 2006. Workplace, household, and personal predictors of pesticide exposure for farmworkers. *Environ. Health Perspect.* 114(6): 943-952.

Quandt, S. A., M. R. Schulz, Q. M. Vallejos, J. S. Feldman, T. A. Arcury. Skin-related quality of life among migrant farmworkers. *J. Cutan. Med. Surg.* (in press).

Tang, R. A., M. Morales, G. Ricur, and J. S. Schiffman. 2005. Telemedicine for eye care. *J. Telemed. Telecare* 11(8): 391-396.

Villarejo, D., and S. L. Baron. 1999. The occupational health status of hired farm workers. *Occup. Med.: State of the Art Reviews* 14(3): 613-635.