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Migrant and Seasonal Crop Worker Injury and Illness Across the Northeast

Melissa Scribani, MPH,[1] **Sherry Wyckoff,** BA,[2] **Paul Jenkins,** PhD,[1] **Henry Bauer,**[2] **and Giulia Earle-Richardson,** PhD[2]*

Background *Northeast farmworkers are a small, widely dispersed, and isolated population. Little is known about their occupational injury and illness risk.*
Methods *Researchers conducted chart reviews in migrant health centers across the Northeast, and calculated incidence-density for agricultural morbidity based on a new method for estimating total worker hours at risk, and adjusting for cases seen at other sources of care.*
Results *An estimated annual average of 1,260 cases translated to an incidence of 30.27 per 10,000 worker weeks, (12.7 per 100 FTEs). Straining/spraining events (56% cases) was the most common occurrence (16.8 per 10,000 worker weeks), and lifting (21.5% cases) was the leading contributing factor. Incidence by crop category ranged from 12.95 (ground crop) to 29.69 (bush crop) per 10,000 weeks. Only 2.8% filed for Workers' Compensation.*
Conclusion *The predominance of straining/spraining events affecting the back, and their association with lifting suggests that Northeastern farmworker occupational health programs should focus on ergonomics, and specifically on safe lifting.* Am. J. Ind. Med. 56:845–855, 2013. *© 2012 Wiley Periodicals, Inc.*

KEY WORDS: migrant; farmworker; occupational; musculoskeletal straining/spraining event; surveillance; agriculture; surveillance methods

INTRODUCTION

Despite the increasing mechanization of many types of agriculture across the US, there continues to be a great demand for hand labor within food crop agriculture. For such crops as apples and peaches, vegetables, berries and melons, and bush crops like blueberries, no automated harvesting systems can match the work quality and low cost of migrant hand-labor. American workers largely stay away from this hand-harvest work, even during times of high unemployment [US Department of Agriculture, 2012], because of the harsh working conditions, the short-term employment, and often times, low pay [Dwoskin, 2011; Westneat, 2011].

The health and safety of the mostly foreign-born workers who fill these hand-harvest jobs has long been a concern of health professionals. Workers who take these jobs are typically poor, uneducated, and likely to continue working even when injured or ill [Arcury and Quandt, 2007; Villarejo et al., 2010]. Many do not speak English and may be undocumented, and therefore may feel they have little choice but to work through injury, illness, and unsafe conditions, for fear of losing their jobs. Further, in many rural agricultural regions of the US, there are little or no Spanish-language health, nutrition, or advocacy resources for these workers.

Although there are no published data directly comparing foreign-born farmworkers to US-born farmworkers

[1]Bassett Research Institute, Bassett Healthcare Network, Cooperstown, New York
[2]New York Center for Agricultural Medicine and Health, Bassett Healthcare Network Bassett Healthcare Network, Cooperstown, New York
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*Correspondence to: Giulia Earle-Richardson, PhD, New York Center for Agricultural Medicine and Health, Bassett Healthcare Network Bassett Healthcare Network, One Atwell Rd. Cooperstown, NY 13326. E-mail: gwrite@stny.rr.com

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(partly because there are so few of the latter), US Bureau of Labor Statistics data show fatality rates among agricultural laborers to be 6× that of the all-industry rate, and elevated rates among Hispanic workers in general [US Department of Labor, Bureau of Labor Statistics, 2010]. Further, higher occupational fatality rates in states where undocumented foreign workers are present in large numbers also suggests that foreign-born workers (many of whom are undocumented) are responsible for increased Hispanic occupational fatality rates [Smith, 2012].

Despite these concerns, occupational injury research on this population is sparse, particularly so in the Northeast, where farmworker populations are comparatively small. While Northeastern health and safety professionals rely on the published research from larger farmworker areas, such as West and Southwest regions, there are many important differences that raise questions about the applicability. Anecdotal evidence suggests that in the Northeast, agricultural operations are typically smaller (and fewer workers per farm), and farm machinery is older. If a farm employs 10 or fewer workers and does not house any workers on the farm, they are exempt from Occupational Safety and Health Administration (OSHA) enforcement. While they are still legally required to provide a safe workplace, the knowledge that OSHA enforcement will not occur is a disincentive to make investments in safety equipment and training. Moreover, smaller farms that operate closer to the line between success and failure are likely to feel more pressure to forego investments in safety. Lastly, Spanish-speaking workers in rural New York, Pennsylvania, and New England often find themselves completely cut-off from any Spanish-language resources. This further impacts training, safety practices on the farm, as well as access to quality health care.

At the time that the authors first began studying the occupational morbidity of migrant and seasonal farmworkers in the Northeast, there were no studies available that identified leading sources of occupational morbidity, contributing factors, or injury/illness patterns by crop type. In 2000 the authors began a chart review-based study of occupational injury and illness in the Northeast [Earle-Richardson et al., 2003]. The rationale for this approach was to take advantage of an existing network of federally supported migrant health centers, all of whom identified migrant and seasonal worker patients as part of their regular record-keeping. This approach also had the advantage that it would only identify medically documented conditions, and utilized already existing data, thereby reducing the imposition on farmworkers involved with surveys.

However, there were some drawbacks to this method as well. First and foremost, calculating incidence would be impossible unless an accurate denominator could be identified. There is little agreement regarding the total number of migrant and seasonal farmworkers in the US, and even less is known about the subset that are employed (which would constitute the denominator). Second, since the only source of case data was the federally supported migrant health center, cases of injury, or illness seen at other sources of care or not treated at all would be missed, resulting in an underestimation of the migrant and seasonal worker morbidity.

In order to address these two major shortcomings, the authors undertook two additional studies before completing the original analysis: one was aimed at developing a method for estimating a defensible denominator, the other for determining the proportion of migrant and seasonal workers using alternative sources of care (including "none") for agricultural injuries and illnesses.

Based on these additional studies, the authors developed a new methodology for estimating the total worker hours at risk in each migrant health center catchment area [Earle-Richardson et al., 2005]. The premise of this research was that while it might not be possible to know how many farmworkers were present in a given area, one could reliably estimate the number of hours worked based on Census of Agriculture data on acres harvested in a given season. This methodology was largely built on previous work by Alice Larson, who has conducted a number of worker enumeration studies based on this principle for the purpose of estimating the total number of migrant and seasonal workers, employed or not, and their family members [Larson, 2000; Plascencia et al., 1993].

Briefly, researchers were able to calculate the total farmworker hours at risk per season by using existing estimates of the hours that it takes one worker to harvest 1 acre of a given hand-harvested crop (see Appendix for a list of hand-harvested crops in the study regions). Essentially this transforms acres to hours. This becomes useful for our purposes, since having total worker hours at risk it becomes possible to estimate incidence density. It should be noted that harvest acreage was unavailable for 21% of the 991 county-crop combinations studied; however missing data represented small proportions of individual commodity categories, and it was possible to impute missing data. Thus it is now possible to estimate crop harvest worker hours at risk for any crop in any county of the US, based on US Census of Agriculture data.

The authors conducted a second study to assess the proportion of migrant and seasonal farmworkers in the Northeast study region who used the federally supported Migrant Health Center programs ("MHCs"), when they experienced an agricultural injury or illness. This was accomplished by conducting a chart review and worker survey simultaneously in two of the seven current study regions (Maine, Western New York). Proportions of occupational morbidity cases by treatment location were calculated from the survey, and a correction factor was computed to adjust chart review morbidity estimates for Maine and New York State. Among 1,103 subjects, 56 work related injuries were reported; 30 (53.6%) were treated at a MHC, 8 (14.3%) at a hospital emergency department, 9 (16.1%) at some other location (e.g., home, relative, chiropractor), and 9 (16.1%) were untreated [Brower et al., 2009]. Thus, it was calculated that a multiplier of 1.87 applied to any future chart review study in the Northeast region would adjust for the fact that migrant health centers were capturing a little over half of the agricultural injury and illness. A second important result of this study was that mechanisms of injuries treated at MHCs versus all other sources did not differ significantly. This is important because it indicates that using chart review data and adjusting upward will not misrepresent the actual distribution of injury or illness types.

Now that these two adjunct studies are complete, researchers can return to the original task of estimating the occupational morbidity of migrant and seasonal farmworkers in the Northeast using data from across the region. This provides the opportunity to not only look at the occupational health experience of workers in the Northeast, a group not well-studied, but also spans a large area, from Maine to Maryland. For the first time, we will also be able to compare incidence between orchard crops, ground crops and bush crops that takes into account the time at risk, and to identify any differences in leading injury or occupational illness types by crop group. This model also has implications for future research throughout the federal migrant health care system, since this model could be replicated in other regions.

METHODS

Migrant and Seasonal Farmworkers in Seven Northeastern States

The study population was defined as all crop harvest workers working in the Northeast during 2001–2002, served by participating federal migrant health programs. During this time period, there were 11 federally supported migrant health center programs ("MHCs") in the Northeast, of which 10 participated. Figure 1 shows the counties and states included in the study.

Pilot research in these areas indicated that the population was almost entirely foreign born, primarily Mexican, with other Hispanic and Caribbean ethnicities represented to a lesser extent. The population was also believed to be largely male, travelling alone, most likely because of the distance of these states from the typical home base states of Florida and Texas.

Enrolling Surveillance Sites

Between the 10 migrant health programs from seven states, more than 30 individual clinic sites were enrolled. Each health center received an orientation and training at the beginning of the harvest season to encourage clinicians to ask whether the injury being treated occurred while working, and to explore the work-relatedness of health conditions. This consisted of a description of the purpose of the surveillance, as well as a description of the data collection system. Reminder posters were also placed in all examining rooms.

Identification of Charts for Review

Using state agricultural statistics, an annual harvest season for all hand-harvested crops grown in the study states was estimated for both 2001 and 2002. Two weeks were added to each end of the season in order to account for individual farm variation. Once this interval was established, health centers generated a list of all chart numbers of migrant and seasonal farmworkers who had been seen for any medical condition during that period. These charts were then pulled for review, or if the number of charts exceeded 500 for any one site, a random sample would be pulled to attain 500 charts.

Chart Abstraction

In order for a medical visit to qualify for inclusion in the data collection, the patient had to be 12 years of age or older, and all the following criteria had to be met: (1) the patient had to be a migrant or seasonal farmworker (as defined by the health center) or be a temporary agricultural harvest worker; (2) the visit had to be documented in the chart as relating to or occurring during manual agricultural labor; (3) if an illness or condition, it had to be one of a pre-established list of conditions deemed consistent with occupational disease;[1] (4) the injury or illness had to have occurred within a region's previously determined harvest season, and within the state served by the health center; and (5) the injury or illness had to be a newly occurring problem, unless the pre-existing condition was healed or well-controlled until work exposures this season caused re-injury or relapse.

[1] If the provider notes work-relatedness for record pertaining to a disease, the disease must also fit into one of the following plausibly occupationally-related categories: Zoonotic or Arthropod-borne bacterial diseases (ICD9 codes: 020–027, 060–066); Mental and personality disorders, non-psychotic (300–316); Diseases of the nervous system and sense organs (320–389); Respiratory conditions: (493–496); Diseases of the skin and subcutaneous tissue (680–709); Diseases of the musculoskeletal system and connective tissue (710–739); Symptoms, signs, and ill-defined conditions (780–799). This excludes non-occupational disease, as well as potentially work-related disease with long latency periods (e.g., malignancies).

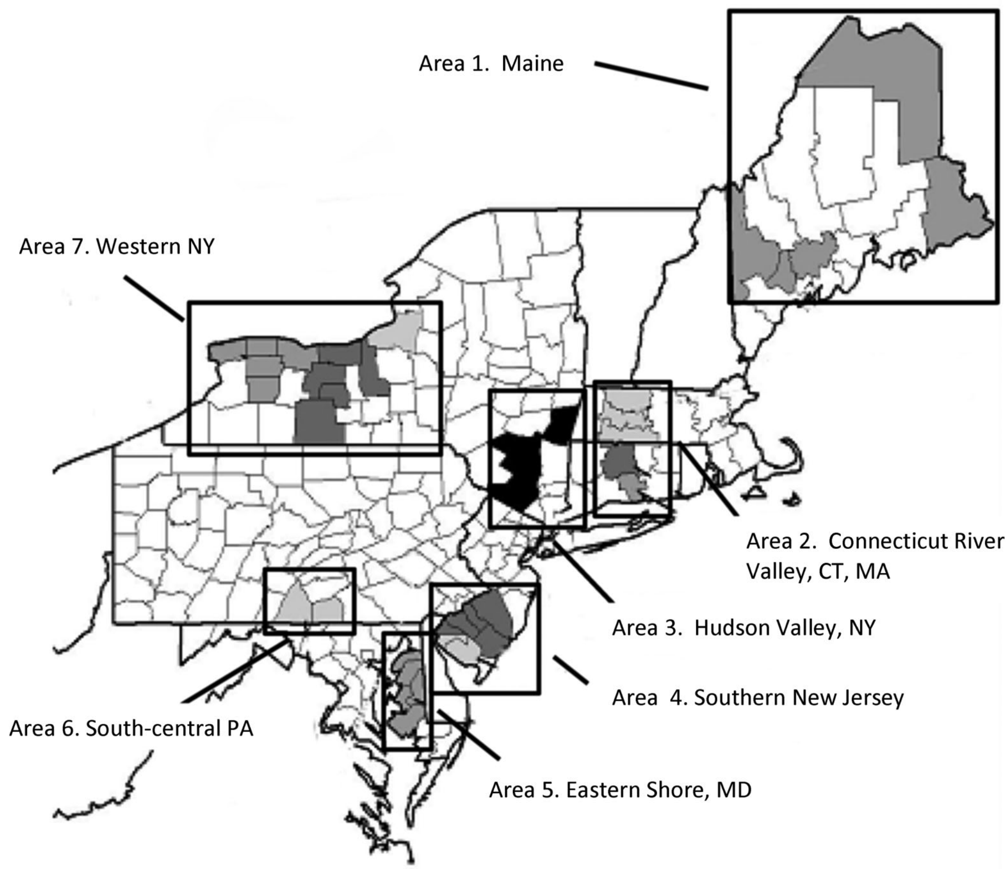

FIGURE 1. Northeast farmworker study region, 2001–2002.

For farmworkers found to have an occupational injury, information on injury date, type, cause, location on the farm, commodity, and body part affected was collected. No personally identifying information about the patient was collected, but demographic characteristics, such as patient age, gender, and country of origin were recorded. Cases in which there was some uncertainty as to whether all criteria were met were abstracted, with all of the non-identifying details recorded, which was then reviewed by a team of researchers.

Establishment of Catchment Regions for Analysis

Because some farmworker health program catchment areas either were adjacent to or overlapped with others, some health program catchment areas were combined with others. The criterion for combining MHC catchment areas was that if two catchment areas had one or more adjacent or overlapping counties, they would be combined. Thus, while 11 migrant and seasonal farmworker health programs participated in the research, only seven distinct study areas are designated.

Institutional Review Board Approval and Waiver of Informed Consent Requirement

The study was reviewed by the Bassett Medical Center institutional review board, and it was determined that because the study only analyzed existing data that was abstracted without identifiers, signed informed consent was not required.

Calculation of Adjusted Average Annual Cases, 2001–2002

For each region, the number of cases was adjusted for sampling, aggregated over the 2001 and 2002 season, and divided by two to obtain an annual average. The annual average was then adjusted upward by a factor of 1.87, based on previous research [Brower et al., 2009].

Calculation of Total Worker Weeks at Risk

First, hours at risk was calculated through a methodology described in detail elsewhere [Earle-Richardson et al., 2005]. Briefly, using published 2002 Census of Agriculture data, researchers were able to convert acres in production by county into total hours worked for a given group of counties that comprises a catchment area. The total number of hours required may be estimated as:

$$\text{THR} = \text{Total harvest acres} \times \text{hours required for one worker to harvest one acre}$$

Total acres is either obtained through published sources or imputed based on published data. Hours required to harvest one acre is available through published industry data.

Previous work by Larson [2002] established the number of worker hours needed to harvest one acre of each type of crop in Maine, New York and Maryland. Estimates for the Connecticut River Valley used New York worker hours-per-acre ratios, while South Central Pennsylvania and Southern New Jersey were calculated using ratios for Maryland. This was determined by geographic proximity. In addition, in counties in which a particular crop was reported as having 10 or fewer acres, that crop (in that county) was excluded, since it is unlikely that this would be harvested with hired labor.

In cases where the number of acres for a crop in a county is not given because small cell size might violate confidentiality, county/crop data was imputed using methods described in detail in a previous publication [Earle-Richardson et al., 2005]. Briefly, unassigned acreage was assigned evenly across all farms for which no acreage was reported. Thus counties were assigned acreage based on the number of farms with undisclosed acreage for a given crop in that county.

Worker hours were then translated into worker weeks, based on an average farmworker worker week of 49.5 hr [Earle-Richardson et al., 2005]. This was used as a means of comparison with other farmworker injury studies, and because farmworkers work an extremely variable number of weeks, making it difficult to establish a meaningful full-time-equivalent year.

Crop Type Categories

Based on previous experience with Northeast crop agriculture, researchers divided all of the hand-harvest crops in the study states [Larson, 2000, 2002, 2005] into three broad categories: ground crops, orchard crops, and bush crops. Appendix A provides a listing of the crops in each. The three broad groupings correspond both to the body posture assumed while harvesting as well as the most common tasks performed with each. For example, ground crops typically involve bending or squatting, and harvesting typically involves the use of a knife or hand tool, orchard harvest work (regardless of specific crop) requires carrying a bag of some sort, reaching and pulling (often climbing), but no knife. Bush crops often involve tying and working with trellises, and cutting with hand tools. Thus these groupings suggest the potential for different types of occupational injury/illness risks, along these categorical lines.

Analytic Methods

Occupational injury/illness incidence density for each region was calculated by dividing the adjusted number of annual cases by the total harvest hours per year. For the overall incidence density in the region, cases with unknown commodity were included. Crop type-specific incidence density and injury mechanism-specific incidence density were calculated in this same manner, limiting cases and harvest hours to the list of commodities in Appendix.

Comparison of incidence densities across crop groups was carried out using the two-sample test for incidence rates [Rosner, 2011]. Three pairwise comparisons were made: (1) orchard versus bush; (2) orchard versus ground; and (3) bush versus ground. These comparisons were made for overall incidence density, as well as for musculoskeletal straining/spraining event incidence.

Among injuries resulting from straining/spraining events, the distribution of body part involved was compared across crop groups using chi-square. A P-value of <0.05 was considered statistically significant.

In this analysis, it is important to note that the term, "straining/spraining event" refers to the act of straining a muscle or joint, and not to the resulting injury (although this resulting injury is likely to be referred to as a "strain" or a "sprain.") The straining/spraining event should be thought of as being parallel to other injury or illness mechanisms such as "fall," "struck by object," or "contact with natural irritant."

RESULTS

There were a total of 20,607,575 hand-harvest hours worked in the seven farmworker study regions in 2002. Fifty-five percent of that time was spent harvesting ground crops (11,362,503 hr), 29% in orchards (6,003,023 hr), and 16% in bush crops (3,242,049 hr). Table I shows further detail regarding leading crop types and other study area characteristics. For the remainder of the discussion, worker time is expressed in terms of worker-weeks, which is defined as 49.5 hr per week [Larson, 2002; Earle-Richardson et al., 2005].

TABLE I. Northeast Hand-Harvest Crop Regions Served by Federal Migrant Health Programs by Total Hours at Risk, Leading Crops (by Hours), Total Farms and Acreage

Region	Total worker weeks (worker hr.)	Leading crop/hr.	Total farms	Total acreage in production
1. Maine	13,013 (644,133)	Blueberries (303,458), wild apples (188,143), strawberries (43,677)	1,541	21,260
2. Connecticut River Valley, CT, MA	23,789 (1,177,568)	Tobacco (184,811), sweet corn (162,467), cucumbers/pickles (156,608)	2,648	17,478
3. Hudson Valley, NY	25,889 (1,281,488)	Apples (456,177), dry onions (303,446), sweet corn (124,061)	1,217	18,638
4. Southern New Jersey	118,538 (5,867,642)	Blueberries (1,313,851), wild tomatoes (789,959), peaches (535,039)	3,193	64,487
5. Eastern Shore, MD	55,450 (2,744,765)	Vegetables (1,951,170), cucumbers/pickles (236,778), sweet corn (116,485)	820	35,384
6. South-central PA	40,686 (2,013,970)	Apples (1,567,384), peaches, (195,878), cherries, tart (104,084)	996	22,256
7. Western New York	138,950 (6,878,009)	Apples (2,006,516), sweet corn (842,280), snap beans (795,029)	4,798	130,270
7-Region total	416,315 (20,607,575)		15,213	309,773

Agricultural Injury/Illness Incidence

Across the Northeast study region, there were an estimated 2,520 agricultural injuries or illnesses during the 2-year period. Among cases, the median age was 37 years (range 13–70 years), 88.1% were male, and 73.1% of those indicating national origin were Hispanic. The most frequently reported injury mechanism was *straining/spraining event* (56% of all cases) and the most frequently reported contributing factor was *lifting* (21.5% of all cases). Of these estimated cases, 2.8% (estimated n = 68) involved a Workers' Compensation claim.

An estimated annual average of 1,260 cases translated to an incidence density of 30.27 per 10,000 worker weeks (6.1 per 100,000 hr). Table II shows the total number of annual injury/occupational illness cases and the incidence, for all crop types and by the three crop type categories. As shown, bush crops have the highest incidence, although this is largely the result of high incidence within shade tobacco in Connecticut. Incidence for bush crops is significantly higher than ground crops ($P < 0.001$), but not significantly different from orchard crops ($P = 0.08$). Incidence for orchard crops was also significantly higher than ground crops ($P < 0.0001$). Within the seven individual study areas, four had their highest incidence within the orchard category.

Mechanisms of Injury or Illness

Table II also shows incidence for the most common mechanisms of injury or illness. *Straining/spraining event*

TABLE II. Occupational Morbidity Incidence (Overall and by Mechanism) by Crop Type

	All crop types (includes cases where crop was *unknown*, n = 462)	Ground crops	Orchard	Bush crops
Total (annual) cases[a]	1,260	297	307	194
Incidence per 10,000 worker weeks	30.27	12.95	25.29[b]	29.69[a,c]
Incidence by mechanism				
Straining/spraining event	16.80	7.98	14.65	13.42
Contact w/natural irritant (poison ivy, dust)	6.02	2.20	3.55	9.12
Contact with chemical	1.53	0.49	1.23	2.28
Struck by object	1.35	0.41	1.70	0.86
Fall	1.17	0.24	1.85	0.86
Cut/pierced by object	0.81	0.49	0.31	1.14
All other mechanisms	2.25	0.81	1.54	2.28
Unknown	0.36	0.33	0.62	0

[a]Estimated number of cases—frequencies weighted for sampling and adjusted by 1.87 correction factor.
[b]Significant difference ($P < 0.0001$), versus ground crop in pairwise comparison.
[c]Non-significant difference ($P = 0.08$), versus orchard crop in pairwise comparison.

TABLE III. Occupational Morbidity Incidence by Study Region and Leading Mechanism

Range	Incidence by study region (n cases[a])	Leading mechanism (rate)[b]
1. Maine	74.73 (n = 97)	Straining/spraining event (57.48)
2. Connecticut River Valley, CT, MA	100.62 (n = 239)	Straining/spraining event (49.52)
3. Hudson Valley, NY	36.12 (n = 94)	Straining/spraining event (18.06)
4. Southern New Jersey	17.35 (n = 206)	Straining/spraining event (8.83)
5. Eastern Shore, MD	5.73 (n = 32)	Straining/spraining event (3.04)
6. South-central Pennsylvania	34.01 (n = 138)	Straining/spraining event (21.14)
7. Western New York	32.84 (n = 456)	Straining/spraining event (18.30)

[a]Estimated number of cases–frequencies weighted for sampling and adjusted by 1.87 correction factor.
[b]Per 10,000 worker-weeks.

TABLE IV. Straining/Spraining Event (Overall and by Body Part) by Crop Type

	All crop types	Ground crops	Orchard	Bush crops	
N[a]	699	183	178	88	
Straining/spraining event incidence[b]	16.80	7.98	14.65[c]	13.42[c,d]	
Body part					***P*-value for difference by crop type**
Back	44.1%	41.9%	42.2%	33.3%	<0.0001
Shoulder	11.9%	8.4%	19.4%	11.9%	
Leg	8.6%	10.9%	3.7%	13.1%	
Wrist/hand	8.6%	8.4%	2.6%	17.0%	
Trunk	8.6%	10.1%	7.9%	8.6%	
Arm/elbow	7.2%	10.9%	9.0%	7.5%	
Neck	6.0%	1.5%	11.3%	3.2%	
Ankle/foot	1.5%	1.5%	0.5%	3.2%	
Other/unspecified	3.5%	6.3%	3.2%	2.1%	

[a]Estimated number of cases–frequencies weighted for sampling and adjusted by 1.87 correction factor.
[b]Per 10,000 worker-weeks.
[c]Significant difference ($P \leq 0.0001$), versus ground crop in pairwise comparison.
[d]Non-significant difference ($P = 0.5419$), versus orchard crop in pairwise comparison.

is by far the leading mechanism for all crop types, followed by *contact with natural irritant* (poison ivy, dust) as a distant second.

Incidence for individual study regions is shown in Table III. There are large variations in total number of cases as well as for incidence. Regardless of overall incidence, *straining/spraining event* is the leading mechanism for each of the study regions.

Body Part and Contributing Factors

Within the category of *straining/spraining event*, there are differences in injury incidence by crop type group, body part affected and contributing factors. As shown in Table IV, incidence was significantly higher for orchard and bush crops as compared to ground crops (orchard vs. ground: $P < 0.0001$; bush vs. ground: $P = 0.0001$). *Straining/spraining event* incidence did not differ significantly between bush and orchard crop groups ($P = 0.5419$). Table IV also details body part affected across the three crop categories, revealing differing patterns for ground crops, orchard crops, and bush crops within the *straining/spraining event* category.

Table V shows the leading contributing factors, for all mechanisms of injury, and specifically for *straining/spraining event*. For both strata in Table V, *lifting*, *bending/stooping*, and *previous injury* are leading contributing factors. When looking specifically at orchards, *carrying* and *reaching* also are leading contributing factors.

DISCUSSION

Occupational Morbidity Incidence

The incidence of 30.27 per 10,000 worker weeks is consistent with that found by the authors in smaller regions of the Northeast using both survey and chart review methods [Brower et al., 2009; Earle-Richardson et al., 2008a]. When translated to a 100 FTE incidence of 12.7, the rate is very similar to two published studies [Villarejo, 1998; Cooper et al., 2006], while substantially higher than some others [McCurdy et al., 2003; Cameron et al., 2006; Wang et al., 2011]. However, incidence comparisons must be made with caution, since there is a great deal of variation in study design and case definition.

Predominance of musculoskeletal straining/spraining event

What is of greater significance is the distributions of mechanisms of injury/illness associated with the occupational morbidity shown in Table II. This shows the overwhelming predominance of *straining/spraining event* throughout all study areas and crop categories. While a number of other studies from other geographic regions

TABLE V. Leading Contributing Factors by All Injury/Illness Events and Spraining/Straining Events

All crop types (N = 1,260[a])		Ground crops (N = 297[a])		Orchard		Bush crops (N = 194[a])	
Contributing factor	**%**	**Contributing factor**	**%**	**Contributing factor**	**%**	**Contributing factor**	**%**
All injury/illness events							
Lifting	12.3	Bending/stooping	18.6	Lifting	12.5	Bending/stooping	13.6
Bending/stooping	11.1	Lifting	13.7	Carrying	10.5	Lifting	9.2
Previous injury	5.2	Previous injury	6.1	Reaching	7.9	Weather conditions	7.2
All crop types (N = 699[a])		**Ground crops (N = 183[a])**		**Orchard (N = 178[a])**		**Bush crops (N = 88[a])**	
Contributing factor	**%**	**Contributing factor**	**%**	**Contributing factor**	**%**	**Contributing factor**	**%**
Spraining/straining events							
Lifting	21.5	Bending/stooping	29.7	Lifting	20.5	Bending/stooping	28.0
Bending/stooping	19.1	Lifting	21.8	Carrying	18.1	Lifting	19.2
Previous injury	7.8	Previous injury	6.1	Reaching	13.6	Reaching	7.7

[a]Estimated number of cases—frequencies weighted for sampling and adjusted by 1.87 correction factor.

have identified straining/spraining events as a leading occurrence [McCurdy et al., 2003; Villarejo and McCurdy, 2008; Anthony et al., 2010], this is the first that shows that even when broken down by crop type, straining/spraining event predominates. This has implications for prevention in the Northeast, because it suggests that regardless of region or leading crops, ergonomic workplace improvement should be a major area of focus.

It is also noteworthy that some studies of orchard health and safety in the Northwest have identified falls (particularly related to ladders) as the leading occupational problem [Salazar et al., 2005; Hofmann et al., 2006]. Further research is needed to determine whether the substantial differences in work organization between these much larger, western orchards and those in the Northeast explain this difference, or whether it can be explained by differences in study design.

Straining/Spraining Occurring While Lifting

One might expect that straining/spraining the back while lifting would be the leading condition for manual labor (as it is in many industries). However, the literature is actually split on whether *lifting* or *overwork/overuse* is more commonly associated with back strain [McCurdy et al., 2003; Cameron et al., 2006; Villarejo and McCurdy, 2008; Anthony et al., 2010; Wang et al., 2011]. The distinction is important because general *overwork/overuse* would imply more rest breaks and possibly shorter overall work hours, while interventions for lifting-related injury are more specific to lifting technique, use of mechanical lifts and mandated lifting weight limits.

Patterns of Straining/Spraining Event by Crop Type Category

While back strain relative to lifting predominates overall, there are also some notable patterns within each of the three crop categories. Among ground and bush crops we see leg and arm strain (both of these crop groups do a lot of bending and use hand tools), and leading contributing factors of *bending/stooping*, while orchard crops emphasize the shoulder and neck, and include *carrying* and *reaching* as contributing factors. This supports our current understanding of how crop-specific tasks lead to different patterns of musculoskeletal strain. Although this is a relatively small study and should be replicated, the results here suggest that in addition to a safe lifting program, ergonomic safety programs that reduce time spent in *bending/stooping* (for ground crops and bush crops) and *carrying* in orchards are likely to have the greatest benefits.

The near non-existent utilization of Worker's Compensation (3% of cases involved claims) was unexpected. While previous research by the authors have found similar low utilization [Earle-Richardson et al., 2003], in California, utilization has been reported as high as 27% of farmworkers (males) during their working years [Villarejo et al., 2010]. Other studies in the West have used having made a Worker's Compensation claim as the case inclusion criteria, under the assumption that all significant injury or illness would involve a claim [Villarejo, 1998; Hofmann et al., 2006]. Such a design would miss the vast majority of the cases described in the current study. The apparent differences in Worker's Compensation utilization between Northeastern and Western agriculture further underscores the need for farmworker research in different regions of the US.

Implications for Practice

Greater resources should be directed toward ergonomic solutions in agriculture

These data suggested that straining/spraining events and the resulting musculoskeletal strain injury are endemic. This joins the growing body of data implying that a great deal more needs to be done in agricultural ergonomics. While the published literature in recent years shows a steady growth of ergonomic intervention research [Kirkhorn et al., 2010], the majority of farmworker health and safety research continues to be focused on other areas. Since workers are known to continue working even when they are in pain [Arcury et al., 2012], we need to develop ways of measuring this type of injury even without lost work time.

While agricultural ergonomics is a small field, significant work has been done developing interventions for reducing exposures [Kirkhorn et al., 2010]. One simple example is the 5-minute per hour rest break. Researchers demonstrated that short work breaks can reduce symptoms of musculoskeletal strain in meat packing workers and ground crop workers [Genaidy et al., 1995; Faucett et al., 2007]. Short work breaks during the middle of the work period are now mandated in five western states (US Department of Labor, 2012), and should be adopted in Northeastern states. This is particularly appealing because it is easy to implement and seems likely to be effective for all types of crop work.

Other interventions that have demonstrated effectiveness are: smaller harvest tubs for wine grapes [Duraj et al., 2000], a gripping device for lifting small containers [Janowitz et al., 1999], and a bucket carrier cart and lifting device [Tang et al., 2006]. A modified blueberry rake [May et al., 2008] and apple bucket redesign [Earle-Richardson et al., 2008b] are tool redesigns that can reduce strain exposure in orchards and for ground crops, respectively. Perhaps the most challenging of all of the ergonomic exposures in agriculture is that of stoop labor involved in ground crop work. Researchers in California (and elsewhere) are exploring a wide range of potential solutions [Ramahi and Fathallah, 2006; Fathallah et al., 2008].

More broadly, five ergonomic issues have been addressed in a number of interventions, and therefore might have application to other agricultural settings. These are: stooping, general overwork, and fatigue, hand tools such as shovels and rakes, transfer of weight to more appropriate part of the body, and the ability to customize an intervention for different body sizes and shapes [Kirkhorn et al., 2010].

Straining due to lifting should be targeted

The fact that lifting was named as a leading contributing factor overall and within each crop category also suggests that proper lifting technique and limiting lift load and frequency should be a priority among farmworker injury prevention professionals in the Northeast. Although this type of information has been in existence for a long time, and is promoted actively in other industries, safe lifting has not been made a priority within migrant and seasonal farmworker safety.

Developing a demand for ergonomic interventions among employers must also be a priority

One of the greatest difficulties facing developers of ergonomic solutions in agriculture is the insufficient demand among agriculture employers for these solutions that ultimately drives successful integration into practice. At the Northeast Center, researchers working with the farm community have found general interest in learning about ergonomic interventions, but not the high level of purchasing demand that would make the interventions commercially viable. Until farms that employ temporary harvest workers view high rates of worker pain symptoms as a problem, the translation of ergonomic innovation into practice will not move forward.

Some recent research has been done examining the "work safety climate" on farms employing migrant and seasonal farmworkers [Arcury et al., 2012]. This offers perhaps the best opportunity for understanding and addressing barriers to ergonomic interventions, and investments in farmworker health and safety more generally. For example, the scale used by Arcury and co-workers includes worker perceptions of: whether supervisors care about their safety; if they have been informed about safety (including training and periodic safety meetings), and whether they feel they are expected to take safety risks as part of their job [Gillen et al., 2002]. Researchers found that with each unit lower on the work safety climate scale, workers were 12% more likely to have musculoskeletal discomfort and 15% more likely to continue working while injured. Further understanding of how we can influence the work safety climate is needed if we are to increase demand for ergonomic interventions on farms. Research by Keifer et al. [2009], also identified similar work safety climate factors (called "psychosocial factors") associated with injury in orchards.

Limitations

The main limitation of the current study is that chart reviews were limited to the ambulatory setting. Therefore, there is the possibility that morbidity that would be more likely seen in hospital emergency rooms is under-represented. Falls, and machine-related trauma fall into this category. Previous research that directly compared chart reviews and survey methods found no differences in mechanisms of injury/health conditions, even though the outcomes for hospitalized cases were more severe [Earle-Richardson et al., 2008a,b]. Still, we believe that both survey and outpatient chart review methods probably miss some types of the most severe morbidity.

Another important limitation is the inherent variability in medical chart documentation with regard to work-relatedness of a health condition. While researchers utilized one consistent training protocol for all clinicians involved in the study, it seems that the extent of noting of cases may have varied by provider and possibly by study location as well. We believe that this explains the extremely low and extremely high incidence in two of the seven data collection sites. For this reason, no formal comparisons were made among the seven individual study regions.

CONCLUSION

The result that musculoskeletal straining/spraining event is the predominant type of hand-harvest related injury mechanism across the Northeast region, regardless of commodity type, and that lifting is cited in the greatest number of cases, suggests that a safe lifting intervention program should be pursued across this region. Further, these data should be shared with agricultural employers to make the case that musculoskeletal strain is a significant problem, one that could affect worker retention and productivity. More research is needed both in ergonomic safety and in developing greater support among small agricultural employers for investing in safety.

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APPENDIX: NORTHEASTERN HAND-HARVESTED CROPS BY CROP TYPE CATEGORY

Ground crop	Orchard	Bush crop
Asparagus	Apples	Blackberries
Berries	Cherries (sweet)	Blueberries (cultivated)
Blueberries (wild)	Cherries (tart)	Christmas trees
Broccoli	Nectarines	Grapes
Brussels sprouts	Peaches	Snap beans
Cantaloupes	Pears	Sweet corn
Cauliflower		Tobacco
Chinese cabbage		
Collards		
Cranberries		
Cucumbers		
Dry onions		
Eggplant		
Endive		
Escarole		
Green onions		
Green peas		
Head cabbage		
Herbs		
Kale		
Lettuce		
Lima beans		
Mixed vegetables		
Mustard greens		
Okra		
Other vegetables		
Parsley		
Peppers—Bell		
Peppers—Hot		
peppers—Sweet		
Plums/prunes		
Potatoes		
Pumpkins		
Radishes		
Raspberries		
Rhubarb		
Spinach		
Squash		
Strawberries		
Sweet potatoes		
Tomatoes		
Turnip greens		
Turnips		
Watermelons		