

Final Performance Report

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Collecting Elusive Data on Immigrant Occupational Health

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Abstract/Significant Findings

A variety of studies have recognized the incompleteness of occupational health surveillance data in the U.S. Surveillance data are particularly expected to miss certain populations, such as low-wage, contingent, and immigrant workers; and certain health problems, such as diseases with ambiguous symptoms. This study investigated these issues among Cambodian and Lao refugees in Lowell, Massachusetts.

Sources of information included selected data from 187 Southeast Asian hospital visits (to Saints Memorial Medical Center, SMMC) charged to workers' compensation; 80 workers' compensation wage replacement cases filed on behalf of Southeast Asian Lowell residents with the Massachusetts Department of Industrial Accidents (DIA); and 160 surveys on self-reports of occupational health collected from 112 Southeast Asian households in Lowell.

One hundred two (64%) of survey respondents reported work in manufacturing, and 67 (42%) specifically in electronics assembly. Large proportions of the study population reported exposure to awkward and static postures, repetitive motion, and chemicals such as soldering flux, dusts and solvents.

The most common injuries from all three data sources included sprains and strains (37.1% of DIA injuries, 27.4% of SMMC injuries, and 21.9% of survey injuries); cut, laceration, puncture (9.3%, 22.9%, 11.4%); contusion, crushing, bruise (19.6%, 14.6%, 8.7%); and fractures (9.3%, 7.6%, 2.9%). Symptoms and ill-defined conditions, including overall ill health, headache, dizziness, made up 28.3% of all injuries reported in the survey (95% CI 22.3%, 34.3%) but only 1.3% of injuries recorded in the hospital data and none in DIA data. Dermatitis, made up 6.8% of survey cases (95% CI 3.5%, 10.1%) but none of the common injuries in the other data sets.

Of 155 respondents currently employed, 39 (25%) reported holding a temporary job. Of 147 adults currently employed, 41 (28%) reported regularly working between 41 and 75 hours per week.. Twenty-two (14% of respondents) were able to identify sources of information about workplace hazards apart from their supervisors. One hundred ten (69%) of survey respondents expressed no knowledge of workers' compensation. Most sought medical care in small private clinics.

Given these employment and medical care patterns, few occupational health problems in this population would be expected in data based on workers' compensation, hospital records, passive surveillance programs, or written questionnaires. Consistent with this expectation, only 4% of workers' compensation cases for Lowell residents filed during the period under study were identified as corresponding to the ethnic groups under study, approximately one eighth the proportion of this group in the Lowell population. Hospital records and workers' compensation record much lower levels of illness and less chemical exposure and awkward/static postures than those reflected in the survey.

Usefulness of Findings

This study's findings are useful in two areas. First, the study characterized common employment, workplace hazards, and work-related injuries and illnesses in a working population about whom little is known. Findings describe the population's knowledge of and access to preventive and curative occupational health services and patterns of medical care. This information is crucial to the design and implementation of occupational health interventions with a vulnerable sector of the workforce.

In addition, the study described discrepancies between information obtained in a household survey and that found in existing occupational health data sources on the study population, specifically workers' compensation cases and hospital records. Exposures and health problems underrepresented in these sources were identified and estimates obtained of overall underreporting. Finally, survey data on the knowledge and practices of the study population describe mechanisms that help prevent the appearance of their work-related health problems in these data sources. This understanding will aid in the assessment and evaluation of other available data on the occupational health of vulnerable populations.

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A variety of studies have recognized the incompleteness of occupational health surveillance data in the U.S. Surveillance data are particularly expected to miss certain populations, such as low-wage, contingent, and immigrant workers; and certain health problems, such as diseases with ambiguous symptoms (Baker, 1989; Campos-Outcalt, 1994; McCaig et al., 1998). The populations of workers often lost to surveillance are in many cases suspected to be most affected by workplace hazards. Thus, gaps in occupational health surveillance for these groups may result in significant underestimates of the occupational injury and disease burden in this country.

To provide a more detailed picture of one group of workers, this study investigates the occupational health status of Southeast Asian immigrants and refugees in Lowell, Massachusetts. Findings from existing occupational health data sources are compared to original findings from a community-based survey.

Background

Healthy People 2000 (USDHHS, 1991) identifies ethnic groups with large numbers of recent immigrants as being at special risk for work-related health problems. Immigrants are more likely to work at dangerous, low-wage, insecure, and low status jobs than the general population (Meisenheimer, 1992; Mort, 1996). Some employers deliberately hire immigrants for dangerous work and save money on training, engineering controls, and protective equipment. Legal protections against retaliation for complaints about working conditions are rarely enforced (Mort, 1996; Stephenson, 1995; Parker and Solomon, 1995; Griffith 1990).

The results of these conditions for immigrants can be seen in the limited available data suggesting high levels of health problems among workers from minority groups which include many recent immigrants. The U.S. population of Hispanics, for example, includes large proportions of immigrants as well as people whose families have lived within the current boundaries of the U.S. for many generations. Kilborn (1992) reviewed studies from several states showing that Hispanic workers, including legal residents, have injury and illness rates two to three times higher than whites.

California data from 1988 showed that Hispanics aged 15 to 64 had an annual age-adjusted incidence rate of work-related eye injury of 3.72/100,000, compared to 2.98 for non-Hispanic whites and 2.01 for African-Americans. Hispanic men ages 25-29 had a rate of 8.3/100,000 of work-related eye injuries, all of which were classified as severe (Baker et al., 1996).

Little occupational health information is available for other immigrant groups, but it has been demonstrated that immigrants in general, Asians as well as Hispanics, are victims of workplace violence and homicides at rates more than twice as high as their proportion in the workplace (Toscano, 1996; Windau, 1997).

Southeast Asians in Lowell

People fleeing war, genocide, and economic collapse in Cambodia, Laos and Vietnam constitute the largest group of refugees ever to settle in the U.S. A total of 1,342,532 Southeast Asian refugees immigrated between 1975 and 1998. This group now comprises one sixth of the Asian Pacific-American population, itself the fastest-growing racial group in the country (US Executive, 2000). The vast majority of Cambodians arrived between 1979 and 1986, with immigration peaking in 1981-82 (Bunte and Joseph, 1992).

More Cambodians live in Lowell, Massachusetts than any other city in the U.S. except Long Beach, California. Estimates of the number of Cambodians residing in Lowell range from 20,000 to 33,000 (McNeilly, 1998; Rodriguez, 1999; Cox, 2000). Other residents include approximately 5,000 Lao (Meehan, 1999).

Healthy People 2000 (USDHHS, 1991) identified Southeast Asian refugees as a high-risk group due to poverty and occupational vulnerability. Cambodians and Lao have the highest poverty rates of any Asian-American groups except Hmong. Data from the early 1990's showed 42% of Cambodians living below the poverty level, with this figure rising to 55% among Cambodian households in Lowell. At the same time unemployment rates for Cambodians in Lowell exceeded 8% (US Executive, 2000; US Defense, 1993; Silka and Tip, 1994; Cox, 2000).

Proportions of Cambodians fluent in English fell as low as 10% among people arriving in the last years of the mass migration. A 1998 assessment by the Massachusetts Department of Public Health found that only 5.3% of Cambodian immigrants spoke English "very well". In the early 1980's, 44% of Cambodian and 53% of Lao refugees had had no formal education. About 20% of Lao refugees can read their own language. In 1990, only 6% of Cambodians and 7% of Lao over 25 had a bachelor's degree (US Executive, 2000; Morrow, 1991; Silka and Tip, 1994; Cox, 2000).

Additional risk factors for Southeast Asian health have included discrimination and overt racism by judges, police, school officials, and others. Episodes of mistreatment and harassment culminated in a public remark made publicly by a Lowell judge in the early 1990's, when he suggested that Cambodians should be sent back to the Killing Fields, where a large proportion of the population was murdered in the 1970's (Silka and Tip, 1994).

All these factors have contributed to overrepresentation of these groups in traditionally hazardous blue collar industries. For example, just 5% of Lao workers in the U.S. have found employment in technical, sales, or administrative support (Morrow, 1991; US Defense, 1993; Silka and Tip, 1994; Cox, 2000).

At the same time, other factors make Cambodians and Lao less vulnerable to the worst working conditions than many workers from other countries. Most Southeast Asians,

except the most recent arrivals, have legally recognized refugee status with permission to live and work in this country. Many have benefited from educational programs and other support resulting from the Migration and Refugee Assistance Act of 1975 (US Defense, 1993). As a result, these refugees are not forced by lack of work permits or fear of deportation to accept substandard working conditions or avoid medical care.

Gathering occupational health data from Cambodians and Lao also presents challenges. The low rates of English fluency and literacy noted above preclude widespread use of mail-in surveys or other written questionnaires. Refugees' experiences with their own governments have made many hesitate to participate in studies. The Khmer Rouge government conducted a census in preparation for killing half a million people based on the occupations they reported to census takers (Rodriguez, 1999). General anxiety and concern about street crime in their neighborhoods and swindles described as public interest activities contribute to Southeast Asians' reluctance to speak with interviewers they do not know (Bunte and Joseph, 1992; Chung and Kagawa-Singer, 1993).

Refugees' refusals to open the door to enumerators was one factor leading to an estimated 50% undercount of Lowell Southeast Asians in the 1990 census (Rodriguez, 1999). An Alternative Enumeration conducted in Long Beach, California, following that census found that knocking on doors often failed to achieve entrance to Cambodian homes even when residents were clearly visible inside. (Bunte and Joseph, 1992). Therefore, face-to-face interviewers belonging to and well-known among Southeast Asian communities seem necessary for effective surveys. In Lowell, connection with the University of Massachusetts carries some additional legitimacy due to a series of successful programs with Asians in that city (Silka and Tip, 1994).

Data Sources

Data sources commonly available for studying the occupational health of defined populations include workers' compensation wage replacement data from state systems and hospital data. In this study, complete workers' compensation wage replacement data were available for the target population for a defined period of time. Hospital data from Lowell's largest hospital were available for a similar period. The third data source, direct interviews with the target population, was sampled in a survey performed as part of this study.

The target population of the study is defined as "Lowell residents of Cambodian or Lao ethnicity who worked for wages at any time between 1997 and 1999." The object was two-fold: to describe the occupational health status of this population, and to describe the utility of data sets from three different sources in doing so.

Methods

Workers' Compensation Data

Employers are required to submit First Reports of Injury to the Massachusetts Department of Industrial Accidents (DIA) when employees miss more than five days of work due to a work-related illness or injury. Employees may also file if their employer fails to do so (Massachusetts, 1999).

The DIA supplied names corresponding to Lowell residents' cases filed with the Department from July 1, 1997 through August 9, 1999. Lao and Cambodian consultants identified names belonging to their respective ethnic groups. The DIA supplied copies of complete records for these cases, with personal identifiers removed.

Causes of injury were coded by the investigator based on descriptions in case documentation. Categories for cause were based on source and event categories used by the Bureau of Labor Statistics, with specific distinctions added based on incidents frequently noted in the records (e.g. accidents due to maintaining machinery, accidents due to using machinery).

Hospital Data

Saints Memorial Medical Center (SMMC) is the largest provider of medical care in the Lowell area. Data from SMMC Health Information Services (HIS) were provided by the HIS Director and tabulated by the investigator. Data were selected in two queries: treatment dates January 1, 1996 - May 31, 1999, patient ages 12-99, race Asian, and financial class workers' compensation; and treatment dates January 1, 1996 - May 31, 1999, patient ages 12-99, race Asian, any financial class.

Data provided included date of visit; gender and age of the patient; diagnostic code based on current editions of the International Classification of Diseases, 9th Revision, Clinical Modification; and Supplementary Classification of External Causes of Injury and Poisoning code based on the same source. All coding had been performed by professionally trained staff at the hospital.

Survey

Cambodian and Lao consultants were chosen due to their leadership and trusted roles in their respective communities and their activities with community-based organizations. The survey questionnaire was designed by English-speaking researchers with input from the consultants and the project's Advisory Board of health professionals and community agency staff. It included open-ended questions about work experience and health and closed-ended questions about common work-related symptoms. The consultants translated the questionnaire. It was field-tested in 10 households and revised based on apparent ambiguities and misunderstandings.

An informed consent form was designed in accordance with NIOSH and University policies for the protection of human subjects and also translated.

The survey was administered orally by researchers in the language chosen by the person interviewed. Khmer- and Lao-speaking researchers interpreted as necessary.

Cambodian households were selected from the two Lowell census tracts with the greatest proportions of Cambodians according to the 1990 census. Based on those numbers, assumed census undercounting, and the subsequent growth of the Cambodian population, no more than 22% of Cambodian households were approached, and no more than 20% actually surveyed.

Households were located through telephone listings with Khmer surnames as identified by the Cambodian consultant, and street addresses corresponding approximately to the selected census tracts. Households were selected through a combination of systematic representative sampling (names selected at regular arithmetic intervals from alphabetic listing), and convenience (people visibly at home during researcher presence in a neighborhood).

Participation by the sub-sample of households systematically selected to be representative was analyzed separately. The proportion of the systematically selected households that refused participation was similar to that in the overall sample.

Lao households were selected from the three Lowell census tracts with the greatest proportions of Lao residents according to the 1990 census. No more than 60% of households were approached, and no more than 46% actually surveyed.

Households were located through telephone listings with Lao surnames as identified by a Lao research team member, and street addresses corresponding approximately to the selected census tracts.

Data were entered and tabulated using Microsoft Access. The database was compared with hard copy and corrected. Descriptive statistics were calculated manually. Categories of responses to open-ended questions were based on the responses.

Factors associated with reporting any work-related symptom during the past two years were identified with logistic regression using SAS version 6.12 (SAS Institute,). An additional outcome variable was defined limiting the self-reported symptoms to signs readily observable by a layperson, including contusion, cut, fracture, rash, and running nose. Independent variables included in the models for predicting symptoms or signs were gender, age, hazardous industry (manufacturing, warehousing, or shipping), working more than 40 hours per week at any time during the past two years, working a late night shift any time during the past two years, temporary employment, and lack of safety training on the job.

Prevalence ratios provide a more accurate estimation of relative risk than do odds ratios when outcomes are highly prevalent. Factors found to be predictive of the outcome of

interest were therefore modeled using proc genmod to estimate the prevalence ratios associated with them (Thompson et al., 1998).

Bureau of Labor Statistics Data

Bureau of Labor Statistics (BLS) data based on sampled OSHA logs were examined for comparison purposes. Data used refer to lost-workday cases for all workers in Massachusetts in 1998.

Comparisons of Data Sources

The three data sources were compared using three approaches: integrated/qualitative, reductionist/quantitative, and case studies.

For quantitative comparisons, discrete data common to all three sets were recoded, counted and compared. These included gender, age, illness/injury, and cause of illness/injury. The DIA, survey, and BLS data sets also included information on industry.

For the purpose of comparison, each data set was broken down into "cases." For the DIA data a "case" simply corresponded to the individual cases as filed, that is an episode of five or more lost workdays due to a work-related health problem. For the hospital data, a "case" was defined as a set of one or more hospital visits in one month by the same person due to the same cause of injury. For the survey data, a "case" was defined as all health problems affecting an individual that resulted from an identified incident. Some analyses examined separately the survey cases for which medical care was sought.

Data common to multiple sources were coded using the same coding systems across data sets. All ages were recoded to date of birth. Injuries and illnesses were coded according to the BLS codes mandated by the DIA system. Causes of injury were coded according to the External Cause of Injury Codes (E Codes) listed in the ICD-9 Manual and used in the SMMC data. These were coded by the investigator with consultation with SMMC professional coders in cases of ambiguity.

Causes of dermatitis are not specified by E Codes, but by ICD-9 diagnostic codes corresponding to dermatitis. Therefore, diagnostic codes were assigned to causes of dermatitis.

Standard Industrial Classification (SIC) Codes were used to code industries. DIA data include the name and address of employers, so for these cases SIC codes were assigned through employer searches first, in Webster's Online Business Guide; then, in OSHA Inspection Data; and, in the absence of information from either of these sources, according to descriptive information in the SIC Manual.

Employer names and addresses were not requested in the survey. In cases where respondents volunteered them, SIC codes were assigned as for the DIA data. In most cases, they were assigned by the investigator based on respondents' descriptions of their jobs and the SIC Manual.

Survey data indicate that people under 26 and men were underrepresented in the survey sample relative to their participation in the labor force. Age and gender composition of the work force among the target population was not known. It was therefore assumed that employment levels in birth year brackets 1946-50 through 1976-80 were high and relatively uniform. For some analyses approximate corrections for sampling bias were made by multiplying prevalences in each of these age groups by the inverse proportion of that age group in the total sample born 1946 through 1980.

Case studies were conducted by identifying cases from the survey data that matched the criteria for inclusion in the other data sets, and seeking corresponding information in those sets.

Qualitative comparisons were obtained by investigating the complete contents of each data set separately. Conclusions were then drawn separately regarding the occupational health status of the study population. Finally, conclusions based on all data sets were compared.

Analysis of Differences Among Data Sources

Differences in data analyzed from the three data sources should correspond to five types. The two types of variance of principal interest in this study refer to differences among workers' compensation, hospital, and survey data: intentional differences among the types of cases targeted by each data collection system, and discrepancies between the types of cases targeted and those actually captured. Three other types of variance refer to differences between cases in the complete data sources and those in the samples used in analysis: bias in selection of samples from each source, random variation in selection of samples from each source, and non-differential error. Investigators attempted to describe and control for these latter types of variance in order to isolate and examine the first two.

When differences were noted between two data sets, investigators first sought to explain them in terms of selection bias, random variation, and coding error. When these explanations did not readily explain differences, explanation due to designed differences in data collection systems was attempted. Discrepancies between types of cases targeted and those actually captured were used to explain differences only after the four more conservative explanations failed to do so.

Bias in Selection of Samples for Analysis

DIA data were used as an example of examining state workers' compensation data to describe a defined population. The data used in this study should completely cover subjects defined as "Lowell residents with Cambodian or Lao surnames for whom reports of five or more lost workdays were filed with the Division of Industrial Accidents, date of injury July, 1997 through July, 1999." Therefore, selection bias should not be a factor in the interpretation of these data.

SMMC data were used as an example of application of hospital data to describe a defined population. However, the data used in this study represent only a portion of subjects defined as "Lowell residents classified by health professionals as Asian who sought medical care at a hospital for a condition coded as work-related, January, 1996 through May, 1999." SMMC is the largest health care provider in Lowell, but the exclusion of other hospitals may result in selection bias of unknown quality and magnitude in using these data as an example of area hospital data.

Survey data did not evenly reflect the subjects defined as "Lowell residents of Cambodian or Lao ethnicity who have worked for wages since 1997." People meeting that definition were excluded if they did not live in the three census tracts with the largest Southeast Asian populations, were not listed in the telephone directory, were repeatedly unavailable upon researchers' visits, or refused to participate. Some Cambodian participants were included based on their availability regardless of their inclusion by researchers' representative sampling schemes. As a result, survey data are likely to select against people working in the informal economy, multiple jobs, or extended overtime. These sources of bias, in turn, are likely to have a conservative effect on estimates of occupational illness and injury.

Men and young people were less likely to be found at home than women and older people. It is therefore probable that disproportionately small numbers of people under 26 and men were interviewed relative to their participation in the labor force.

Random Variation in Selection of Samples for Analysis

No random bias is expected in the DIA data set, since all data from that source were used in analysis. Since SMMC is the largest hospital in the Lowell area, investigators estimate that close to one half of work-related hospital visits by members of the target population take place at this facility. Therefore, random variation between findings in area hospital data as a whole and data from this hospital alone is unlikely to be significant.

Survey data were gathered from only a small proportion of potential subjects: 160 of an estimated 25,000 Cambodian and Lao workers living in Lowell. Therefore, the potential for random sample variation is large. Assuming independence of observations, and using a normal sampling distribution, this means that the prevalence of a condition in the

underlying target population would have to approach 4% before being observed at least once in 95% of 160-member samples.

Non-Differential Error

The high level of professional training among hospital staff and multiple checks of the survey data render this error an unlikely contributor to significant misinterpretation.

Intentional Differences Among Types of Data Collected

The Division of Industrial Accidents gathers information only on workers who miss five or more days of work due to work-related health problems. The hospital, on the other hand, seeks to code as work-related all occupational injuries and illnesses requiring medical attention. These sources rely on the opinions of medical professionals both to diagnose illness and recognize work-relatedness. The survey gathered data based on self-reports of both illness and work-relatedness, regardless of severity, lost work time, or need for medical attention.

The use of surnames and home addresses for case definition allowed specific targeting of Cambodian and Lao Lowell residents in the DIA sample. The ambiguity of some surnames which can belong to Vietnamese or Chinese may have resulted in the inclusion of subjects from these groups in numbers unlikely to be significant given the city's population. Face-to-face contact permitted the exclusion of all non-targeted ethnic and residential groups for the survey. Hospital cases, however, were defined as ethnicity coded "Asian," and are therefore likely to include small numbers of Indian immigrants, other immigrants, and Asian-Americans, as well as people residing in the hospital catchment area but outside the city.

These designed differences in data collection would be expected to manifest themselves in several differences in the data:

- DIA data would be expected to contain disproportionately severe or long-lasting health problems resulting in inability to work.
- Hospital data would be expected to contain a disproportionate number of acute and severe injuries requiring immediate care.
- Hospital data may include more health problems associated with white collar work.
- DIA and hospital data would be expected to undercount illnesses lacking readily identifiable signs or with ambiguous work-relatedness.
- Survey data would be expected to disproportionately reflect illnesses with sub-clinical severity, as well as problems suited to treatment at a family doctor's office rather than immediate care at a hospital.

Results

Data Collected

Of all visits to SMMC by Asians ages 12-99 during the period under study, 187, or 9.2% of such visits, were charged to workers' compensation. Of all visits for all patients charged by the hospital to workers' compensation, 1.1% corresponded to Asians.

DIA cases belonging to Lowell residents and corresponding to the dates specified totaled 1,884. Of these, 80 (4%) were identified as pertaining to the ethnic groups under study. Complete records were supplied for these 80 cases. Of the 80 records, 69 (86%) included the employers' required First Report of Injury. Of the 69 First Reports, 44 (55% of records) contained injury and body part codes consistent with other information in the documents.

Twenty-four DIA case records (30%) lacked SIC codes. Of those that included SIC codes, 34 agreed with reassigned codes to at least two digits (industry major group). Eight, or 10%, of the records categorized the employer in entirely different industrial divisions (e.g. manufacturing as opposed to services) than did the reassigned codes. Four records (5%) did not include sufficient information to assign any SIC code.

Of 19 First Reports for women, nine, or 47%, contained injury, illness and body part codes consistent with other information in the records. Of 50 records for men, 35, or 70%, contained consistent codes. A chi-square test showed that this odds ratio of 2.6 for men rather than women having accurately coded First Reports was statistically insignificant.

The majority of First Reports filed for electronics manufacturing and services contained illness, injury, or body part codes inconsistent with other information in the records. For the cases overall, the most prevalent inconsistently coded injury was sprains and strains. The type of injury with the highest proportion of miscoding was contusions; just over one quarter of contusions described in case records were coded as such.

Table 1. Comparison between SIC codes given on First Reports in DIA cases and those reassigned^a for this study

agreement in SIC code between sources	number of records
matching 4-digit code	3 (4%)
matching 2-digit code (major group), only	31 (39%)
matching division, only	9 (11%)
disagreement in division	8 (10%)
no code in DIA documents, only reassigned code available	21 (26%)
only code from DIA documents, insufficient information to reassign code	4 (5%)
no code in DIA documents and insufficient information to assign code	4 (5%)
total	80 (100%)

^a SIC codes in records were reassigned based, first, on Websters Business Service, then on OSHA inspection records, then on investigator's judgement based on information in records (18 records coded by investigator's judgement: 11 matching to 2 digits; 2 matching division; 5 no code in DIA documents).

A total of 160 respondents from 112 households participated in the survey (Tables 2 and 3). Approximately 11% of Cambodian households approached declined participation. Approximately 24% of Lao households were repeatedly unavailable, or, in the case of three, declined participation. In participating Cambodian homes, at least 39 people, or one quarter of those sought, refused participation or were unavailable. Five Lao individuals in participating households were unavailable.

Respondents were distributed among five-year age brackets between 26 and 50 years of age, with at least five respondents from each ethnic group in each age bracket (Table 5). Respondents were almost evenly divided by gender (Table 4). Among Lao respondents, teenagers and young adults were disproportionately unavailable and therefore undersampled.

Table 2. Cambodian Households Surveyed

	households	interviews		individual refusals (in participating households)			individuals unavailable (in participating households)		
		f	m	f	m	ND	f	m	ND
participating households	57 (89%)	45	41	5	5	2	11	14	2+
non-participating households (refused)*	7 (11%)	0		NA					
totals	64 (100%)	86		12			27+		

* Numbers of unavailable houses not included in these numbers. Cambodian households were selected based partly on convenience and presence of people at time of interviews.

Table 3. Lao Households Surveyed

	households	interviews		individual refusals (in participating households)		individuals unavailable (in participating households)		
		f	m	f	m	f	m	ND
participating households	55 (76%)	37	37	0	0	2	1	2
non-participating households (refused or unavailable)*	17 (24%)	0		NA				
totals	72 (100%)	74		0			5	

*All listed Lao households in target census tracts were attempted.

Quantitative Comparisons

Table 4. Gender by Data Source (percent of cases)

	Percent of DIA cases (n=80)	Percent of Hospital Cases (n=163)	Percent of Survey Cases (n=208)	Percent of Survey Cases, Medical Care Sought (n=23)
female	24	31	50	61
male	64	69	50	39
gender unknown	13	0	0	0

Age and Gender

Approximately two thirds of cases in the DIA and SMMC data sets involved males. In the case of the survey, half the cases involved males. The most conservative explanation for this difference is selection bias, since 51% of survey respondents were women. Participation rates in the labor force are not readily available for gender and specific ethnicities, but in the U.S. overall the prevalence of employment among Asian men is approximately 1.3 that of Asian women (USBLS, 1998). Thus, when gender breakdown is corrected for survey participation and estimated labor force participation it appears consistently at two thirds male for all three sources.

When survey cases requiring medical care were analyzed separately, the proportion of females rose to 61%. The most conservative explanation for this difference is random sample variation. Assuming the true underlying proportion of females among survey cases is 0.5, 95% confidence intervals were calculated for this subsample as (0.4, 0.8). Therefore, this proportion is not significantly different from the underlying proportion of females.

DIA and SMMC cases are distributed differently among age groups. People born between 1946 and 1960 account for two to three times the proportions of DIA cases as SMMC cases. People born between 1961 and 1970 account for twice the proportion of SMMC cases as DIA cases. Because DIA cases comprise the complete workers' compensation data source and SMMC cases comprise approximately one half the hospital data source, random variation is not a factor in these differences. Survey data corrected for selection bias by age show more than twice the proportion of cases corresponding to people born 1971-1975 than in either the DIA or SMMC data. In the case of the survey data the calculation of a 95% confidence interval for this proportion is appropriate:

(14.5%, 25.3%), and confirms the significance of higher proportions of cases corresponding to this age bracket.

Table 5. Year of Birth by Data Source (percent of cases)

Five-Year Birth Brackets	Percent of DIA Cases (n=80)	Percent of Hospital Cases (n=163)	Percent of Survey Cases (n=206)	Survey Corrected for Numbers Interviewed
1926-30	1.3	0.0	0.0	NA
1931-35	0.0	0.5	0.0	NA
1936-40	2.5	1.6	1.9	NA
1941-45	2.5	3.2	2.8	NA
1946-50	10.0	3.2	4.2	9.2
1951-55	17.5	9.6	10.3	7.8
1956-60	20.0	9.6	19.6	12.5
1961-65	10.0	20.2	18.7	12.7
1966-70	15.0	30.9	7.5	9.9
1971-75	7.5	8.0	12.1	19.9
1976-80	11.3	12.8	10.3	12.7
1981-85	1.3	0.5	12.6	NA
no data	1.3	0.0	1.0	NA

Industry

Table 6. Private Sector Employment in Lowell by 2-Digit SIC Code, 1998, All Residents: Industries accounting for 2.0% or more of subjects from either source

Standard Industrial Classification, Industrial Major Group	Percent Employment in BLS Data (n=46,872)	Percent of Survey Respondents (n=160)
22 Textile Mill Products	3.4	1.9
30 Rubber and Miscellaneous Plastic Products	<0.5	3.8
32 Stone, Clay, Glass and Concrete Products	confidential	3.1
34 Fabricated Metal Products, Except Machinery and Transportation Equipment	0.6	2.5
35 Industrial, Commercial Machinery and Computer Equipment	1.9	3.8
36 Electronic, Other Electrical Equipment, Except Computers	4.5	23.8
38 Measuring, Analyzing, and Controlling Instruments	<0.5	3.1
58 Eating and Drinking Places	4.1	3.1
73 Business Services	5.7	1.3
80 Health Services	11.3	0.0
83 Social Services	2.9	0.0

Table 7. Industries Accounting for 2.0% or More of Cases from BLS Massachusetts Data, DIA Data, and Survey Data

Standard Industrial Classification, Industrial Major Group	Percent of BLS Massachusetts Lost Workday Cases, 1998 (n=48,300)	Percent of DIA Cases (n=80)	Percent of Survey Cases (n=206) (95% CI)	
20 Food and Kindred Products	2.1	8.8	2.9	(0.6, 5.2)
22 Textile Mill Products	8.3	3.8	1.0	(0.0, 2.4)
23 Apparel and Other Finished Products Made From Fabrics and Similar Materials	6.2	0.0		0.0
24 Lumber and Wood Products, Except Furniture	4.1	3.8	2.9	(0.6, 5.2)
26 Paper and Allied Products	1.2	6.3	1.9	(0.0, 3.8)
30 Rubber and Miscellaneous Plastics Products	2.1	8.8	3.4	(0.9, 5.9)
32 Stone, Clay, Glass and Concrete Products	0.6	0.0	5.5	(2.4, 8.6)
33 Primary Metal Industries	0.8	3.8	0.5	(0.0, 1.5)
34 Fabricated Metal Products, Except Machinery and Transportation Equipment	2.9	3.8	2.5	(0.4, 4.6)
35 Industrial and Commercial Machinery and Computer Equipment	2.7	8.8	4.4	(1.6, 7.2)
36 Electronic and Other Electrical Equipment and Components, Except Computer Equipment	1.2	13.0	39.8	(33.1, 46.5)
38 Measuring, Analyzing, and Controlling Instruments	1.2	8.0	3.4	(0.9, 5.9)
42 Motor Freight Transportation and Warehousing	2.5	6.3		0.0
50 Wholesale Trade: durable goods	7.5	0.0		0.0
54 Food Stores	5.0	0.0	4.4	(1.6, 7.2)
58 Eating and Drinking Places	4.6	1.3	8.3	(4.5, 12.1)
59 Miscellaneous Retail	1.9	0.0	3.4	(0.9, 5.9)
70 Hotels, Rooming Houses, Camps, and Other Lodging Places	1.4	2.5	0.5	(0.0, 1.5)
73 Business Services	3.5	6.3	1.5	(0.2, 3.2)
80 Health Services	15.0	6.3		0.0

Table 6 shows BLS data on prevalent industries of employment in Lowell and industries of employment among survey respondents. Electronics manufacture, major group 36, employed an average 4.5% of Lowell workers in 1998, and 23.8% of survey respondents. Health services, major group 80, employed 11.3% of Lowell workers and no survey respondents.

Table 7 shows two-digit SIC codes, or major industry groups, corresponding to more than 2.0% of cases listed in BLS state data for 1998, DIA cases, or survey cases. Of survey cases, 39.8% (95% CI 33.1%, 46.5%) correspond to electronics manufacturing. This code accounts for 13.0% of DIA cases. Rubber and Miscellaneous Plastics Products; Food and Kindred Products; Measuring, Analyzing and Controlling Instruments; Industrial and Commercial Machinery and Computer Equipment; Paper and Allied Products; Business Services; and Health Services corresponded to more than 5% of DIA cases but not survey cases. Eating and Drinking Places and Stone, Clay, Glass and Concrete Products accounted for more than 5% of survey cases but not DIA cases. All these differences were statistically significant.

Coding error may account for some of these differences. DIA data may code cases of employees contracted through temporary agencies according to the industry worksite or as business services, 73, depending on workers' compensation arrangements and other factors. Given the high prevalence of temporary employment in the survey sample, it is likely that some cases in manufacturing would have been coded as 73 by the DIA.

However, coding error and random variation do not easily account for the significantly higher proportions of survey cases involving electronics assembly and eating and drinking places, or the higher proportions of DIA cases involving health services and paper and allied products. It is also difficult to explain these differences with intentional differences in data collection systems or selection bias.

**Table 8. Injuries Accounting for over 2.0% of Injuries From Any Source,
 Coded by BLS Injury Codes**

Injury Codes	Percent of DIA Injuries (n=97)	Percent of Hospital Injuries (n=157)	Percent of Survey Injuries (n=219) (95% CI)	Percent of Survey Injuries, Medical Care Sought (n=34)
120 burn (heat)	2.1	5.7	6.8 (3.5, 10.1)	0.0
140 concussion	2.1	0.6	0.0	0.0
150 infective or parasitic disease	0.0	1.9	0.5 (0.0, 1.4)	0.0
160 contusion, crushing, bruise	19.6	14.6	8.7 (5.0, 12.4)	8.8
170 cut, laceration, puncture	9.3	22.9	11.4 (7.2, 15.6)	2.9
180 dermatitis, unspecified	0.0	0.0	6.8 (3.5, 10.1)	5.9
200 electric shock, electrocution	0.0	0.0	1.4 (0.0, 3.0)	0.0
210 fracture	9.3	7.6	0.5 (0.0, 1.4)	2.9
230 hearing loss or impairment	0.0	0.0	2.7 (0.6, 4.8)	0.0
240 effects of environmental heat	0.0	0.0	0.9 (0.0, 2.2)	2.9
250 hernia, rupture	2.1	0.0	0.0	0.0
260 inflammation of joints, etc	2.1	0.6	0.0	0.0
270 poisoning, systemic, unspecified	0.0	0.0	0.5 (0.0, 1.4)	2.9
271 poisoning due to materials not lead	0.0	1.3	0.0	0.0
300 scratches, abrasions	2.1	5.7	0.0	0.0
310 sprains, strains	37.1	27.4	21.9 (16.4, 27.4)	38.2
530 eye, other diseases of the eye	0.0	1.9	5.0 (2.1, 7.9)	5.9
540 mental disorders	0.0	0.0	0.5 (0.0, 1.4)	2.9
570 respiratory system, unspecified	0.0	0.6	1.8 (0.1, 3.5)	2.9
572 asthma, influenza, pneumonia	0.0	0.6	0.5 (0.0, 1.4)	2.9
580 symptoms and ill-defined conditions	0.0	1.3	28.3 (22.3, 34.3)	17.6
999 unclassifiable	3.1	3.8	0.0	0.0
uncoded	5.2	1.3	0.5 (0.0, 1.4)	2.9

Injury Type

Types of injury sorted by BLS code are shown in Table 8. The most common injuries from all three data sources included 310, sprains and strains (37.1% of DIA injuries, 27.4% of SMMC injuries, and 21.9% of survey injuries); 170, cut, laceration, puncture (9.3%, 22.9%, 11.4%); 160, contusion, crushing, bruise (19.6%, 14.6%, 8.7%); and fractures (9.3%, 7.6%, 2.9%). The relatively high proportion of DIA injuries coded as sprains and strains, high proportion of hospital injuries coded as cuts and lacerations, and low proportion of survey injuries coded as fractures are all consistent with intentional differences in data collection: sprains and strains are expected to account for extended periods of lost work time; cuts and lacerations require treatment in hospitals more than most other types of injuries; fractures are expected to be a common reason for hospital visits and lost worktime but not as common in the source population.

The most common injury in the survey data, 580, symptoms and ill-defined conditions, made up 28.3% of all injuries reported in the survey (95% CI 22.3%, 34.3%). This injury accounted for only 1.3% of injuries recorded in the hospital data and none in DIA data. Code 180, dermatitis, made up 6.8% of survey cases (95% CI 3.5%, 10.1%) but none of the common injuries in the other data sets. The confidence intervals show that these changes are not readily explained by random variation. Nor is it reasonable to expect that they might be explained through selection bias or coding error. Intentional differences between cases captured by the DIA and survey might account for this difference if these problems are not severe or long-lasting enough to result in five or more lost workdays. However, levels of severity requiring medical care do not explain differences between survey and hospital data since symptoms and ill-defined conditions accounted for 17.6% of survey injuries associated with medical care and dermatitis accounted for 5.9%.

Table 9. External Causes of Injury Accounting for Over 2.0% of Causes From Any Source, Coded by ICD-9 Codes

ICD-9 Codes	Percent of DIA E Codes (n=80)	Percent of Hospital E Codes (n=164)	Percent of Survey E Codes (n=204)
692 (diagnostic code) contact dermatitis and other eczema	0.0	0.0	3.9 including 692.5, Due to food in contact with skin 1.0; 692.6, Due to plants 1.0; 692.83, Due to metals 0.5
E862 Accidental poisoning by petroleum products, other solvents and their vapors	1.3	0.0	2.9
E880 Fall on or from stairs or steps	2.5	0.0	0.0
E882 Fall from or out of building or other structure	2.5	0.0	0.0
E883 Fall into hole or other opening in surface	2.5	0.0	0.0
E885 Fall on same level, tripping, slipping, or stumbling	6.3	1.2	0.5
E887 Fracture, cause unspecified	0.0	2.4	0.0
E888 Other and unspecified fall	1.3	2.4	0.0
E914 Foreign body accidentally entering eye and adnexa	0.0	3.7	0.5
E916 Struck accidentally by falling object	8.8	0.0	1.0
E917 Striking against or struck accidentally by objects or persons	2.5	9.1	4.9
E918 Caught accidentally in or between objects	0.0	3.7	0.5
E919 Accidents caused by machinery	18.8	11.6	1.0

ICD-9 Codes	Percent of DIA E Codes (n=80)	Percent of Hospital E Codes (n=164)	Percent of Survey E Codes (n=204)
E920 Cutting and piercing instruments or objects	3.8	23.8 including E920.5, Hypodermic needle 3.7	9.4
E924 hot substance or object, caustic or corrosive material, and steam	1.3	2.4	8.8
E927 Overexertion and strenuous movements	28.8	14.6	36.0
E928 Other and unspecified environmental and accidental causes	1.3	0.0	2.5 E 928.1, Exposure to noise 2.5
E999 Not classifiable	0.0	0.0	12.3
no data	12.5	0.0	6.4

External Causes of Injury

External causes of injury accounting for at least two percent of E Codes in each source are listed in Table 9. External injury codes highly prevalent in all three lists include E927, overexertion and strenuous movements (28.8% of DIA cases, 14.6% of hospital cases, and 36.0% of survey cases); E920, cutting and piercing instruments or objects (3.8%, 23.8%, 9.4%); and E917, striking against or struck accidentally by objects or persons (2.5%, 9.1%, 4.9%). Falls account for 13.8% of DIA external causes and 2.4% of hospital causes but less than two percent of survey causes. Exposure to solvents comprised 2.9% of external causes for survey cases and exposure to noise accounted for 2.5%, but these causes did not appear in the other lists. Diagnostic codes which identify causes of dermatitis were used to describe 3.9% of survey causes and none in the other lists.

Some of these changes may be explained by coding error. Several cases lacked sufficient information to code external causes, resulting in 12.5% of DIA causes and 6.4% of survey causes coded as no data. An additional 12.3% of survey causes were not considered classifiable according to the E Code scheme. Other differences are readily explained by intentional differences in data collection systems. For example, the much higher proportion of external causes coded as cutting and piercing instruments in hospital data is consistent with the expected high proportion of such accidents treated at a hospital rather than being seen at a family doctor's office or remaining untreated. Likewise, falls would reasonably be expected to result in several days of lost work, and thus disproportionately common in the DIA data.

The restriction to survey data of external causes coded as exposure to solvents or other chemicals is not readily explainable by designed differences in data collection systems. Chemical exposure can result in both hospital treatment and lost workdays. The presence

of allergenic agent exposure in the survey data alone is also not explainable by random variation, since 3.9% is significantly different from 0. The 2.9% proportion attributed to solvent exposure is not significantly different from 0. However, these differences between the survey and other data raise questions about the absence of chemical exposures in the DIA and hospital data.

Case Studies

Table 10. Survey Participants Reporting Medical Care at SMMC for Work-Related Health Problems Since 1997

Characteristics of Subject	Self-Reported Injury	Self-Reported Cause of Injury	Self-Reported Month of Treatment	In SMMC Records of Workers' Comp. Cases, 1/96-5/99	In SMMC Records of any Financial Class, 1/96-5/99	Month of Treatment in SMMC Records
Lao male	cut and bruise	caught by malfunctioning machine	6/98	yes	yes	5/98
Lao female	bruise	hit by forklift	10/98	no	possibly	10/98
Lao male	bruise and headache	struck by falling lumber	12/98	yes	yes	12/97
Lao male	backache	lifting heavy lumber	2/99	yes	yes	5/99
Lao female	cut	sharp metal	unable to recall	no	no	NA
Lao male	cut	wood cutting machine	unable to recall	no	no	NA
Lao male	fracture	struck by falling wood	unable to recall	no	no	NA

Table 10 describes the cases of survey respondents who reported receiving treatment at SMMC for work-related health problems since 1997. Of the four who were able to provide approximate months of treatment, three were found in the SMMC data set within one year of the self-reported date. The fourth was not in the SMMC data set of work-related injuries, but matched part of the description of a case treated at SMMC but not coded as work-related. Three respondents who were not able to recall a date of treatment were not found in the data set.

The most conservative explanation of these discrepancies is coding error. The respondents missing from the SMMC database may have reported injuries occurring before the 1996 cutoff date of the SMMC data as well as the 1997 cutoff in the survey data. However, all involved injuries were severe and traumatic, so it is worth noting that all three must have misidentified the time of accident by more than one year.

It is also interesting to note that all workers reporting treatment at SMMC for work-related injuries were Lao.

Table 11. Survey Participants Reporting Five or More Lost Workdays Due to Work-Related Health Problem Since 1997

Demographic Characteristics of Subject	Self-Reported Injury	Self-Reported Cause of Injury	Self-Reported Month of Treatment	Report Receiving Workers' Compensation	In DIA Records of >5 Lost Workdays, 7/97-7/99
Lao female	backache	sitting too long soldering for electronics assembly	12/97	no	no
Lao female	dizziness, headache, problems breathing	solvent used to clean wires in electronics assembly	6/98	no	no
Lao female	bruise	struck by forklift in warehouse	10/98	no	no
Lao male	bruise, headache, eye injury, head injury	struck by falling lumber	12/98	yes	yes
Cambodian male	feeling sick	dust, old parts	unable to recall	no	no
Cambodian male	feeling sick	bacteria on meat in supermarket	unable to recall	no	no

Table 11 describes the six cases of survey respondents who reported missing five or more days of work due to work-related health problems since 1997. One reported receiving workers' compensation, and his case was documented in DIA data. The others reported not receiving workers' compensation and their cases were not documented in DIA data. Both undated cases corresponded to young workers who had started their jobs more recently than July 1997, the earliest month of available DIA data.

The discrepancies between DIA and survey data on these cases cannot readily be explained by coding error or intentional differences in data collection.

Qualitative Comparisons

The survey collected information from respondents beyond that gathered by the workers' compensation and hospital systems. These data helped inform conclusions regarding the occupational health of the population under study.

Of 155 respondents currently employed, 39 (25%) reported holding a temporary job, typically through a temporary employment agency. This proportion rose to 36% among Cambodians, and 77% among Cambodian women.

Of 147 adults (ages 18 and above) currently employed, 41 (28%) reported regularly working between 41 and 75 hours per week, and working at least 40 hours every week. An additional seven (5%) reported sometimes working under 40 and sometimes over 40 hours per week.

Thirty-five respondents, or 23% of those currently employed and not self-employed, were not aware of having received health or safety training at their work. Of temporary workers, 28% reported this lack of training. Most people who had received such training had learned about personal protective equipment, but not about controlling hazardous exposures at their source (data not shown). Twenty-two, or 14% of respondents, identified sources of help or information about workplace hazards apart from their supervisors; others identified supervisors or no one.

Of the 160 respondents, 108 (68%) reported that health insurance was offered by their current or most recent employer. Among Cambodians, this prevalence was 55%. However, the questionnaire did not inquire about the affordability or adequacy of these plans.

Respondents named a total of 171 locations where they and family members normally seek medical care. Of these, 19 (11%) specified SMMC or a pediatric clinic affiliated with SMMC. Thirty-eight (22%) specified a Vietnamese or other Asian doctor, and 59 (35%) reported seeing an unspecified personal doctor. Ten (6%) reported no usual source of medical care or "don't know." Others listed specific hospitals or clinics. Of responses given by people whose employers do not offer health insurance, 31% specified an Asian doctor and 15% reported no usual source of medical care or "don't know."

Respondents asked how they would pay for medical treatment for injuries or illnesses due to their work responded health insurance (39%), the company or employer (28%), and "don't know" (22%). Seven respondents, or 4%, provided an answer describing workers' compensation. A total of 32% therefore provided some indication that the company would be responsible for ensuring coverage of their medical treatment.

This finding is consistent with the 32% positive response to this question: "A state program called Workers' Compensation is supposed to pay for medical expenses for sicknesses or injuries that you get because of your job. Workers' Compensation is also supposed to pay for part of your lost wages if you miss more than five days of work because of a sickness or injury you got because of your job. Have you heard of Workers' Compensation?"

Compensation?" Fifty participants responded "yes" to this question; 110 responded "No" or "Don't know."

Twenty-three individuals (14%) reported seeking medical care for 29 work-related incidents from 1997 to the survey date. Allowing more than one treatment site for each episode, 48% of the treatment sites reported were hospitals and major clinics in and near Lowell, including six (21%) at SMMC. All respondents who sought hospital care were Lao. Six (21%) incidents were attended at an unspecified private doctor and six (21%) at a doctor specified as Asian. Four (14%) received care at a company clinic.

Payment information was available for 27 episodes of treatment obtained for work-related health problems. Respondents reported that six (22%) were paid for by the company or company insurance, suggesting coverage by workers' compensation or direct company coverage in a company clinic. They described 48% as being covered by their or their family's regular health insurance. Respondents could not recall the source of payment for medical treatment for four episodes (15%) of work-related health problems, which therefore may or may not have been covered by workers' compensation. Three (11%) paid for all or some of the expenses out of pocket. One case was covered by free care.

Prevalent workplace hazards reported included exposure to a variety of chemicals, especially soldering fumes; inadequate ventilation for these chemicals; prolonged sitting or standing; prolonged awkward postures; unguarded machinery; and shift work with associated long hours and pressure to produce quickly (Table 12). These and other conditions led to common symptoms including headaches (31% of respondents), backaches (26%), dizziness (18%), cuts (16%), illness (14%), contusions (11%), skin rashes (9%), burns (7%), eye or head injuries (7%), and sprains or strains (6%).

Logistic regression models controlling for gender, manufacturing/shipping/warehouse work, and age identified one factor strongly associated with reporting at least one work-related symptom: long hours of work. People who reported working more than 40 hours any time during the past two years were 3.5 times more likely than others to report such symptoms (p value < 0.0020). Also controlling for gender, age, and industry, working a late-night shift was associated with reporting a work-related sign, with an odds ratio of 2.1 and borderline statistical significance (p value < 0.059). Controlling for the same potential confounders but using proc genmod to estimate the more appropriate prevalence ratio, working over 40 hours demonstrated a prevalence ratio of 1.4 (95% confidence interval 1.1, 1.7) for reporting a work-related symptom, and working a late shift had a prevalence ratio of 1.5 (95% confidence interval 1.0, 2.3, $p < 0.05$) for reporting a work-related sign.

Of 25 lost workday incidents, six (24%) were reportedly due to dizziness, five (20%) to backache; and five to feelings of illness including nausea, fatigue, and flu-like symptoms. One such incident was described as dizziness, headache, and problems breathing.

Table 12. Selected Cited Causes of Symptoms

Cited Causes of Reported Work-Related Symptoms	Reporting Cause	Sought Treatment
Reported Causes of Backache		
prolonged sitting, including soldering or microscope work in electronics assembly	14	5
prolonged standing	8	0
Reported Causes of Burns		
electronics assembly: soldering iron or hot plate	7	1
Reported Causes of Cuts		
electronics assembly: razors, tweezers, knives; small, sharp parts	6	1
packaging: boxes, bins, crates	4	0
Reported Causes of Dizziness		
stress and overwork: too much work, too busy, long hours, boss pushing, too much overtime, understaffed, not enough sleep, working on different shift from wife	14	1
eye strain from electronics assembly: small parts, computer monitor, microscope work	5	1
chemicals used in electronics assembly: alcohol, soldering fumes, cleaning solvents	4	1
Reported Cause of Eye or Head Injury		
electronics assembly: perceived vision loss due to prolonged computer use or microscope use	4	0
soldering fumes and flux	2	0
struck by falling wood, resulting in nerve damage	1	1
Reported Causes of Headaches		
long hours, too much work, very busy, work too hard, lack of sleep, lack of food, late shifts, different shift from wife	12	0
chemicals, including alcohol, wire cleaner, coolant, freon, mothballs, soldering fumes	8	2
electronics assembly: prolonged microscope work	6	0
noise	2	0
Reported Causes of Illness ("Feeling Sick") (nausea, fatigue, distress, or flu-like symptoms)		
long hours, shift work, lack of rest	6	1
chemicals, including coolant, soldering fumes, alcohol	4	0
dust	2	0
extended work with high-power microscope	2	0
noise	1	0

Cited Causes of Reported Work-Related Symptoms	Reporting Cause	Sought Treatment
Reported Causes of Respiratory Problems		
dust from fabric	1	0
fiberglass and other dusts	1	1
freon	1	0
Reported Causes of Skin Rashes		
dusts: nuisance dust, fiberglass, iron filings, sugar, wood dust	6	1
chemicals: chemical for tightening bolts, cleaning ink, coolant, paint or glaze, sanitizer, wool, mothballs	6	1
microwave or hot plate used to replace PC components	2	1

Thus, the overall results of survey describe a population working long hours in light manufacturing, predominantly electronics assembly. Awkward and static postures, repetitive motion, and chemicals such as soldering flux lead to a high prevalence of low level back strain, sensation of overall ill health, headache, dizziness, eye strain, and dermatitis, as well as cuts, burns, and contusions. Long hours and late shifts contribute to these problems. Most people in the study population are unfamiliar with workers' compensation benefits, and few access compensation benefits even for medical costs. Those who seek medical care are likely to visit small private clinics not connected with systems of reporting and compensation (data not shown). Almost none are aware of resources for obtaining information or help for addressing hazardous workplace conditions. Thus, it appears that very few occupational health problems among these populations would appear in data based on workers' compensation, medical records, passive surveillance programs, or written questionnaires.

DIA data, on the other hand, would suggest that the study population experiences work-related health problems at a much lower rate than the general population. Most work-related problems they do experience involve traumatic injuries. Only three electronics assembly companies reported injuries due to repetitive, awkward, or static motion, and just one such case corresponded to the typical description of strain and sprain injuries in electronics assembly described in survey. This data source suggests that fumes and solvent exposure are not a significant hazard affecting the target population. Few teens appear to be affected by work-related health problems. Temporary employment does not emerge as an issue, since just five cases were reported by three temporary agencies, and only an agency specializing in asbestos remediation reported a sprain or strain injury.

SMMC data also suggest that most work-related injuries among the study population are traumatic and rarely involve chemical exposures or ergonomic problems. Women in this population demonstrated relatively high proportions of external causes given as hypodermic needles or unclassified. Comparing the SMMC data to national findings results suggests that work-related back pain and dermatitis may be more prevalent in the

population under study than in the overall U.S. working population, while hand discomfort appears to be less prevalent (Behrens et al., 1994).

Discussion

This study investigated three sources of data on the occupational health status of Cambodian and Lao residents of Lowell, Massachusetts. These sources were Massachusetts workers' compensation records for work-related health problems resulting in five or more lost workdays; medical records data for patients seen at Lowell's largest hospital; and a household survey conducted in the city neighborhoods with the largest proportions of Southeast Asian residents.

Sensitivity of Data Sources

Cambodians and Lao comprise an estimated 32% of the population of Lowell. Given other findings about immigrant workers, this population would typically be expected to face more hazardous workplace conditions than the general population. However, existing data sources demonstrated weaknesses in the capture of work-related health problems among the target populations.

Only 4% of workers' compensation cases for Lowell residents filed with the DIA during the period under study were identified as corresponding to the ethnic groups under study, approximately one eighth the proportion of this group in the Lowell population. Of six survey respondents reporting lost work time of five days or more due to work-related health problems, one was found in the DIA data. This person had suffered severe traumatic injuries.

DIA data also suggest the possibility of inconsistent reporting practices among area businesses. The Massachusetts Department of Education and Training lists 75 establishments with SIC code 36 in the Lowell Labor Market Area, and almost 24% of survey respondents described work corresponding to this code. However, just eight such establishments reported the 10 cases found for SIC code 36 in the DIA data, and three reported all sprain and strain injuries found in this source. The Lowell telephone directory yellow pages lists over 60 temporary employment agencies, yet the five cases reported to the DIA were all reported by three agencies, and strain and strain injuries were reported by just one.

Only one percent of hospital visits charged to workers' compensation during the study period corresponded to patients coded as Asian. This low number is consistent with survey results indicating that most of the study population seeks medical care in private doctors' offices, particularly those staffed by physicians from Vietnam or other Asian countries. However, three of the four survey participants who remembered approximate dates of hospital visits for work-related health problems were in fact found in the hospital data and coded as payment class=workers' compensation.

As an active rather than passive system, the household survey more sensitively captured occupational health problems. Face-to-face interviews by highly respected members of the ethnic groups under study enabled investigators to gather information from populations with limited English skills, limited literacy, and deeply embedded distrust of censuses and surveys. Conducting these interviews in private in people's homes facilitated the sharing of information by people whose traditional cultures and experiences have discouraged them from speaking in public or settings such as focus groups. Despite previous reports of Lao women's reluctance to speak with outside interviewers (Bunte and Joseph 1992), people of both ethnic groups and genders appeared to participate freely.

Completeness of Data Sources

Both the Massachusetts Department of Industrial Accidents and Health Information Services at Saints Memorial Medical Center generously and efficiently shared all relevant data with investigators. Thus, this study examined nearly complete data sets matching eligibility criteria of time period, Lowell residency, and ethnicity. However, of DIA case records, 14% lacked First Reports of Injury, the documents containing the data categories examined in this study.

The labor-intensive nature of the survey process, which required two adults to work a full weekend day or several weekday evenings for approximately six surveys, resulted in a low total participation, n=160. Selection of Cambodian participants was partly based on convenience, or the visible presence of household members. This was likely to bias the selection against people who work multiple shifts, or on weekends or early evenings when the survey was performed. Refusals or unavailability among members of both ethnic groups may be expected to have excluded people working in the informal economy or especially insecure employment who may be frightened to speak to strangers about their jobs. Thus, some of the most dangerous jobs, including day labor and other casual work in construction, fishing, and manufacturing, were likely underrepresented in this sample (discussions with project Advisory Board). Survey results are therefore likely to underestimate both the frequency and severity of workplace hazards and associated health problems in the population of interest.

Accuracy and Depth of Data

SMMC data are coded by trained professionals and are expected to demonstrate a high level of accuracy, an assumption not tested in this study. These data include injury, illness, body part, and external cause codes as well as demographic information, but no in-depth narrative data.

First Reports of Injury and other documents included in DIA case records are typically completed by company personnel with no training in occupational health. Of the records

studied, only 43% provided industrial codes matching other information in the case records to the level of industrial major group. Just 55% listed injury, illness, and body part codes consistent with other documentation in the case records. Records provided varying amounts of descriptive information about the cause and type of health problems, surrounding circumstances, and interactions with the health care and compensation systems.

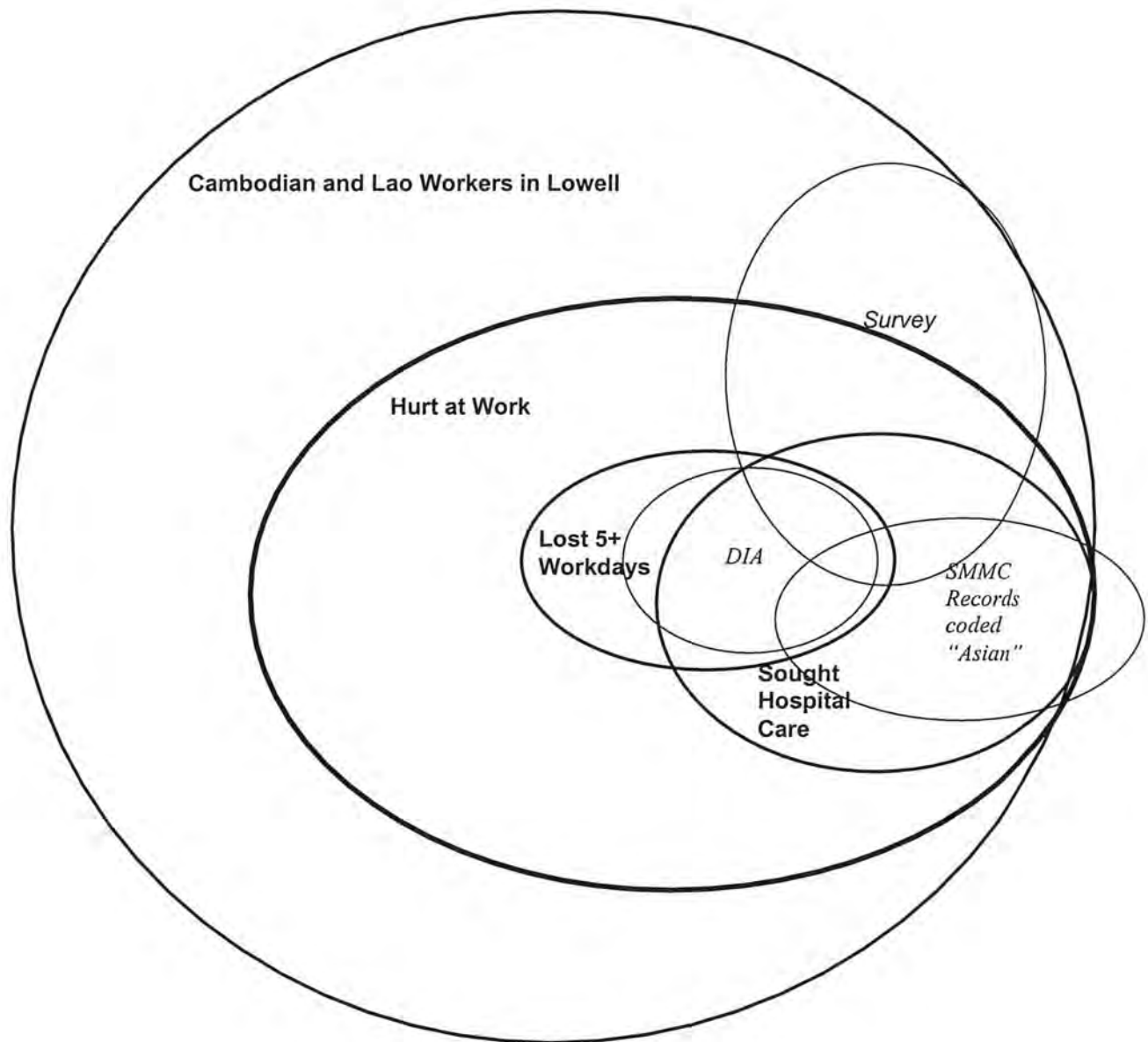
In order to elicit trust and cooperation, the survey did not solicit specific information about employers. Thus, some industrial codes may have been coded inaccurately. In general, survey results are not entirely accurate because people do not necessarily have the knowledge to diagnose their own health problems or correctly identify the sources of those problems. Surveys do not usually provide the means of confirming or validating either health conditions themselves or the reported sources of those conditions. As a result, both reported conditions and their relationship to work can be underreported or overreported (Behrens et al, 1994). Symptoms not resulting in lost work time may be forgotten and underreported, and recall periods of more than a few weeks can reduce reliability (Silverstein et al., 1997; Lalich and Sestito, 1997).

By including open and closed questions about a variety of related employment and health issues, the survey also provided in-depth information about factors causing work-related health problems and preventing their capture by surveillance systems. Supplementary discussions with the project's Advisory Board and local health care providers improved understanding of the complex phenomena under investigation. The limited number of interviewers, and principal investigator participation in almost all interviews, reduced inter-investigator variability.

Table 13. Strengths of Data Collection Systems

Data Source Characteristics	DIA	Hospital	Survey
Complete Coverage of Defined Group	yes	yes	no
Specific to Defined Ethnic Groups	yes	no	yes
Information on Industry	yes	no	yes
Information on Employer	yes	no	no
Information on Cause of Injury	yes	limited	yes
Clinical Validation of Injury	yes	yes	no
Active	no	no	yes
Largely Independent of Employer Practice	no	yes	yes
Information on Work Hours and Conditions	no	no	yes
Information on Subjects' Knowledge	no	no	yes
Coded by Trained Professionals	no	yes	no

Figure 1. Model for Data Collection on Cambodian and Lao Occupational Health in Lowell (not proportional or to scale)



Conclusions

This study describes highly prevalent occupational illnesses as well as injuries among Southeast Asians in Lowell, Massachusetts. Commonly reported injuries include sprains and strains, dermatitis, and generalized fatigue and ill health among these workers.

Nationally, occupational skin diseases are among the most commonly reported occupational illnesses. Principal sources of these problems include epoxy and other resins such as those found in plastics manufacturing. The Bureau of Labor Statistics reported steady increases in these diseases throughout the 1990's, and results from the National Health Interview Study suggest that BLS statistics underestimate their prevalence by as much as 20 fold (Kaufman and Cohen, 1998; Behrens et al., 1994).

Findings from this study are not strictly comparable to those of the Occupational Health Supplement survey due to different criteria for self-reported health problems (Behrens et al., 1994). However, comparing the results suggests that work-related back pain and dermatitis may be more prevalent in the population under study than in the overall U.S. working population.

Proximate causes of these and other health problems among the study population include long hours of work, awkward and static postures, and exposure to dusts, fumes, and solvents. When asked to name hazards in their current work environment, 48% of respondents in this study provided examples. A 1987 study by Shilling and Brackbill which found that 35% of workers nationally perceived exposure to hazardous work conditions (Behrens and Brackbill, 1993). However, almost no survey respondents report training on recognizing and controlling hazards at the source.

A large proportion of the survey respondents worked in electronics assembly and described hazards related to that industry. This is significant since this industry employs more workers than any other type of manufacturing in the U.S. and has grown more rapidly than any other industry. It is also a large employer in several other countries (USEPA, 1995). Electronics assembly is known to entail a number of documented and putative health risks from exposure to hundreds of chemicals as well as awkward and static postures (USEPA, 2000; LaDou and Rohm, 1998). Therefore, the experiences described in the survey results may pertain to increasing proportions of the U.S. and international workforce.

The survey in this study failed to inquire about union membership. Most respondents worked in electronics assembly plants and other local industries where unionization is virtually unknown. Almost no respondents described resources apart from their supervisors for obtaining help or information about health and safety on the job.

Although temporary workers were probably undersampled in this study, one quarter of respondents reported holding temporary jobs. Hazards and health problems associated with this form of employment emerged strongly. Lack of experience in a given work environment has been shown in previous studies to be associated with accidents and

injuries. The insecurity and irregular schedules, low wages and therefore long hours of temporary work in this area clearly contribute to the prevalence of fatigue, headaches, lightheadedness, and general lack of well-being in the population studied.

Fewer than one third of survey respondents expressed any familiarity with the workers' compensation system. Most expected to charge medical care to other payment sources, and in fact did so when hurt on the job.

More than half of survey respondents cited small private clinics as the normal source of medical care for themselves and their families, and almost one third of incidents of medical care for work-related illnesses and injuries were reported to take place at such clinics. This seems consistent with the findings of McCaig et al. (1998), who reviewed data from the National Ambulatory Medical Care Survey, which examined visits to office-based physicians rather than emergency departments and found that 21% of injury visits were work-related. Some of the clinics used by the respondents do not accept workers' compensation.

Given these patterns of employment and health care utilization, it would be expected that existing data sources would fail to capture the majority of work-related injuries and illnesses in this population. This study supports this supposition. The workers' compensation and hospital data studied contain very small numbers of cases corresponding to the study population relative to their presence in the overall local population. These sources tend to record traumatic injuries and some sprains and strains, but much lower levels of illness and less chemical exposure and awkward/static postures than those reflected in the survey.

It is important to note that Southeast Asians in Lowell represent in many ways a best-case scenario for working conditions compared with other groups of refugees and immigrants who arrive in the U.S. with low levels of formal education. Unlike most of the large numbers of refugees fleeing violence and destruction in Latin America and the Caribbean, Cambodians and Lao in the U.S. are overwhelmingly legal residents with permission to work. Many have been granted refugee status with associated benefits. Thus, they are not forced by fear or deportation or prosecution to work in the underground economy and remain silent in the face of dangerous working conditions. Jobs in electronics assembly tend to pay well over minimum wages and many are benefited. Indeed, two thirds of people surveyed reported that health insurance was offered by their employer (although the survey failed to inquire about the affordability, adequacy, and accessibility of the insurance). Such jobs are not secure and very few are unionized, but employers in this industry value experienced workers, adding an element of security to such positions.

Recent years have seen some of the lowest levels of unemployment in this region since the Massachusetts Miracle of the 1980's. It would be expected that working conditions would therefore be significantly safer now than during normal economic periods.

In summary, Southeast Asian workers in Lowell, although a relatively privileged population of immigrant workers, appear to suffer a significant burden of occupational illness as well as injuries. Members of this population report little access to preventive or curative resources for addressing workplace hazards, and are largely unfamiliar with mechanisms for compensation. Prevalence of temporary employment, lack of occupational health training, low levels of unionization, and utilization of small clinics for health care may all contribute to the significant underrepresentation of this population in existing occupational health surveillance systems.



DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service
Centers for Disease Control
and Prevention (CDC)

Memorandum

Date: May 4, 2001

From: Roy M. Fleming, Sc.D., Director, Research Grants Program
Office of Extramural Programs, NIOSH, D30

RMF

Subject: Final Report Submitted for Entry into NTIS for Grant 1 R03 OH003783-01.

To: William D. Bennett
Data Systems Team, Information Resources Branch, EID, NIOSH, P03/C18

The attached final report has been received from the principal investigator on the subject NIOSH grant. If this document is forwarded to the National Technical Information Service, please let us know when a document number is known so that we can inform anyone who inquires about this final report.

Any publications that are included with this report are highlighted on the list below.

Attachment

cc: Sherri Diana, EID, P03/C13

List of Publications

None

Title: Collecting Elusive Data on Immigrant Occupational Health
Investigator: Charles Levenstein, Ph.D.
Affiliation: University of Massachusetts
City & State: Lowell, MA
Telephone: (978) 934-3268
Award Number: 1 R03 OH003783-01
Start & End Date: 9/30/1998–9/29/2000
Total Project Cost: \$74,000
Program Area: Special Populations
Key Words:

Abstract:

A variety of studies have recognized the incompleteness of occupational health surveillance data in the U.S. Surveillance data are particularly expected to miss certain populations, such as low-wage, contingent, and immigrant workers; and certain health problems, such as diseases with ambiguous symptoms. This study investigated these issues among Cambodian and Lao refugees in Lowell, Massachusetts.

Sources of information included selected data from 187 Southeast Asian hospital visits (to Saints Memorial Medical Center, SMMC) charged to workers' compensation; 80 workers' compensation wage replacement cases filed on behalf of Southeast Asian Lowell residents with the Massachusetts Department of Industrial Accidents (DIA) and 160 surveys on self-reports of occupational health collected from 112 Southeast Asian households in Lowell.

One hundred two (64%) of survey respondents reported work in manufacturing, and 67 (42%) specifically in electronics assembly. Large proportions of the study population reported exposure to awkward and static postures, repetitive motion, and chemicals such as soldering flux, dusts and solvents.

The most common injuries from all three data sources included sprains and strains (37.1% of DIA injuries, 27.4% of SMMC injuries, and 21.9% of survey injuries); cut, laceration, puncture (9.3%, 22.9%, 11.4%); contusion, crushing, bruise (19.6%, 14.6%, 8.7%); and fractures (9.3%, 7.6%, 2.9%). Symptoms and ill-defined conditions, including overall ill health, headache, dizziness, made up 28.3% of all injuries reported in the survey (95% CI 22.3%, 34.3%) but only 1.3% of injuries recorded in the hospital data and none in DIA data. Dermatitis made up 6.8% of survey cases (95% CI 3.5%, 10.1%), but none of the common injuries in the other data sets.

Of 155 respondents currently employed, 39 (25%) reported holding a temporary job. Of 147 adults currently employed, 41 (28%) reported regularly working between 41 and 75 hours per week. Twenty-two (14% of respondents) were able to identify sources of information about workplace hazards apart from their supervisors. One hundred ten (69%) of survey respondents expressed no knowledge of workers' compensation. Most sought medical care in small private clinics.

Given these employment and medical care patterns, few occupational health problems in this population would be expected in data based on workers' compensation, hospital records, passive surveillance programs, or written questionnaires. Consistent with this expectation, only 4% of workers' compensation cases for Lowell residents filed during the period under study were identified as corresponding to the ethnic groups under study, approximately one eighth the proportion of this group in the Lowell population. Hospital records and workers' compensation records reveal much lower levels of illness and less chemical exposure and awkward/static postures than those reflected in the survey.

Publications

No publications to date.