# Occupational Distribution of Persons With Confirmed 2009 H1N1 Influenza

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**Objective:** To assess the distribution of illness by industry sector and occupation reflected in early 2009 H1N1 influenza surveillance. **Methods:** We analyzed data reported for April to July 2009, for 1361 laboratory-confirmed 2009 H1N1 influenza-infected persons 16 years or older, with work status information from four states. A North American Industry Classification System 2007 code was assigned to each employed person. For a subset, an occupation code was assigned. **Results:** Of 898 employed individuals, 611 (68.0%) worked in the non-health care sector. The largest proportions worked in public administration, educational services, and accommodation and food services. In Wisconsin health care personnel, 53.6% were paraprofessionals, 33.6% professionals, and 12.7% other workers; 26.9% worked in ambulatory settings, 46.2% in hospitals, and 26.9% in nursing or residential care facilities. **Conclusions:** Our findings suggest that industry sectors and occupations should be explored systematically in future influenza surveillance.

Influenza is known to be one of the most significant causes of acute respiratory illness around the world, and the morbidity and mortality associated with influenza infection in the United States has been extensively studied.[1–5] The Centers for Disease Control and Prevention (CDC) has consistently estimated that influenza is responsible for greater than 30,000 deaths annually in the United States.[4–6] Among US adults, the annual burden of infection includes more than 30 million outpatient visits, 226,000 to 334,000 influenza-related excess hospitalizations, and 44 million days of productivity lost.[1,6]

Each year, influenza poses a significant burden to working adults and employers in the United States, accounting for an estimated 10% to 12% of all sick-related work absences.[7] In addition to worker absenteeism, reduced productivity following influenza illness has substantial impact on businesses. Studies have estimated the mean number of working days lost per laboratory-confirmed influenza diagnosis to be 1.5 to 4.9 days, and as many as 80% of workers report impaired performance even after returning to work.[7] Workers who are self-employed, in positions of higher responsibility, or are health care workers are often less likely to take sick leave compared with other workers, which might lead to increased workplace-based transmission of influenza.[7–9]

Despite the clear public health significance of influenza and influenza-like illness on the US workforce and the obvious potential for workplace transmission, occupation and industry-related data are not routinely collected as part of most public health surveillance systems. Thus, inferences regarding who, where, and how workers might be at increased risk of influenza pandemics are difficult to answer.

The objectives of our analyses were twofold: first, to assess the distribution of illness by industry sector and occupation reflected in early H1N1 influenza surveillance; and second, to evaluate the quality and validity of the current systems of surveillance in recording industry and occupational data.

## METHODS

The Florida Department of Health, Kansas Department of Health and Environment, and Wisconsin Division of Public Health provided data regarding all reported persons with laboratory-confirmed 2009 H1N1 influenza infection for April to July 2009. The Oregon Public Health Division collected data for April 23 to May 5, 2009. A *confirmed case* was defined as a person with an influenza-like illness and laboratory-confirmed novel influenza A (H1N1) virus infection by real-time reverse transcriptase–polymerase chain reaction or viral culture.[10]

Of 4334 confirmed 2009 H1N1 influenza cases among persons 16 years or older, work status information was available for 1378 (31.8%) cases: 331 (14.9%) from Florida, 66 (54.1%) from Kansas, 12 (54.5%) from Oregon, and 489 (24.9%) from Wisconsin. Florida and Kansas provided survey data from a list of predefined job types (eg, health care worker, food handler, etc) and free texts on occupation, employer, and worksite. Wisconsin and Oregon provided data only from free texts on occupation, employer, and worksite.

Three-digit 2007 North American Industry Classification System (NAICS) codes were assigned for the health care and social assistance sectors, and two-digit NAICS codes were assigned for other industry sectors.[11] Categories were created for disabled persons, homemakers, retirees, students, the self-employed, and unemployed. Those with unclassifiable industry ($n = 17$) were excluded, leaving 1361 persons (31.4%) for analysis.

Further classification within the health care industry by Standard Occupational Classification (SOC) codes and workplace settings were limited to Wisconsin health care personnel (HCP). Insufficient data were available for other states. Workers in the health care sector (NAICS 621-623) with SOC 29-1011-29-1199 were classified as professionals (eg, physicians, dentists, therapists, pharmacists, or nurses); SOC 29-2011-31-9099 as paraprofessionals (eg, dental assistants, nurse assistants, paramedics, medical aides, home health aides, or technicians); and other SOC codes as other workers within the health care sector (eg, managers, office and administrative support staff, protective service workers, cleaners, medical interpreters).[11,12]

To evaluate the quality and validity of the current systems of surveillance in recording industry and occupational data,

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The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

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we compared the percentages of missing values for demographic characteristics (age, sex, ethnicity, and race), hospitalization, and death between groups with and without work status. Second, we used the available information to compare demographic characteristics (age, sex, ethnicity, and race), hospitalization, and death distributions between both groups. All statistical significance testings were done using chi-square or Fisher exact test.

## RESULTS

### Distribution of 2009 H1N1 Influenza Cases by Industry Sector and Occupation

Of the 1361 persons with work status, 898 (66.0%) were employed. Of those, 287 (32.0%) were in the health care sector (Table 1). Eighty-two percent of HCP with 2009 H1N1 influenza were women, 81.2% were aged 20 to 49 years, 58.2% were white, and 18.8% were Hispanic. Among infected HCP, 12.2% were hospitalized and 0.7% died, while among non-HCP, 19.0% were hospitalized and 3.9% died. Of the 463 persons with 2009 H1N1 influenza not in the workforce, students (51.4%) and unemployed persons (33.7%) comprised the majority.

The health care sector was analyzed separately from the non-health care sector, because HCP were targeted by CDC for surveillance purposes.[13] Many states, including Wisconsin, adopted this strategy for targeting surveillance efforts on the basis of occupational risk but Florida, Kansas, and Oregon did not. Of 611 employed persons not in the health care sector (Table 2), 10.1% were in public administration, 10.0% in educational services, and 9.5% in the accommodation and food services sector. The proportions of

**TABLE 1.** Number and Percentage of Employed Persons With Laboratory-Confirmed H1N1 Influenza* by Selected Characteristics and Industry

| Characteristics | Health Care ($n = 287$), No. (%)† | Non-Health Care ($n = 611$), No. (%)† | *P* Value‡ | Total ($n = 898$), No. (%)† |
|---|---|---|---|---|
| Sex | | | <0.001 | |
| Female | 235 (81.9) | 272 (44.5) | | 507 (56.5) |
| Male | 50 (17.4) | 335 (54.8) | | 385 (42.9) |
| Unknown | 2 (0.7) | 4 (0.7) | | 6 (0.7) |
| Age group (yrs) | | | 0.163 | |
| 16–19 | 12 (4.2) | 41 (6.7) | | 53 (5.9) |
| 20–29 | 94 (32.8) | 225 (36.8) | | 319 (35.5) |
| 30–39 | 74 (25.8) | 136 (22.3) | | 210 (23.4) |
| 40–49 | 65 (22.6) | 108 (17.7) | | 173 (19.3) |
| 50–59 | 36 (12.5) | 92 (15.1) | | 128 (14.3) |
| ≥60 | 6 (2.1) | 9 (1.5) | | 15 (1.7) |
| Race | | | 0.395 | |
| White | 167 (58.2) | 386 (63.2) | | 553 (61.6) |
| Black | 35 (12.2) | 66 (10.8) | | 101 (11.2) |
| Asian | 17 (5.9) | 22 (3.6) | | 39 (4.3) |
| Other | 3 (1.0) | 9 (1.5) | | 12 (1.3) |
| Unknown | 65 (22.6) | 128 (20.9) | | 193 (21.5) |
| Ethnicity | | | 0.814 | |
| Hispanic | 54 (18.8) | 126 (20.6) | | 180 (20.0) |
| Non-Hispanic | 158 (55.1) | 331 (54.2) | | 489 (54.5) |
| Unknown | 75 (26.1) | 154 (25.2) | | 229 (25.5) |
| Hospitalization | | | 0.007 | |
| Yes | 35 (12.2) | 116 (19.0) | | 151 (16.8) |
| No | 190 (66.2) | 402 (65.8) | | 592 (65.9) |
| Unknown | 62 (21.6) | 93 (15.2) | | 155 (17.3) |
| Death | | | 0.003 | |
| Yes | 2 (0.7) | 24 (3.9) | | 26 (2.9) |
| No | 267 (93.0) | 568 (93.0) | | 835 (93.0) |
| Unknown | 18 (6.3) | 19 (3.1) | | 37 (4.1) |

*A confirmed case was defined as a person with an influenza-like illness and laboratory-confirmed novel influenza A (H1N1) virus infection by real-time reverse transcriptase–polymerase chain reaction or viral culture.

†Percentages in groupings might not add to 100% because of rounding.

‡All statistical significance testing to evaluate the difference observed between the health care versus non–health care workers was done using chi-squared or Fisher exact test.

**TABLE 2.** Number and Percentage of Employed Persons With Laboratory-Confirmed H1N1 Influenza in the Non-Health Care Industry Sector

| North American Industry Classification System Code And Industry Sectors* | Persons With Laboratory-Confirmed 2009 H1N1 Influenza ($n = 611$) No. (%)† | US Non-Health Care Workforce % |
|---|---|---|
| 92. Public administration‡ | 62 (10.1) | 8.1 |
| 61. Educational services‡ | 61 (10.0) | 10.5 |
| 72. Accommodation and food services‡ | 58 (9.5) | 9.5 |
| 56. Administrative and support and waste-management and remediation services | 53 (8.7) | 6.9 |
| 624. Social assistance‡§ | 51 (8.3) | 2 |
| 44–45. Retail trade | 50 (8.2) | 12.9 |
| 54. Professional, scientific, and technical services | 48 (7.9) | 6.4 |
| 31–33. Manufacturing | 34 (5.6) | 11.3 |
| 48–49. Transportation and warehousing | 32 (5.2) | 4.4 |
| 81. Other services (except public administration) | 31 (5.1) | 3.2 |
| 52. Finance and insurance | 28 (4.6) | 4.9 |
| 71. Arts, entertainment, and recreation | 26 (4.3) | 1.6 |
| 23. Construction | 24 (3.9) | 6.2 |
| self-employed not classified elsewhere | 16 (2.6) | |
| 55. Management of companies and enterprises | 15 (2.5) | 1.6 |
| 51. Information | 10 (1.6) | 2.5 |
| 11. Agriculture, forestry, fishing, and hunting | 7 (1.1) | 0.3 |
| 53. Real estate and rental and leasing | 5 (0.8) | 1.8 |

*Industry sectors are based on NAICS from US Bureau of Labor Statistics.

†Percentages in groupings might not add to 100% because of rounding.

‡The public administration sector (NAICS 92) includes executive, legislative, and other general government support (eg, consulate workers); justice, public order, and safety activities (eg, police officers or firefighters); and national security and international affairs (eg, military workers). The education services (NAICS 61) include workers in elementary and secondary schools; junior colleges; college, universities, and professional schools; business schools, and computer and management training; and technical and trade schools. The accommodation and food services (NAICS 72) include workers at hotels and casinos, recreational parks and camps, and eating and drinking establishments. The social assistance services (NAICS 624) include workers in individual and family services (eg, services for the elderly and disabled persons), community food and housing, and emergency and other relief services, vocational rehabilitation services, and child day care services).

§The social assistance sector appeared to be overrepresented compared with its proportion in the US non-health care workforce, but reporting bias might have been a factor because child care center staff and correctional facility staff were variably targeted for influenza surveillance.[18]

these three sectors were similar to their proportions among the US non-health care workforce.[11]

We characterized occupation for 110 of 156 (71%) Wisconsin HCP: 53.6% were health paraprofessionals, 33.6% health care professionals, and 12.7% were other workers (Table 3). Information regarding health care settings was available for 93 of 156 (60%) HCP: 26.9% worked in ambulatory health care settings, 46.2% in hospitals, and 26.9% in nursing and residential care facilities (Table 4).

## Data Quality and Validity

Compared with groups with work status data, those without work status data showed a significantly higher proportion of missing data in all additional data fields, including missing values for sex, ethnicity, race, hospitalization, and death (Table 5). Age was complete for both groups. Using the available information, there was a higher proportion of blacks and a lower proportion of deaths in groups without occupational data ($P < 0.001$). Nevertheless, there were no apparent differences in age ($P = 0.22$), sex ($P = 0.12$), ethnicity ($P = 0.30$), or hospitalization status ($P = 0.85$).

## DISCUSSION

Workplace-based prevention strategies can complement community-wide efforts to curtail the impact of influenza pandemics.[14] Knowledge is limited regarding the epidemiology of 2009 H1N1 influenza by occupational grouping and represents a missed opportunity to assess the role of occupation in risk of influenza infection. This study suggests that future systematic influenza surveillance should be targeted to workers in health care, public administration, educational services, and accommodation and food services.

The health care sector proportion among all confirmed cases was threefold greater than the proportion among the US workforce.[11] Nevertheless, as a result of targeted surveillance and greater access to testing and reporting for health care workers,[13] no inferences can be made regarding true overrepresentation of cases among health care workers compared with their proportion in the US workforce. The 2009 H1N1 influenza laboratory-testing and reporting policy was uniformly applied among all HCP, regardless of their specific occupations. Thus, the case distribution of persons into professional, paraprofessional, and other categories is less subject to case ascertainment bias.

Considerations of the distribution of occupations and source of transmission are important in efforts to inform policy for influenza prevention in the workplace. A study early in the 2009 H1N1 influenza pandemic in 26 HCP with probable ($n = 8$) or confirmed infection ($n = 18$) reported that health care professionals were more affected than paraprofessionals (a 1.6:1 ratio).[15] In 110 Wisconsin HCP with laboratory-confirmed infection, the ratio was 0.6:1, which reflects the ratio of both the Wisconsin and US health care workforces.[11,12] This suggests that infection prevention in health care settings should continue to target a broad spectrum of personnel.

Beginning in the fourth week of the pandemic, testing priorities were shifted to persons who were hospitalized or died with suspected H1N1 influenza. Case ascertainment of early cases and hospitalized cases may have been less subject to changes in testing and reporting. We examined whether subsamples of the surveillance data might better reflect the US workforce by stratifying our data by either date of diagnosis or hospitalization status. Persons diagnosed during the first 3 weeks had similar demographics to the persons diagnosed in April through July, with the exception of a higher proportion of students in the early group. Hospitalized persons differed from nonhospitalized persons in being significantly older. This might reflect increasing disease severity seen in older age groups with higher prevalences of underlying medical conditions such as asthma and diabetes.[16] Such underlying conditions are nonrandomly distributed among workers, and selection of a sample of workers with higher prevalence of underlying conditions would likely lead to a skewing of results in favor of less physically demanding occupations. The hospitalized group also showed a significantly higher proportion of unemployed and retired persons than the nonhospitalized group. As a result of these subgroup analyses, we concluded that the subgroups

**TABLE 3.** Number and Percentage of Wisconsin Health Care Personnel With Laboratory-Confirmed H1N1 Influenza by Occupations

| | No. | Proportion in Wisconsin Health Care Sector Cases* ($n = 110$) | Proportion in All Wisconsin Employed Cases ($n = 489$) | Proportion in Wisconsin Workforce | Proportion in US Workforce |
|---|---|---|---|---|---|
| Health care professionals | 37 | 33.6 | 7.6 | 3.3 | 2.5 |
| Health paraprofessionals | 59 | 53.6 | 12.1 | 5.3 | 3.8 |
| Other workers | 14 | 12.7 | 2.9 | Unknown | 4.1 |

*The percentages might not add to 100% because of rounding.

**TABLE 4.** Number and Percentage of Wisconsin Health Care Personnel With Laboratory-Confirmed H1N1 Influenza by Workplace Settings*

| | No. | Proportion in Wisconsin Health Care Sector Cases† ($n = 93$) | Proportion in Wisconsin Workforce | Proportion in US Workforce |
|---|---|---|---|---|
| Ambulatory health care services | 25 | 26.9 | 36.9 | 39.6 |
| Hospitals | 43 | 46.2 | 38.0 | 39.2 |
| Nursing and residential care facilities | 25 | 26.9 | 25.2 | 21.2 |

*Setting where transmission occurred (eg, work site, community) was not assessed.
†The percentages might not add to 100% because of rounding.

**TABLE 5.** Number and Percentage of Employed Persons With Laboratory-Confirmed H1N1 Influenza by Selected Characteristics and Work Status

| | Work Status | | |
|---|---|---|---|
| **Characteristics** | **Available ($n = 1378$), No. (%)*** | **Missing ($n = 2956$), No. (%)*** | ***P* Value†** |
| Sex | | | |
| Female | 779 (56.5) | 1566 (53.0) | |
| Male | 592 (43.0) | 1316 (44.5) | |
| Unknown | 7 (0.5) | 74 (2.5) | <0.001 |
| Age group (yrs) | | | |
| 16–19 | 250 (18.1) | 550 (18.6) | |
| 20–29 | 441 (32.0) | 1018 (34.4) | |
| 30–39 | 244 (17.7) | 493 (16.7) | |
| 40–49 | 217 (15.8) | 458 (15.5) | |
| 50–59 | 172 (12.5) | 299 (10.1) | |
| ≥60 | 54 (3.9) | 138 (4.7) | |
| Race | | | |
| White | 840 (61.0) | 1057 (35.8) | |
| Black | 189 (13.7) | 423 (14.3) | |
| Asian | 52 (3.8) | 50 (1.7) | |
| Other | 27 (2.0) | 70 (2.4) | |
| Unknown | 270 (19.6) | 1356 (45.9) | <0.001 |
| Ethnicity | | | |
| Hispanic | 319 (23.2) | 479 (16.2) | |
| Non-Hispanic | 744 (54.0) | 1023 (34.6) | |
| Unknown | 315 (22.9) | 1454 (49.2) | <0.001 |
| Hospitalization | | | |
| Yes | 276 (20.0) | 300 (10.2) | |
| No | 909 (66.0) | 970 (51.6) | |
| Unknown | 193 (14.0) | 1686 (57.0) | <0.001 |
| Death | | | |
| Yes | 44 (3.2) | 14 (0.5) | |
| No | 1288 (93.5) | 2151 (72.8) | |
| Unknown | 46 (3.3) | 791 (26.8) | <0.001 |

*Percentages in groupings might not add to 100% because of rounding.

†The chi-square tests compared the proportion of the missing values (unknowns) between those with and without work status.

were less representative of the US workforce when compared with the total number of individuals with H1N1 infection aged 16 or elder, despite the possibility for reporting bias because of changing testing priorities.

Our analyses had limitations. These surveillance data were not collected with the intent to provide information regarding risk ratios among occupational groups, and they lack denominator data that would enable rate calculations. Second, the current surveillance data collection was not designed to address workplace versus community transmission, which is important to guide intervention priorities at the workplace. Third, data from Florida and Wisconsin accounted for the majority of cases in our data set, and our analyses may not be generalizable to either the four states whose data are included or to the entire United States. Finally, the high proportion (two thirds) of cases without work status restricted inferences regarding the distribution of illness by occupation or industry sector.

Lack of work status information in case records was often accompanied by a lack of other descriptive information. This indicates that incomplete reporting of patient information in general had a substantial impact on the quality of occupational data described in this study. Any selection bias relating to occupational distribution also appears minimal, given that age, gender, ethnicity, and hospitalization distributions of the groups with and without occupational data are similar. Compared with 2009 H1N1 influenza data reported by CDC for the same period, this sample was comparable in age, race, and ethnicity but had higher proportions of hospitalizations and deaths.[17] This might be explained by the fact that CDC reported both confirmed and probable cases or that more severe cases were more likely to have complete information and therefore to be included in the analysis.

This study suggests the kinds of industry sector and occupational distribution patterns that should be explored more systematically. It also suggests that infection-prevention strategies for health care settings should continue to target all persons working in health care settings, paid and unpaid, regardless of their specific occupation. Information on current job was recently added to the novel and pandemic influenza case investigation form. Yet, work-status information was missing in two thirds of the cases, because it was not routinely collected during influenza surveillance. These findings highlight the need for improving the completeness and uniformity of occupational and industry data collection in future influenza surveillance to better characterize groups at increased risk for exposure or adverse outcomes during outbreaks or pandemics.

The lack of occupational and industry information in public health surveillance systems is not unique to influenza. There is a concerted effort by the National Institute for Occupational Safety and Health and the Council of State and Territorial Epidemiologists Case Report Standardization Workgroup to promote the routine collection of occupation and industry in electronic health records. This will make it possible to fill the gap in information regarding work that limits its analysis of patterns of illness and injury within the workforce. Success in this effort will support specific surveillance of conditions such as influenza in ambulatory and hospitalized patients. Our data suggest that such a comprehensive surveillance will allow us to discern the important patterns of transmission that can guide intervention.

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