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Sex Differences Among Adult Influenza Hospitalizations Associated With Age, Race, And Socioeconomic Status In 14 Us Sites, 2010-2012

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Abstract

BACKGROUND: Previous studies have shown sex differences in influenza hospitalizations, but sex differences across the United States by demographic characteristics have not been well-established. We investigated potential sex differences across 14 FluSurv-NET (FSN) sites that conduct active population-based surveillance for laboratory-confirmed influenza-associated hospitalizations among residents of 76 counties in 2010-2012, stratifying by age, race, and census tract-level poverty.

METHODS: We used 6,292 laboratory-confirmed adult (≥18 years) cases collected by the 14 FSN sites during the 2010-11 and 2011-12 influenza seasons linked to 2010 Census data to calculate overall age-adjusted and age-specific incidence and incidence rate ratios (IRRs) for sex by four race/ethnic and four census-tract poverty (SES) categories. Analyses were repeated excluding pregnant women, with denominator pregnancy adjustments calculated by subtracting the percentage of women 18-49 years old with live births in 2010.

RESULTS: Overall, 55.5% of cases were female. Females were more likely to be hospitalized than males (IRR 1.17, 95% CI 1.11-1.22), but this difference did not remain after age adjustment. Females at highest risk were 18-49 years old (IRR 1.32, 95% 1.20-1.44), which was fully accounted for by pregnancy. Females were at lower risk in the ≥85 year old category (IRR 0.67, 95% CI 0.59-0.77). IRRs varied by race and SES, but in no SES group was the aIRR significantly greater than 1. White females were less likely to be hospitalized than white males (aIRR 0.91, 95% CI 0.85-0.98) while Hispanic females were more likely to be hospitalized than Hispanic males (aIRR 1.25, 95% CI 1.06-1.44). Of the 14 sites examined, 12 had crude incidence rate ratios greater than 1, but none were significant after age adjustment.

CONCLUSIONS: In 2010-2012, there were sex differences in influenza-associated hospitalizations that were highly dependent upon age, but varied by race/ethnicity and US site. Further research is needed to understand the drivers behind these differences, and analysis of data from different years is needed to determine the consistency of these findings.

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Introduction

Previous studies have identified sex differences in influenza morbidity and mortality, although the direction of the disparities varies by geographic location and influenza season. Overall it appears that influenza morbidity and mortality are higher for females (1), although numerous studies both in the United States and elsewhere have found the opposite effect (2, 3). A previous study from the Emerging Infections Program found that adult females in New Haven County, CT were more likely to have influenza-associated hospitalizations than males (4). This finding was most prominent among women of low census tract-level socioeconomic status (SES), blacks, and Hispanics, and could not be explained by pregnancy, vaccination, or underlying co-morbidities.

Few studies have comprehensively assessed sex disparities in influenza morbidity and mortality, especially controlling for the interaction between sex and age. Two studies previously assessed the effects of sex, age, and census tract socioeconomic status (SES) on hospitalization rates in adults and children in New Haven County, Connecticut (4, 5). They found that among adults over a 7-year period, female sex and lower census tract-level SES were independently associated with higher rates of hospitalization, even when controlling for pregnancy. However, no studies have comprehensively examined these factors across a large geographic area to determine whether these findings can be applied more broadly.

There are several hypotheses explaining sex disparities in influenza-associated hospitalization rates. Notably, growing evidence supports the role of biological factors that make females more susceptible to influenza (6). The major hypothesis for these biological mechanisms is that sex steroids influence the immune system and cause excessive proinflammatory cytokine and chemokine responses. Other, non-biological hypotheses for explaining sex disparities include differences in healthcare-seeking behaviors between sexes and differences in exposure to the influenza virus, both occupationally and from exposure to young children (1).

Using population-based surveillance data from 14 FluSurv-NET (FSN) sites that measure laboratory-confirmed influenza-associated hospitalizations among residents of 76 counties, we investigated potential sex disparities in influenza-associated hospitalizations by age, race, and census tract-level poverty during two flu seasons.

Methods

Surveillance Data

Analyses exploring sex disparities in influenza hospitalization rates were performed using population-based surveillance for laboratory-confirmed, influenza-associated hospitalizations from the 2010-2011 and 2011-2012 influenza seasons collected at 14 FSN sites across the United States. Residential catchment areas included the 76 counties in California, Colorado, Connecticut, Georgia, Maryland, Michigan, Minnesota, New Mexico, New York, Ohio, Oregon, Rhode Island, Tennessee, and Utah that participated in active surveillance during the study period. The total catchment population contained nearly 21 million adults.

The surveillance data included the 7,936 cases collected by active surveillance that were successfully geocoded (of 8,716 cases, 91%), of whom 6,292 were adults. Surveillance was conducted by reviewing medical charts and interviewing healthcare providers and patients to complete a standardized case report form. Variables collected included demographic information (including age, sex, and race/ethnicity), residential address, co-morbidities complicating influenza, ICU admission, patient outcome, and vaccination status. Case residential addresses were geocoded by each site using a variety of methods.

Census Data

Overall and group-specific population estimates for the residential catchment areas were obtained from the 2010 Census and used for the denominator in all incidence calculations. Neighborhood SES data was obtained from the US Census 2010. Analyses of SES used 2008-2012 American Community Survey (ACS) data and used the following categories describing the percentage of households living below the federal poverty level in each census tract: <5%, 5-<10%, 10-<20%, and ≥20%, as recommended by the Public Health Disparities Geocoding Project (7, 10).

Census tract-level poverty has been used in previous studies as a measure of area-based SES (4, 5, 11). This has been demonstrated to be an appropriate predictor of health, as a person's health

may be directly influenced by the neighborhood in which he or she resides (12). In these previous studies, cases' residential addresses were geocoded to census tracts in order to calculate overall and age-specific rates by neighborhood SES.

Data Analysis

All statistical analyses were performed using SAS version 9.3 (SAS Institute Inc, Cary, NC, USA). Average annual incidence rates were calculated by dividing the total number of cases by the total number of adults in the residential catchment area and dividing by two to average across two flu seasons. Incidence rate ratios were calculated by dividing the incidence rate among females by the incidence rate among males, and 95% confidence intervals were calculated to determine their significance. All incidence rates were age-adjusted using the 2000 US Standard Population. The incidence rate ratio calculations were then stratified by age groups (18-49, 50-64, 65-74, 75-84, and ≥85 years old), race (non-Hispanic white, non-Hispanic black, Hispanic, non-Hispanic Asian, and non-Hispanic other), SES group (<5% 5-<10%, 10-<20%, and ≥20%), and FSN site.

All analyses were repeated to account for pregnancy. In these calculations, pregnant cases were excluded from the numerator. For calculations excluding pregnant women from the denominator, average percentages of women who were pregnant were estimated by taking the number of live births in 2010 measured by the Centers for Disease Control and Prevention's National Center for Health Statistics (NCHS) as a percentage of national data from the 2010 Census.

Results

Overall Trends by Sex and Age

During two influenza seasons, there were 6,292 laboratory-confirmed influenza-associated hospitalizations among adults in 76 counties across 14 FSN sites composed of nearly 21 million adults. Of these, 55.5% were female (Table 1). The crude female:male incidence rate ratio (IRR) was 1.17 (95% CI 1.11-1.22, p<0.0001), but this difference disappeared when age-adjusted (Table 2).

The relative risk for females compared to males was highest for the youngest age group, 18-49 year olds with a 32% increased risk compared to males in the same age group (IRR=1.32, 95% CI 1.20-1.44, p<0.0001, Table 3). This risk was lower in each subsequent age group, ending with the lowest IRR among ages ≥85 (IRR=0.67, 95% CI 0.59-0.77, p<0.0001), in which males were at increased risk compared to females.

Sex Differences by SES

Socioeconomic groups approximated by area-based poverty also demonstrated a clear IRR gradient in which risk for females compared to males increased with decreasing SES (Table 4). While there was no difference between females' and males' incidence rates in census tracts with <5% poverty (IRR=0.98, 95% CI 0.88-1.10, p=0.78), when age-adjusted, the IRR indicated that females were significantly less likely to be hospitalized than males (aIRR=0.83, 95% CI 0.72-0.95, p=0.0017). Even though age-adjusted IRRs increased as SES decreased, no low SES group had an aIRR that was significantly greater than 1.

Sex Differences by Race

Analysis of crude IRRs indicated that non-Hispanic white, non-Hispanic black, and Hispanic females were statistically more likely to be hospitalized than their male counterparts (Table 5). When adjusted for age, the risk of hospitalization shifted sharply among non-Hispanic whites, and females were less likely to be hospitalized than males (aIRR=0.91, 95% CI 0.85-0.98, p=0.0091). The only group in which females remained at higher risk than males was among Hispanic women (aIRR=1.25,

95% CI 1.06-1.44, p=0.0208). When Hispanic females were stratified by age, only 18-49 year old females were at significantly greater risk than males (IRR=1.70, 95% CI 1.34-2.14, p<0.0001, Table 6).

Pregnancy

When adjusted for pregnancy, the overall age-adjusted IRR lowered from 1.00 to 0.92 (95% CI 0.87-0.97, p=0.0019), indicating that non-pregnant females overall were significantly less likely to be hospitalized than males for influenza-associated infections during 2010-2012 (data not shown). This trend remained during age stratifications; females ages 18-49 had previously been at higher risk than their male counterparts, but when adjusted for pregnancy, the IRR lowered to 1.03 (95% CI 0.94-1.14, p=0.53, Table 7).

Pregnancy fully accounted for the increased risk among Hispanic females ages 18-49 that were at significantly greater risk than males, as adjusting for pregnancy lowered the IRR from 1.70 to 1.11 (95% CI 0.85-1.46, p=0.43, Table 7). When adjusted for pregnancy, the age-adjusted IRR among all Hispanic females similarly lowered from 1.25 to 1.12 (95% CI 0.92-1.32, p=0.26, data not shown).

No SES group showed significant differences between females and males ages 18-49 once adjusted for pregnancy (Table 7). However, within this age category the highest SES groups had IRRs less than 1, indicating females were less likely to be hospitalized than males, while the lowest SES groups had IRRs greater than 1, indicating females were more likely to be hospitalized than males. In the lowest SES group (≥20% poverty), when adjusted for pregnancy, females ages 18-49 were on the margin of being statistically more likely to be hospitalized than males (IRR 1.15, 95% 0.98-1.35, p=0.08).

Geographic Sites

Of the 14 sites, 12 had crude female:male IRRs greater than 1 and 7 of those were statistically significant (Table 8). Of those 12, they ranged from 1.08 (95% CI 0.85-1.38, p=0.53) in

New Mexico to 1.46 (95% CI 1.08-1.98, p=0.0134) in Tennessee. The two sites with crude IRRs less than 1 were New York and Michigan. After age adjustment, no site had a statistically significant IRR >1 and one site, New York, had a statistically significant IRR that was less than 1, showing that females were less likely to be hospitalized than males (aIRR 0.81, 95% CI 0.63-0.98, p=0.0176). The point estimate of the IRRs for all sites was less than 1 for persons ≥85 years old.

Vaccine Coverage

Seasonal vaccine coverage rates among adult cases were similar, as 48.1% of females and 49.9% of males were vaccinated in the season of their hospital admission (Table 9). When stratified by age, both sexes exhibited a clear gradient where older age categories were more likely to be vaccinated. There were no differences by age group except among cases ages ≥85 years old, in which female cases were less likely to be vaccinated than males (68.4% vs 78.3%, p=0.0013). Among pregnant women ages 18-49, 25.2% were vaccinated compared to 27.8% of their non-pregnant counterparts (p=0.48, Table 10).

Discussion

In this analysis females overall were not at greater risk for influenza-associated hospitalization than males, even though 55.5% of the cases were female. In fact, certain categories of males—including non-Hispanic whites, those living in census tracts with <5% poverty, and persons ≥85 years old—were at greater risks than females. These differences do not appear to be fully explained by vaccine coverage. The only group of females at significantly higher risk than males were Hispanic women, particularly those ages 18-49, but this increased risk was fully accounted for by pregnancy.

Sex differences were largely consistent across US sites. Of the 14 sites, 12 had crude IRRs greater than 1, but after age-adjustment no site had an IRR that was significantly greater than 1. New York had a statistically significant aIRR less than 1, indicating that females were less likely to be hospitalized than males. This has important implications for the consistency of these findings across the US, as this is one of the few studies to examine sex differences across a large geographic area during the same influenza seasons with similar data collection and analysis methodology.

Interestingly, females ≥85 years old were consistently at lower risk than their male counterparts for hospitalization. This finding was consistent across SES group but not race. There is no clear implication to this finding, as there has been a long-standing recommendation for annual influenza vaccination for all persons ≥65 years old. Furthermore, the increased IRR for males is not accounted for by vaccination status; in fact, males ≥85 have significantly higher vaccination rates than their female counterparts ($p=0.0013$). Further studies should explore the possibility of underlying co-morbidities as drivers of this sex difference.

Notably, only 25.5% of pregnant females were vaccinated, a rate that was 2.3% lower than their age-matched non-pregnant counterparts. These findings reinforce vaccine policy recommendations for focused efforts targeting pregnant women (13) given their relatively low vaccination rates compared to older age groups. There are two important reasons to vaccinate

pregnant women: first, they are at higher risk of complications and severe illness when they get influenza (13) and secondly, they provide passive immunity to protect their future infant (14). Recommendations that specifically encourage vaccination of pregnant women began in 2004, but it is unclear if there is any comprehensive routine monitoring of vaccination rates among pregnant women. Estimations conducted by the CDC through an annual Internet Panel Survey suggest approximately 50% of pregnant women were vaccinated in the past influenza season (15), but more robust surveillance systems are necessary to accurately measured vaccine uptake in this vulnerable target group.

This study's findings contrast with a previous study conducted at the EIP, but there are several differences (4). First, the former EIP study only analyzed data from one site, Connecticut. However, when broken into site-specific analyses, this project did not show significant differences between females and males in Connecticut when age-adjusted. Thus, a more important difference may be that this analysis only covered two years of influenza-associated hospitalization surveillance in which H3N2 was the predominant strain. The former study covered four years of influenza-associated hospitalizations, including the 2009 pandemic H1N1 strain, which tended to affect younger age groups and had been shown to have worse morbidity and hospitalization rates for females (1). Additional contrasts with other studies include this study's stratifications by age, race, and SES, as well as adjustments for pregnancy.

Limitations

The data examined is limited to laboratory-confirmed cases of influenza and some patients may not be tested for influenza or may falsely test negative, although this is unlikely to be sex-specific. Additionally, conclusions cannot be extrapolated beyond hospitalization to true influenza incidence or mortality patterns in the population, as hospitalization patterns may reflect other issues (such as SES). However, sex differences in the patterns of influenza-associated hospitalizations

themselves are of public health significance as they are costly in addition to being indicators of serious illness.

Additionally, analyses covered two flu seasons, 2010-2011 and 2011-2012, which may not be representative years of influenza hospitalization patterns. Analyses from different years are needed to determine the consistency of these findings. This is especially important given that the circulating strain in any given year may affect sex differences, especially if there is little existing immunity in the population.

Finally, the effect of pregnancy on influenza-associated hospitalizations was estimated given the number of live births in 2010 compared to the number of females in the 2010 Census. These estimations may not accurately represent the effect of pregnancy on influenza-associated hospitalizations, although they are conservative estimates that only subtracted pregnancies that resulted in live births.

Strengths

This is the first study to assess sex differences in influenza-associated hospitalizations across a large geographic area with many cases. Additionally, this is one of the few studies to examine the relationship between sex, age, and influenza-associated hospitalizations along with additional demographic factors including race and SES, and adjustment for pregnancy. Finally, vaccination status was analyzed for those hospitalized, allowing direct comparisons between different groups of cases to be made.

Future Studies

Studies covering sex differences in influenza-associated hospitalizations by age over a long period of time are necessary to establish the stability of these patterns. Drivers for these differences should be explored more fully, including more specific vaccine coverage among the different risk groups analyzed and co-morbidities among cases. Sex differences in influenza-associated hospitalizations should also be compared to sex differences in influenza-associated mortalities to

determine if survival outcomes are similar for females and males. Finally, monitoring influenza vaccination rates for pregnant women should be strengthened to effectively evaluate efforts to improve vaccination levels among this group.

Conclusions

Despite mixed evidence, reports from the WHO have noted that influenza morbidity and mortality is overall worse for females, although there is currently no verdict on sex differences in influenza-associated hospitalizations (1). This study provides new evidence that in the United States in 2010-2012, there was not an important sex difference in influenza-associated hospitalizations other than increased rates of hospitalizations among pregnant women. The fact that the greatest risks to females were pregnancy-associated reinforces vaccine policy targeting pregnant women and suggests the need for more public health efforts to vaccinate them.

Tables

Table 1. Characteristics of adult cases with influenza-associated hospitalizations, 2010-2012

	Cases (n=6,292)	%*
Sex		
Female	3,493	55.5%
Male	2,799	44.5%
Age		
18-49	1,897	30.1%
50-64	1,498	23.8%
65-74	899	14.3%
75-84	1,026	16.3%
≥85	972	15.4%

*****Percentages may not total 100 due to rounding.

Table 2. Average annual incidence rate and incidence rate ratio of influenza-associated hospitalizations among adults by sex, 2010-2012

	Cases	Incidence rate†	IRR	95% CI	p-value	Age-adjusted IRR	95% CI	p-value
Incidence	6,292	15.05	---	---	---	---	---	---
Female	3,493	16.16	1.17	1.11, 1.22	<0.0001	1.00	0.94, 1.05	0.85
Male	2,799	13.86	Ref	---	---	Ref	---	---

† Incidence rates are per 100,000 person-years.

Table 3. Average annual incidence rate and incidence rate ratio of influenza-associated hospitalizations by age and sex, 2010-2012

	Cases	Incidence rate†	IRR	95% CI	p-value
Ages 18-49	1,897	7.51	---	---	---
Female	1,083	8.53	1.32	1.20, 1.44	<0.0001
Male	814	6.48	Ref	---	---
Ages 50-64	1,498	14.52	---	---	---
Female	793	14.87	1.05	0.957, 1.65	0.33
Male	705	14.13	Ref	---	---
Ages 65-74	899	26.74	---	---	---
Female	473	26.07	0.95	0.83, 1.08	0.42
Male	426	27.53	Ref	---	---
Ages 75-84	1,026	51.76	---	---	---
Female	570	48.85	0.87	0.77, 0.99	0.0312
Male	456	55.93	Ref	---	---
Ages ≥85	972	108.46	---	---	---
Female	574	93.95	0.67	0.59, 0.77	<0.0001
Male	398	139.53	Ref	---	---

† Incidence rates are per 100,000 person-years.

Table 4. Average annual incidence rate and incidence rate ratio of influenza-associated hospitalizations among adults by sex and socioeconomic status (poverty level by census tract), 2010-2012

	Cases (n=6,288)*	Incidence rate†	IRR	95% CI	p-value	Age-adjusted IRR	95% CI	p-value
<5% poverty	1,239	11.77	---	---	---	---	---	---
Female	636	11.68	0.98	0.88, 1.10	0.78	0.83	0.72, 0.95	0.0017
Male	603	11.86	Ref	---	---	---	---	---
5-<10% poverty	1,434	13.31	---	---	---	---	---	---
Female	804	14.32	1.17	1.06, 1.30	0.0027	0.99	0.88, 1.09	0.79
Male	630	12.21	Ref	---	---	---	---	---
10-<20% poverty	1,735	15.40	---	---	---	---	---	---
Female	980	16.72	1.20	1.09, 1.32	0.0002	1.02	0.92, 1.11	0.72
Male	755	13.97	Ref	---	---	---	---	---
≥20% poverty	1,880	20.54	---	---	---	---	---	---
Female	1,072	22.93	1.27	1.16, 1.39	<0.0001	1.08	0.98, 1.17	0.12
Male	808	18.05	Ref	---	---	---	---	---

*There are 4 (0.06%) missing cases and 43,463 (0.2%) persons in the population with missing socioeconomic status data.

† Incidence rates are per 100,000 person-years.

Table 5. Average annual incidence rate and incidence rate ratio of influenza-associated hospitalizations among adults by sex and race, 2010-2012

	Cases (n=5,779)*	Incidence rate†	IRR	95% CI	p-value	Age-adjusted IRR	95% CI	p-value
White	3,554	12.99	---	---	---	---	---	---
Female	1,907	13.53	1.09	1.02, 1.16	0.0099	0.91	0.85, 0.98	0.0091
Male	1,647	12.41	Ref	---	---	Ref	---	---
Black	1,254	21.97	---	---	---	---	---	---
Female	740	23.90	1.21	1.09, 1.36	0.0007	1.08	0.96, 1.2	0.22
Male	514	19.68	Ref	---	---	Ref	---	---
Hispanic	597	12.32	---	---	---	---	---	---
Female	357	15.08	1.56	1.32, 1.83	<0.0001	1.25	1.06, 1.44	0.0208
Male	240	9.69	Ref	---	---	Ref	---	---
Asian	298	10.49	---	---	---	---	---	---
Female	157	10.41	0.98	0.78, 1.24	0.89	0.85	0.61, 1.08	0.17
Male	141	10.58	Ref	---	---	Ref	---	---
Other	76	7.25	---	---	---	---	---	---
Female	42	7.59	1.11	0.70, 1.74	0.66	0.96	0.43, 1.48	0.87
Male	34	6.86	Ref	---	---	Ref	---	---

*There are 513 (8.2%) cases with missing race.
† Incidence rates are per 100,000 person-years.

Table 6. Average annual incidence rate and incidence rate ratio of influenza-associated hospitalizations among adults by sex among Hispanics, 2010-2012

	Cases	Incidence rate†	IRR	95% CI	p-value
Ages 18-49	278	7.43	---	---	---
Female	169	9.48	1.70	1.34, 2.17	<0.0001
Male	109	5.56	Ref	---	---
Ages 50-64	139	18.34	---	---	---
Female	78	20.12	1.22	0.87, 1.71	0.24
Males	61	16.47	Ref	---	---
Ages 65-74	83	40.36	---	---	---
Females	50	44.21	1.24	0.80, 1.92	0.34
Males	33	35.66	Ref	---	---
Ages 75-84	55	51.78	---	---	---
Females	34	54.42	1.13	0.66, 1.95	0.65
Males	21	48.01	Ref	---	---
Ages ≥85	42	122.46	---	---	---
Females	26	115.73	0.86	0.46, 1.60	0.62
Males	16	135.23	Ref	---	---

† Incidence rates are per 100,000 person-years.

Table 7. Average annual incidence rate and incidence rate ratio of influenza-associated hospitalizations among adults adjusted for pregnancy, 2010-2012

	Cases	Incidence rate†	IRR	95% CI	p-value
Overall Ages 18-49	1,615	6.59	---	---	---
Female	801	6.69	1.03	0.94, 1.14	0.53
Male	814	6.48	Ref	---	---
White Ages 18-49	699	4.78	---	---	---
Female	333	4.70	0.97	0.83, 1.12	0.65
Male	366	4.86	Ref	---	---
Black Ages 18-49	488	13.22	---	---	---
Female	252	13.24	1.00	0.84, 1.20	0.97
Males	236	13.20	Ref	---	---
Hispanic Ages 18-49	211	5.86	---	---	---
Females	102	6.20	1.11	0.85, 1.46	0.43
Males	109	5.56	Ref	---	---
Asian Ages 18-49	59	3.15	---	---	---
Females	25	2.59	0.69	0.41, 1.16	0.17
Males	34	3.73	Ref	---	---
Other Ages 18-49	29	3.74	---	---	---
Females	15	3.71	0.98	0.47, 2.04	0.96
Males	14	3.77	Ref	---	---
<5% Poverty Ages 18-49	222	3.96	---	---	---
Female	102	3.68	0.87	0.67, 1.14	0.31
Males	120	4.22	Ref	---	---
5-<10% Poverty Ages 18-49	312	5.17	---	---	---
Females	143	4.81	0.87	0.70, 1.09	0.23
Males	169	5.52	Ref	---	---
10-<20% Poverty Ages 18-49	455	6.74	---	---	---
Females	233	7.06	1.10	0.91, 1.32	0.33
Males	222	6.44	Ref	---	---
≥20 Poverty Ages 18-49	622	10.28	---	---	---
Females	321	11.04	1.15	0.98, 1.35	0.08
Males	301	9.58	Ref	---	---

† Incidence rates are per 100,000 person-years.

Table 8: Average annual incidence rate and incidence rate ratio across 14 FluSurv-NET sites, 2010-2012

	Cases	Incidence rate	IRR†	95% CI	p-value	Age-adjusted IRR	95% CI	p-value
California	866	16.30	---	---	---	---	---	---
Female	476	17.53	1.17	1.02, 1.33	0.0237	0.98	0.84, 1.11	0.73
Male	390	15.02	Ref	---	---	Ref	---	---
Colorado	619	16.95	---	---	---	---	---	---
Female	332	17.90	1.12	0.96, 1.31	0.16	0.91	0.75, 1.08	0.28
Male	287	15.98	Ref	---	---	Ref	---	---
Connecticut	726	24.36	---	---	---	---	---	---
Female	419	26.76	1.23	1.06, 1.43	0.0053	1.05	0.90, 1.20	0.55
Male	307	21.70	Ref	---	---	Ref	---	---
Georgia	558	10.25	---	---	---	---	---	---
Female	317	11.12	1.20	1.01, 1.42	0.0347	1.00	0.83, 1.18	0.97
Male	241	9.29	Ref	---	---	Ref	---	---
Maryland	624	15.21	---	---	---	---	---	---
Female	358	16.55	1.21	1.03, 1.41	0.0205	1.08	0.92, 1.24	0.34
Male	266	13.72	Ref	---	---	Ref	---	---
Michigan	57	7.88	---	---	---	---	---	---
Female	29	7.72	0.96	0.57, 1.61	0.88	0.85	0.32, 1.37	0.53
Male	28	8.05	Ref	---	---	Ref	---	---
Minnesota	498	11.59	---	---	---	---	---	---
Female	271	12.27	1.13	0.95, 1.35	0.18	0.94	0.75, 1.12	0.47
Male	227	10.87	Ref	---	---	Ref	---	---
New Mexico	258	13.55	---	---	---	---	---	---
Female	138	14.07	1.08	0.85, 1.38	0.53	0.94	0.69, 1.19	0.62
Male	120	13.00	Ref	---	---	Ref	---	---
New York	527	15.55	---	---	---	---	---	---
Female	265	15.09	0.94	0.79, 1.12	0.49	0.81	0.63, 0.98	0.0176
Male	262	16.04	Ref	---	---	Ref	---	---
Ohio	369	13.35	---	---	---	---	---	---
Female	198	13.89	1.09	0.89, 1.33	0.43	1.02	0.81, 1.23	0.84
Male	171	12.78	Ref	---	---	Ref	---	---
Oregon	375	14.82	---	---	---	---	---	---
Female	225	17.34	1.43	1.16, 1.75	0.0008	1.20	0.98, 1.41	0.10
Male	150	12.16	Ref	---	---	Ref	---	---
Rhode Island	233	23.82	---	---	---	---	---	---
Female	138	26.84	1.31	1.01, 1.70	0.0424	1.11	0.85, 1.38	0.44
Male	95	20.48	Ref	---	---	Ref	---	---
Tennessee	178	7.84	---	---	---	---	---	---
Female	109	9.25	1.46	1.08, 1.98	0.0134	1.31	0.99, 1.62	0.10
Male	69	6.32	Ref	---	---	Ref	---	---
Utah	404	27.68	---	---	---	---	---	---
Female	218	29.82	1.17	0.96, 1.42	0.12	1.01	0.81, 1.21	0.95
Male	186	25.53	Ref	---	---	Ref	---	---

† Incidence rates are per 100,000 person-years.

Table 9: Vaccine coverage among influenza-associated hospitalizations by sex and age, 2010-2012

	Females Vaccinated (n=3,135)*	Males Vaccinated (n=2,483)*	p-value**
Total	1,507 (48.1%)	1,240 (49.9%)	0.16
Ages 18-49	256 (27.2%)	181 (25.6%)	0.46
Ages 50-64	289 (40.5%)	270 (43.8%)	0.23
Ages 65-74	269 (61.0%)	230 (58.8%)	0.52
Ages 75-84	345 (65.0%)	284 (68.1%)	0.31
Ages ≥ 85	348 (68.4%)	275 (78.3%)	0.0013

*There were 358 (10.2%) females and 316 (11.3%) males with missing vaccination status.
**P-values were calculated by χ^2.

Table 10: Vaccine coverage among female influenza-associated hospitalizations ages 18-49 by pregnancy status, 2010-2012

	Pregnant Females Vaccinated	Non-Pregnant Females Vaccinated	p-value**
Total*	63 (25.5%)	193 (27.8%)	0.48
Ages 18-24	25 (25.3%)	26 (24.3%)	0.87
Ages 25-29	11 (14.9%)	30 (28.0%)	0.0374
Ages 30-34	15 (35.7%)	26 (26.0%)	0.24
Ages 35-39	11 (44.0%)	26 (24.1%)	0.0451
Ages 40-44	1 (14.3%)	37 (30.3%)	0.33**
Ages 45-49	n/a	48 (32.0%)	n/a

*There were 142 (13.1%) females ages 18-49 with missing vaccination status.

**P-values were calculated by χ^2 for age groups 18-24, 25-29, 30-34, and 35-39. A Fisher's exact test was used for ages 40-44 due to low counts in this group, and no tests were run for ages 45-49 because there were no pregnant cases in this age group.

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