The European Journal of Biomedical and Life Sciences 2024, No 1–2
ISSN 2310-5674

PREMIER Publishing
ppublishing.org

DOI:10.29013/EJBLS-24-1.2-13-23

UNDERSTANDING INFLUENZA SUSCEPTIBILITY: AN ANALYSIS OF DEMOGRAPHIC, SOCIOECONOMIC, AND HEALTH FACTORS USING NHANES DATA

Zitong Zheng [1]

[1] Shenzhen Middle School

Cite: *Zitong Zheng. (2024). Understanding Influenza susceptibility: An analysis of demographic, socioeconomic, and health factors using NHANES data. The European Journal of Biomedical and Life Sciences 2024, No 1–2.* https://doi.org/10.29013/EJBLS-24-1.2-13-23

Abstract

Background: Influenza continued to be a significant global health concern in recent 2 years, leading to significant economic burdens and public health challenges globally. Thus, understanding the complex risk factors associated with influenza susceptibility is crucial for effective prevention and mitigation strategies.

Objects: Our study evaluated the association of several risk factors with infection related to influenza, including socioeconomic, demographic and medical conditions.

Method: We examined data from the National Health and Nutrition Examination Survey (NHANES) spanning 5 survey cycles, from 2005 to 2018, to provide a comprehensive assessment of influenza susceptibility factors. Both univariate and multivariate logistic regression models were utilized to analyze the relationships between influenza outcomes and various factors in the general population. In our model, we also conducted Chi-square test for independence to evaluate the interaction between explanatory variables.

Results: In the multivariate logistic regression analysis, the risk of an influenza infection varies in different races: Compared to Hispanic, influenza susceptibility is significant within Non-Hispanic Black, Non-Hispanic Asian and multiracial groups (OR =1.96, 95% CI [1.5,2.55], *P* value <0.0001 for Non-Hispanic Black, OR = 1.43, 95% CI [1.11,1.84], *P* value = 0.0064 for Non-Hispanic Asian and multiracial). While Non-Hispanic White (OR = 1.34, 95% CI [0.92,1.97], *P* value = 0.134) shows no statistical significance associated with influenza. For medical conditions, individuals with Chronic Bronchitis or Asthma displayed higher probability of flu infection (OR = 1.34, 95% CI [1.01, 1.79], *P* value = 0.0483 for asthma, and OR = 1.77, 95% CI [1.14, 2.75], *P* value = .0137 for chronic bronchitis).

Conclusion: Ethnicity, respiratory diseases (Chronic Bronchitis and Asthma) were associated with higher odds of flu infection. We found no interaction between race and respiratory illness in their association with influenza. Targeted interventions addressing socioeconomic disparities and respiratory health are crucial for reducing the burden of influenza morbidity and mortality.

Keywords: *influenza, risk factors, racial disparity, respiratory diseases, logistic regression*

Introduction

Influenza, commonly known as the flu, is a contagious respiratory illness transmitted through airborne droplets during coughing or sneezing, or by contact with contaminated surfaces. It is caused by four main types of viruses: influenza A, influenza B, influenza C, and influenza D. Influenza A and B are responsible for seasonal flu outbreaks globally (CDC, Burden of Influenza, Centers for Disease Control and Prevention (2024). For instance, the H1N1 influenza pandemic, caused by an influenza A virus, now becomes a regular human flu virus and continues to circulate seasonally worldwide. Treatments of influenza include Oseltamivir, also known as Tamiflu, which is an antiviral medication against influenza A and B (Flu and Older Adults — NFID, Https://Www.Nfid.Org/ (n.d.). 2024), as well as humidifiers (Klein S.L., Hodgson A., Robinson D.P., 2012). Additionally, vaccination remains the most effective preventive measure against influenza. Given the capacity for flu viruses to mutate, new vaccines are developed annually to target prevalent strains (Fiscella K., Dressler R., Meldrum S., Holt K., 2007).

Despite these treatments, influenza imposes a significant worldwide economic burden each year. According to the Centers for Disease Control and Prevention (CDC), the annual economic cost of seasonal influenza in the United States ranges from $11 to $18 billion, encompassing direct costs such as medical treatment, hospitalizations, and medications, as well as indirect costs like lost productivity due to missed workdays and school absences (CDC, Burden of Influenza, Centers for Disease Control and Prevention (2024). Furthermore, influenza stands as a challenge to public health, particularly impacting vulnerable populations such as young children, elderly individuals, and those with underlying medical conditions. Severe complications including pneumonia, bronchitis, and exacerbation of chronic conditions like asthma, diabetes, or chronic obstructive pulmonary disease (COPD) can arise from influenza infections (Aligne C.A., 2016).These complications and comorbidity can result in hospitalizations and even fatalities. The World Health Organization (WHO) estimates that seasonal influenza epidemics result in approximately 3–5 million cases of severe illness globally each year, with respiratory deaths attributed to flu-related causes ranging from 290,000 to 650,000 annually (Vaughan E., Tinker T., 2009).

Therefore, a comprehensive understanding of the complex risk factors associated with influenza is imperative. Given its rapid transmission and potential for severe illness and mortality, identifying and studying these risk factors is crucial for developing effective strategies to mitigate the impact of influenza outbreaks and pandemics. This research aims to explore a variety of influenza risk factors, spanning individual, and societal dimensions. Through synthesizing empirical evidence on associated risk factors, our goal is to provide insights that can inform targeted interventions and policy initiatives, thereby reducing the burden of influenza morbidity and mortality.

Several factors collectively contribute significantly to the susceptibility to influenza, encompassing demographic variables, socioeconomic status, and underlying health conditions. Previous research has elucidated the associations between these factors and flu infection. Age and gender are pivotal determinants, with adults aged 65 years and older being identified as a high-risk group for developing severe complications from influenza (Flu and Older Adults — NFID, Https://Www.Nfid.Org/ (n.d.). 2024), while females typically experience greater morbidity and mortality during influenza outbreaks and pandemics (Klein S.L., Hodgson A., Robinson D.P., 2012). In addition, Fiscella's study highlighted racial and ethnic disparities that contribute to poorer health outcomes and higher mortality rates among minority groups (Fiscella K., Dressler R., Meldrum S., Holt K., 2007). From a socioeconomic perspective, overcrowded living conditions serve as a vehicle for respiratory infection transmission, including the flu, and can exacerbate disease severity (Aligne C.A., 2016). Low-income communities often experience worse health conditions and have a higher likelihood of premature mortality during epidemics (Adler N.E., Newman K., 2002). Moreover, individuals with lower educational levels tend to exhibit inferior receptiveness to precautionary health information (Vaughan E., Tinker T., 2009), thereby increasing their susceptibility to infection during pandemics.

Furthermore, medical conditions also account for vulnerability in flu pandemic. On one hand, people with regular health care had a higher probability of receiving influenza vaccination than those without health care coverage, which reduces their vulnerability in flu infection (Gurel-Headley M., Mamisashvili M., CarlLee S., Reece S., Chapman C., Kraleti S., Andersen J.A., Selig J.P., Willis D.E., Li J., McElfish P.A. 2023). On the other hand, respiratory conditions such as chronic bronchitis are associated with flu infections (Stark J.E., Heath R.B., Curwen M.P., 1965), while individuals with asthma are at a higher risk of having complications from the flu, such as pneumonia (Flu (Influenza), Asthma & Allergy Foundation of America (n.d.)). Besides, individuals with heart disease are more likely to develop complications from the flu, including pneumonia, bronchitis and lung failure (National Health and Nutrition Examination Survey (NHANES) — Healthy People 2030).

Building upon the existing research investigating various risk factors, this study addresses a significant gap regarding the influence of asthma and chronic bronchitis on flu risk across different racial groups. Our approach involves building logistic regression models to analyze the relationships between flu outcomes and the predictors of asthma, chronic bronchitis, and race. Additionally, we tested potential interactions between race and these respiratory conditions. By synthesizing evidence from population-representative data, we aspire to provide insights that can guide targeted interventions and policy measures to alleviate the impact of influenza morbidity and mortality. However, there remains a crucial need for further study on the intersection of social determinants of health, particularly in the context of influenza preparedness, response strategies, and post-flu recovery efforts. Future research should delve deeper into these determinants to develop effective solutions, and assist decision-makers and service organizations in addressing the needs of populations adversely affected by pandemic influenza.

Methods

2.1. Study population

The National Health and Nutrition Examination Survey (NHANES) is a cross-sectional, population-based health survey of the non-institutionalized U.S. civilian population conducted by the U.S. National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention (National Health and Nutrition Examination Survey (NHANES) — Healthy People 2030). The purpose of this survey is to evaluate the nutritional status and health of adults and children every two years. The NHANES program enrolled a nationally representative sample of the U.S. population every survey cycle and included interviews, examinations, and laboratory tests of serum and urine samples. We obtained the data from NHANES for the years 2005–2008 and 2011–2018 which span 5 cycles of surveys.

In each NHANES data cycle, each subsample was representative of the complete population, and the corresponding weight for the subsample was calculated after considering the additional step of sampling, the unequal probability of selection, and the non-response rate (Centers for Disease Control and Prevention, 2017). A total of 71,058 people participated in the study throughout seven cycles, with 39,221 of them aged ≥ 20 years. Individuals with missing HTN and urine OH-PAHs data were not included in the final design. Finally, 8951 participants of the NHANES2003–2016 were included in the final examinations (Supplementary Fig. S1). The NHANES representatives gathered information about prospective confounders using a self-reported questionnaire. Body parameters were measured in the Mobile Examination Center (MEC) by NHANES staff who had been trained. The NHANES procedure was approved by the National Center for Health Statistics (NCHS) Institutional Review Committee, and signed informed consent forms were acquired.

2.2 Dependent variable

The dependent variable in this study is whether an individual has influenza or pneumonia during the past 30 days. The question is administered to participants as, “Did you have flu, pneumonia, or ear infections that started during those 30 days?” Participants who answered “1” were recorded as «Yes,» and “2” as «No.»

2.3 Independent variables

The independent variables in this study were selected based on risk factors reported

in the literature, and classified into five broad categories: 1) demographic *i.e.* age, gender, race (Hispanic, Non-Hispanic Black, Non-Hispanic White, and other races); 2) socioeconomic *i.e.* education (less than high school, High school graduate, College, College graduate); 3) Disease: Diabetes, Chronic bronchitis, Coronary heart disease; and 4) other characteristics *i.e.* Family size, Marital Status (Married, Never Married), Routine Healthcare.

2.4 Statistical analysis

The distributions of demographic variables in total sample and population with and without flu were described using the numbers of sample (n) and proportions of each category (%). The association between the individual variables and outcome were determined by weighted Chi Squared tests. In order to determine the odds ratio and 95% confidence intervals between independent variables and outcome, we conducted univariate and multiple logistic regression models using gender, education, age, marital status, family size, diabetes, coronary heart disease, asthma, chronic bronchitis. For univariate models, only one independent variable was used to fit the model, whereas the multivariate logistic regression model also included all other covariates to adjust for the potential confounding effects. The interaction effects between the statistically significant main effects were also tested but no significance was found. The Chi-squared tests and logistic regression models were adjusted to incorporate weighted measures, ensuring that the estimates reflected more precise standard errors.

Multivariate logistic regression analysis was used to adjust for the various independent variables. Also, we calculated the *P* value, and odds ratios (OR) with their corresponding 95% confidence intervals (CI). A *P* value less than 0.05 was considered as statistical significance. All analyses were conducted using the R version (Using the R Statistical Computing Environment to Teach Social Statistics Courses).

Results

Table 1 shows the sample characteristics of study in total and by whether participants have had the flu during the past 30 days. Factors such as gender, education, age, marital status, family number, diabetes and coronary heart disease were not significantly associated with flu. For the race of all participants, 5.8% were Non-Hispanic White, 10.3% were Non-Hispanic Black, 73.7% were Hispanic, and 10.2% were other races (Non-Hispanic Asian and multiracial). However, the proportions for each race were significantly different between participants with and without flu ($P < .001$). For instance, the proportion of Non-Hispanic Black in the group with flu was about 16.9%, which was significantly higher than that in the non-flu group (10%). When considering diseases, we found that for all the participants, 14.5% people have asthma, and 85.5% people don't have asthma. However, the proportion of people having asthma among people having flu (20.1%) was significantly higher ($P = .005$) than people having asthma among people having no flu (14.3%). For 13546 participants, 7.5% people reported to have chronic bronchitis. But people having chronic bronchitis had a significantly larger proportion among people having flu (12.8%) than people having no flu (7.3) with a *P* value of 0.016.

Table 1. *Sample characteristics in all participants and groups by flu status.*

Variables	All n(%)	Flu Yes	No	P value
Cycle				0.814
2005–2006	2422(18.3)	137(21.6)	2285(18.2)	
2007–2008	2798(17.3)	123(15.1)	2675(17.4)	
2011–2012	1964(15.4)	84(14.7)	1880(15.5)	
2013–2014	2267(17.1)	107(18.6)	2160(17.1)	
2015–2016	2108(15.9)	101(15.3)	2007(16)	
2017–2018	1987(15.9)	76(14.8)	1911(16)	

Variables	All n(%)	Flu Yes	No	P value
Gender				0.313
Male	6476(46.4)	256(43.5)	6220(46.5)	
Female	7070(53.6)	372(56.5)	6698(53.5)	
Education				0.156
Less than high school	1885(7.1)	114(8.8)	1771(7.1)	
College	4108(33.8)	157(31.3)	3951(33.9)	
College graduate	5132(45.2)	220(43.2)	4912(45.3)	
High school graduate	2421(13.9)	137(16.8)	2284(13.8)	
Age				0.086
20–34	1829(14.8)	85(14.7)	1744(14.8)	
35–49	3193(28.6)	157(31.2)	3036(28.4)	
50–65	4328(33.3)	224(35.7)	4104(33.2)	
above 65	4196(23.3)	162(18.3)	4034(23.5)	
Poverty income ratio				0.057
<1.3	4635(22.9)	271(28.9)	4364(22.7)	
1.3–3.5	3078(34.6)	116(30.9)	2962(34.8)	
>3.5	5833(42.4)	241(40.3)	5592(42.5)	
Race				<0.001
Hispanic	6521(73.7)	223(64)	6298(74.1)	
Non-Hispanic Black	2651(10.3)	182(16.9)	2469(10)	
Non-Hispanic White	1431(5.8)	77(6.7)	1354(5.7)	
Other races	2943(10.2)	146(12.5)	2797(10.1)	
Marital Status				0.376
Divorced	2174(15.5)	110(16.8)	2064(15.5)	
Married	8916(71.2)	378(68.3)	8538(71.3)	
Never Married	1700(9.2)	92(9.6)	1608(9.2)	
Other	756(4.1)	48(5.3)	708(4.1)	
Family size				0.006
1	2549(16.6)	122(17.4)	2427(16.5)	
2	4246(34.5)	148(26.7)	4098(34.8)	
3–6	6170(46.1)	325(51.6)	5845(45.8)	
>7	581(2.9)	33(4.4)	548(2.9)	
Diabetes				0.365
No	11196(86.8)	496(85)	10700(86.9)	
Yes	2350(13.2)	132(15)	2218(13.1)	
Routine healthcare				0.815
No	1759(12.6)	83(13)	1676(12.6)	
Yes	11787(87.4)	545(87)	11242(87.5)	
Asthma				0.005
No	11633(85.5)	498(79.9)	11135(85.7)	
Yes	1913(14.5)	130(20.1)	1783(14.3)	
Chronic Bronchitis				0.016
No	12568(92.5)	560(87.2)	12008(92.7)	
Yes	978(7.5)	68(12.8)	910(7.3)	

Variables	All n(%)	Flu Yes	No	P value
Coronary heart disease				0.874
No	12779(95.3)	593(95.4)	12186(95.3)	
Yes	767(4.7)	35(4.6)	732(4.7)	

Table 2 presents the results of univariate logistic regression models examining the relationship between each independent variable and flu occurrence. Among the variables analyzed, several were found to be statistically significant in their association with flu, including race, poverty income ratio (PIR), and medical conditions related to the respiratory system (asthma and chronic bronchitis). Specifically, a higher poverty income ratio (> 3.5) was associated with a lower likelihood of flu occurrence (OR=0.74, 95% CI [0.57, 0.97], P = .031). For race, Non-Hispanic Black and other races (Non-Hispanic Asian and multiracial) had a higher prevalence of flu compared to Hispanic (OR =1.96, 95% CI [1.5, 2.55], P < .001 for Non-Hispanic Black, OR = 1.43, 95% CI [1.11, 1.84], P = .006 for other races, and OR = 1.34, 95% CI [0.92, 1.97], P = .134 for Hispanic). Furthermore, asthma showed a statistically significant association with flu, with a 51% higher probability of flu occurrence among individuals with asthma compared to those without asthma (95% CI [1.19, 1.91], P = .001), and chronic bronchitis was also significantly associated with flu, with an 85% higher odds among individuals with chronic bronchitis compared to those without (OR = 1.85, 95% CI [1.24, 2.75], P = .003), indicating a heightened risk of flu infection among individuals with this condition.

Table 2. *Univariate analyses of flu status and risk factors*

Variables	OR*	LCL**	UCL**	P value
Cycle				
2005–2006		Ref.		
2007–2008	0.73	0.44	1.19	0.203
2011–2012	0.8	0.44	1.44	0.453
2013–2014	0.92	0.58	1.45	0.715
2015–2016	0.81	0.49	1.32	0.393
2017–2018	0.78	0.47	1.3	0.335
Gender				
Female		Ref.		
Male	0.89	0.7	1.12	0.314
Education				
Less than high school		Ref.		
College	0.75	0.53	1.06	0.104
College graduate	0.77	0.57	1.04	0.091
High school graduate	0.98	0.74	1.3	0.889
Age				
20–34		Ref.		
35–49	1.1	0.79	1.53	0.558
50–65	1.08	0.75	1.55	0.677
above 65	0.78	0.56	1.09	0.153

Variables	OR*	LCL**	UCL**	P value
poverty income ratio				
<1.3		Ref.		
1.3–3.5	0.7	0.49	1	0.051
>3.5	0.74	0.57	0.97	0.031
Race				
Hispanic		Ref.		
Non-Hispanic Black	1.96	1.5	2.55	<0.001
Non-Hispanic White	1.34	0.92	1.97	0.134
Other races	1.43	1.11	1.84	0.006
Marital Status				
Divorced		Ref.		
Married	0.88	0.64	1.22	0.448
Never Married	0.96	0.65	1.41	0.841
Other	1.21	0.81	1.79	0.357
Family size				
1		Ref.		
2	0.73	0.53	1.01	0.06
3–6	1.07	0.79	1.46	0.663
>7	1.47	0.96	2.26	0.081
Diabetes				
No		Ref.		
Yes	1.16	0.85	1.6	0.35
Routine health-care				
No		Ref.		
Yes	0.96	0.67	1.37	0.813
Asthma				
No		Ref.		
Yes	1.51	1.19	1.91	0.001
Chronic bron-chitis				
No		Ref.		
Yes	1.85	1.24	2.75	0.003
Coronary heart disease				
No		Ref.		
Yes	0.97	0.62	1.5	0.876

** Odds ratio (OR)*
** Limits of the 95% confidence interval. Lower confidence limit (LCL) and upper confidence limit (UCL)*

Table 3 displays the results of multiple logistic regression models including all variables to adjust for potential confounding effects. Variables such as gender, education, age, marital status, family number, diabetes, routine healthcare, and coronary heart disease were not significantly associated with flu after adjusting for other covariates. However, the effects of PIR on flu were attenuated after adjusting for all the covariates, indicating the effects of this variable might be confounded. Among these variables, three variables remained significant risk factors for flu in the multivariate logistic model: Race, Asthma, Chronic bronchitis. Non-Hispanic Black and other race (Non-Hispanic Asian, multiracial) were significantly associated with higher susceptibility to flu compared to Hispanic (OR = 1.94, 95% CI [1.44, 2.62], $P < .001$ for Non-Hispanic Black, and OR =1.34, 95% CI [1.05, 1.71], $P = .02$ for Non-Hispanic Asian and multiracial, respectively). Additionally, asthma and chronic bronchitis were also independent risk factors of flu (OR = 1.34, 95%, CI [1.01, 1.79], $P = .048$ for asthma, and OR = 1.77, 95% CI [1.14, 2.75], $P = .014$ for chronic bronchitis, respectively).

Table 3. *Multivariate logistic regression analysis of risk factors associated with influenza*

Variables	OR	LCL	UCL	P value
Cycle				
2005–2006		Ref.		
2007–2008	0.71	0.45	1.14	0.16
2011–2012	0.78	0.43	1.4	0.411
2013–2014	0.88	0.56	1.37	0.569
2015–2016	0.77	0.48	1.22	0.268
2017–2018	0.74	0.44	1.24	0.262
Gender				
Female		Ref.		
Male	0.92	0.72	1.19	0.53
Education				
Less than high school		Ref.		
College	0.99	0.69	1.42	0.964
High school graduate	1.18	0.87	1.61	0.342
College graduate	1.02	0.73	1.42	0.912
Age				
20–34		Ref.		
35–49	1.12	0.81	1.57	0.496
50–65	1.22	0.86	1.75	0.268
above 65	0.91	0.61	1.35	0.628
poverty income ratio				
<1.3		Ref.		
1.3–3.5	0.91	0.64	1.3	0.603
>3.5	0.89	0.66	1.19	0.437
Race				
Hispanic		Ref.		
Non-Hispanic Black	1.94	1.44	2.62	<0.0001
Non-Hispanic White	1.32	0.9	1.91	0.156
Other races	1.34	1.05	1.71	0.02
Marital Status				
Divorced		Ref.		
Married	0.93	0.68	1.29	0.677
Never Married	1.07	0.7	1.63	0.759
Other	1.05	0.71	1.57	0.801

Variables	OR	LCL	UCL	P value
Family size				
1		Ref.		
2	0.82	0.6	1.11	0.204
3–6	1.08	0.76	1.53	0.659
>7	1.31	0.83	2.07	0.25
Diabetes				
No		Ref.		
Yes	1.11	0.79	1.55	0.542
Routine healthcare				
No		Ref.		
Yes	1.06	0.73	1.54	0.744
Asthma				
No		Ref.		
Yes	1.34	1.01	1.79	0.048
Chronic bronchitis				
No		Ref.		
Yes	1.77	1.14	2.75	0.014
Coronary heart disease				
No		Ref.		
Yes	1.03	0.63	1.68	0.907

In conclusion, our study identified race, asthma, and chronic bronchitis as major independent predictors of flu. While we also tested the interaction among asthma, race, and chronic bronchitis, no significant interaction effects were found between any of these variables (data not shown).

Discussion

This study investigated the association between influenza and various risk factors encompassing demographic variables (gender, age, race, family size), socioeconomic status indicators (education, marital status, access to routine healthcare) and medication conditions (diabetes, chronic bronchitis, coronary heart disease, and asthma). We found that risk factors including race, chronic bronchitis and asthma are significantly associated with influenza susceptibility. Specifically, individuals of Non-Hispanic Black and other races (Non-Hispanic Asian and multiracial) exhibited a notably higher likelihood of flu compared to Hispanics. Other two respiratory diseases like asthma and chronic bronchitis also showed statistical significance in association with flu, displaying an increased susceptibility to flu infection.

Whereas some studies exploring the risk factors of influenza focused on socioeconomic risk factors (Mamelund S.-E., Shelley-Egan C., Rogeberg O., 2021; Pandemic influenza and socioeconomic disparities: Lessons from 1918 Chicago. 2024) or emphasized the relationship between respiratory disease and flu (Peteranderl C., Herold S., Schmoldt C., 2016), our research examined multiple risk factors simultaneously using logistic regression models and a large dataset representing the non-institutionalized US population. Notably, contrary to some prior studies that linked lower literacy to higher flu prevalence (3–1–4–2_dm_high_risk_populations.pdf, (n.d.)) our study did not find significant differences in flu prevalence based on education levels. This discrepancy may stem from variations in survey design and demographic characteristics of the study samples. Regarding race, our study's findings regarding racial disparities in flu infection differed from some previous findings. One study of the 1918 pandemic indicated smaller racial disparities in flu-related mortality (Eiermann M., Wrigley-Field E., Feigenbaum J. J., Helgertz J., Hernandez E., Boen C. E., 2022) (and another study highlighted higher hospitalization rates among Blacks and Native Americans during the H1N1 pandemic compared to Whites (Quinn S. C., Kumar S., Freimuth V. S., Musa D., Casteneda-Angarita N.,

Kidwell K., 2011), whereas our study suggested that Non-Hispanic Black and other races (Non-Hispanic Asian and multiracial) shows significantly high susceptibility to influenza. For socioeconomic conditions, although one study found a strong association between income level and probability of having flu (Gaskin C. M., Woods D. R., Ghosh S., Watson S., Huber L. R., 2023), our regression model did not find a direct association between income and flu, suggesting a potential confounding variable related to race influencing this relationship. Additionally, overcrowding has been previously linked to flu transmission (Aligne C. A., 2016), however, our model showed no association between numbers of family members and flu prevalence.

Nevertheless, our research findings aligned with prior studies regarding the relationship between medical conditions and influenza. One study revealed that asthmatic children suffer from more frequent and severe virus-induced illnesses (Olenec J. P., Kim W. K., Lee W.-M., Vang F., Pappas T. E., Salazar L. E. P., Evans M. D., Bork J., Roberg K., Lemanske R. F., Gern J. E., 2010), while another study identified asthma as a risk factor for hospitalization during the influenza pandemic (Frontiers | Influenza in Asthmatics: For Better or for Worse? (n.d.). 2024). These findings are consistent with the significant impact of asthma observed in our study. Moreover, research by Stark, Heath, and Curwen suggested that chronic bronchitis increases susceptibility during flu pandemics (Stark J. E., Heath R. B., Curwen M. P., 1965), which is in accordance with our model.

Furthermore, our study boasts several strengths. Firstly, we conducted a cross-sectional exploration on the multiple risk factors of influenza, encompassing socioeconomic, demographic, and medical factors, contributing to a more comprehensive understanding of influenza risk factors. Moreover, our data were derived from a large national representative database, enhancing the generalizability of our findings to diverse populations, including minorities. Furthermore, we explored potential interaction effects among various factors, although no significant interactions were detected among the primary risk factors.

However, our study has limitations. On one hand, certain factors such as working conditions, pregnancy, language, culture (linked to ethnicity), disabilities, and other pre-existing medical conditions were not accounted for in our analysis. On the other hand, as our study is cross-sectional, the temporal causality cannot be inferred from the analysis in this study.

In brief, our findings revealed varying levels of susceptibility to influenza associated with racial disparities and respiratory diseases. We anticipate that policymakers and healthcare professionals will enact precautionary measures to mitigate ethnic disparities and respiratory-related illness during pandemics. Further investigation is warranted to elucidate the underlying mechanisms, including molecular and genetic pathways, through which respiratory conditions like asthma and COPD influence influenza outcomes.

References

CDC, Burden of Influenza, Centers for Disease Control and Prevention (2024). URL: https://www.cdc.gov/flu/about/burden/index.html (accessed March 18, 2024).

Flu and Older Adults – NFID, URL: https://Www.Nfid.Org/ (n.d.). URL: https://www.nfid.org/infectious-diseases/flu-and-older-adults/ (accessed April 2, 2024).

Klein S. L., Hodgson A., Robinson D. P. Mechanisms of sex disparities in influenza pathogenesis, J Leukoc Biol 92 (2012) 67–73. URL: https://doi.org/10.1189/jlb.0811427.

Fiscella K., Dressler R., Meldrum S., Holt K. Impact of influenza vaccination disparities on elderly mortality in the United States, Prev Med 45 (2007) 83–87. URL: https://doi.org/10.1016/j.ypmed.2007.03.007.

Aligne C. A. Overcrowding and Mortality During the Influenza Pandemic of 1918: Evidence From US Army Camp A. A. Humphreys, Virginia, American Journal of Public Health 106 (2016) 642. URL: https://doi.org/10.2105/AJPH.2015.303018.

Adler N. E., Newman K. Socioeconomic Disparities In Health: Pathways And Policies, Health Affairs 21 (2002) 60–76. URL: https://doi.org/10.1377/hlthaff.21.2.60.
Vaughan E., Tinker T. Effective Health Risk Communication About Pandemic Influenza for Vulnerable Populations, Am J Public Health 99 (2009) S324–S332. URL: https://doi.org/10.2105/AJPH.2009.162537.
Gurel-Headley M., Mamisashvili M., CarlLee S., Reece S., Chapman C., Kraleti S., Andersen J. A., Selig J. P., Willis D. E., Li J., McElfish P. A. Associations between Influenza Vaccination and Health Care Access among Adults in the United States, Vaccines (Basel) 11 (2023) 416. URL: https://doi.org/10.3390/vaccines11020416.
Stark J. E., Heath R. B., Curwen M. P. Infection with Influenza and Parainfluenza Viruses in Chronic Bronchitis, Thorax – 20. 1965. – P. 124–127.
Flu (Influenza), Asthma & Allergy Foundation of America (n.d.). URL: https://aafa.org/asthma/asthma-triggers-causes/respiratory-infections-flu-cold-asthma/flu-influenza/ (accessed April 2, 2024).
National Health and Nutrition Examination Survey (NHANES) – Healthy People 2030 | health.gov, (n.d.). URL: https://health.gov/healthypeople/objectives-and-data/data-sources-and-methods/data-sources/national-health-and-nutrition-examination-survey-nhanes (accessed March 31, 2024).
Mamelund S.-E., Shelley-Egan C., Rogeberg O. The association between socioeconomic status and pandemic influenza: Systematic review and meta-analysis, PLOS ONE – 16. (2021). e0244346. URL: URL: https://doi.org/10.1371/journal.pone.0244346.
Pandemic influenza and socioeconomic disparities: Lessons from 1918 Chicago | PNAS, (n.d.). URL: https://www.pnas.org/doi/full/10.1073/pnas.1616537113 (accessed April 18, 2024).
Peteranderl C., Herold S., Schmoldt C. Human Influenza Virus Infections, Semin Respir Crit Care Med – 37. (2016).– P. 487–500. URL: https://doi.org/10.1055/s-0036–1584801.
3-1-4-2_dm_high_risk_populations.pdf, (n.d.). URL: https://www.redcross.ca/crc/documents/3-1-4-2_dm_high_risk_populations.pdf (accessed April 21, 2024).
Eiermann M., Wrigley-Field E., Feigenbaum J. J., Helgertz J., Hernandez E., Boen C. E. Racial Disparities in Mortality During the 1918 Influenza Pandemic in United States Cities, Demography 59 (2022) 1953–1979. URL: https://doi.org/10.1215/00703370–10235825.
Quinn S. C., Kumar S., Freimuth V. S., Musa D., Casteneda-Angarita N., Kidwell K. Racial Disparities in Exposure, Susceptibility, and Access to Health Care in the US H1N1 Influenza Pandemic, Am J Public Health 101 (2011) 285–293. URL: https://doi.org/10.2105/AJPH.2009.188029.
Gaskin C. M., Woods D. R., Ghosh S., Watson S., Huber L. R. The Effect of Income Disparities on Influenza Vaccination Coverage in the United States, Public Health Rep 138 (2023) 85–90. URL: https://doi.org/10.1177/00333549211069190.
Olenec J. P., Kim W. K., Lee W.-M., Vang F., Pappas T. E., Salazar L. E.P., Evans M. D., Bork J., Roberg K., Lemanske R. F., Gern J. E. Weekly monitoring of children with asthma for infections and illness during common cold seasons, Journal of Allergy and Clinical Immunology 125 (2010) 1001–1006.e1. URL: https://doi.org/10.1016/j.jaci.2010.01.059.
Frontiers | Influenza in Asthmatics: For Better or for Worse?, (n.d.). URL: URL: https://www.frontiersin.org/journals/immunology/articles/10.3389/fimmu.2018.01843/full (accessed April 19, 2024).

submitted 27.04.2024;
accepted for publication 11.05.2024;
published 22.07.2024

Contact: Theresazhengq@gmail.com