

Assessment of Influenza Testing Distribution in the United States for the 2021-2022, 2022-2023, and 2023-2024 Respiratory Virus Seasons

Autumn Gertz, Juliana B Sopko, Christopher Remmel, Benjamin Rader, John S Brownstein

Submitted to: JMIR Public Health and Surveillance
on: April 23, 2025

Disclaimer: © The authors. All rights reserved. This is a privileged document currently under peer-review/community review. Authors have provided JMIR Publications with an exclusive license to publish this preprint on its website for review purposes only. While the final peer-reviewed paper may be licensed under a CC BY license on publication, at this stage authors and publisher expressly prohibit redistribution of this draft paper other than for review purposes.

Table of Contents

Original Manuscript..... 5
Supplementary Files..... 15
 Multimedia Appendixes 16
 Multimedia Appendix 1..... 16



Assessment of Influenza Testing Distribution in the United States for the 2021-2022, 2022-2023, and 2023-2024 Respiratory Virus Seasons

Autumn Gertz¹ MS; Juliana B Sopko¹ MPH; Christopher Remmel¹; Benjamin Rader^{1,2} PhD, MPH; John S Brownstein^{1,3} PhD

¹ Boston Children's Hospital Boston US

² Harvard Medical School Boston US

Corresponding Author:

Autumn Gertz MS

Boston Children's Hospital
300 Longwood Ave
Boston
US

Abstract

Background: Effective surveillance of seasonal influenza is crucial to understanding disease burden and impact. Traditional surveillance accounts for those who interact with the healthcare system. Understanding who is being captured by current surveillance methods can help further knowledge around influenza and identify areas of improvement.

Objective: To examine influenza testing amongst a United States representative population to better understand who is testing over three seasons.

Methods: Outbreaks Near Me is a participatory surveillance system that, in partnership with SurveyMonkey, conducted a weekly cross-sectional survey. Survey data from three influenza seasons was used, (2021-2022 flu season N = 335,964; 2022-2023 season N = 334,584; 2023-2024 season N = 267,940) with analysis conducted to examine influenza testing among different demographic groups. Descriptive proportions applying survey weights targeting U.S. census targets were produced to understand which demographics were testing for influenza. A weighted multivariate logistic regression was conducted for influenza testing by income, adjusting for other demographics and COVID-19 testing.

Results: Generally, low levels of influenza testing were reported. Across all influenza seasons, those who had lower income tested for influenza at higher proportions. Lower household annual income was associated with higher odds of testing for influenza, while higher incomes were less likely to have been tested for influenza.

Conclusions: : Individuals who fall within lower income brackets tested at higher proportions and had an increased likelihood of having tested for influenza in the past 30 days than their higher income counterparts. These trends suggest that populations that may historically have more barriers to care, have access to and are using influenza tests.

(JMIR Preprints 23/04/2025:76459)

DOI: <https://doi.org/10.2196/preprints.76459>

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**

Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.
Only make the preprint title and abstract visible.

No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**

Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain visible to all users.
Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in http://www.jmir.org/preprint/76459

No. Please do not make my accepted manuscript PDF available to anyone. I understand that if I later pay to participate in <https://preprints.jmir.org/preprint/76459>



Original Manuscript

Assessment of Influenza Testing Distribution in the United States for the 2021-2022, 2022-2023, and 2023-2024 Respiratory Virus Seasons

Authors: Autumn Gertz^{1*}, Juliana Sopko¹, Christopher Remmel¹, Benjamin Rader^{1,2}, John S Brownstein^{1,2}

¹ Computational Epidemiology Lab, Boston Children's Hospital, Boston, Massachusetts

² Harvard Medical School, Boston, Massachusetts

*Corresponding author

*Corresponding author: Autumn Gertz

Address: 300 Longwood Ave, Boston MA, 02215

Email: autumn.gertz@childrens.harvard.edu

Summary: Understanding capture in surveillance can improve disease monitoring. We studied who was testing for influenza, finding those with lower income were more likely to test. A population that is historically underrepresented is better captured in influenza testing and surveillance.

Abstract

Background: Effective surveillance of seasonal influenza is crucial to understanding disease burden and impact. Traditional surveillance accounts for those who interact with the healthcare system. Understanding who is being captured by current surveillance methods can help further knowledge around influenza and identify areas of improvement.

Objective: To examine influenza testing amongst a United States representative population to better understand who is testing over three seasons.

Methods: Outbreaks Near Me is a participatory surveillance system that, in partnership with SurveyMonkey, conducted a weekly cross-sectional survey. Survey data from three influenza seasons was used, (2021-2022 flu season N = 335,964; 2022-2023 season N = 334,584; 2023-2024 season N = 267,940) with analysis conducted to examine influenza testing among different demographic groups. Descriptive proportions applying survey weights targeting U.S. census targets were produced to understand which demographics were testing for influenza. A weighted multivariate logistic regression was conducted for influenza testing by income, adjusting for other demographics and COVID-19 testing.

Results: Generally, low levels of influenza testing were reported. Across all influenza seasons, those who had lower income tested for influenza at higher proportions. Lower household annual income was associated with higher odds of testing for influenza, while higher incomes were less likely to have been tested for influenza.

Conclusion: Individuals who fall within lower income brackets tested at higher proportions and had an increased likelihood of having tested for influenza in the past 30 days than their higher income counterparts. These trends suggest that populations that may historically have more barriers to care, have access to and are using influenza tests.

Keywords: Influenza; Flu Testing; Syndromic Surveillance; Health Survey; Influenza-like illness

Introduction

Effective surveillance of respiratory illnesses is crucial to early outbreak detection and robust response efforts¹. In the United States (U.S.), surveillance of respiratory disease, such as influenza, has largely been conducted via encounters with the healthcare system². Laboratory-confirmed influenza cases, outpatient influenza-like illness (ILI), and mortality data help public health researchers gauge the burden of influenza.² However, variable access to medical care suggests that traditional surveillance is only capturing a part of the population³. Additionally, as at-home testing has become more available for respiratory illnesses, not all individuals testing for disease interact with the healthcare system.^{4, 5}

In addition to advancements like at-home testing, digital disease surveillance methods like participatory surveillance can augment traditional disease surveillance.⁶ Outbreaks Near Me (ONM) is an online participatory syndromic surveillance system that allows for the general public to report disease and health related information in the United States.⁷ ONM enables near real time collection and aggregation of data related to disease burden, vaccination coverage, and symptomatology.⁷ In addition, participants are asked to answer questions related to age, gender, race, income, and occupation.

In this study we leverage the previously validated ONM cross-sectional survey to assess the population testing for influenza in the 2021-2022, 2022-2023, and 2023-2024 influenza seasons.^{8, 9} Specifically, we assess which demographic groups were likely to get tested for influenza, and examine if there were any changes in the seasons following the COVID-19 pandemic. ONM is well situated to capture and evaluate any trends and changes to influenza testing, to further the understanding of the impacts and burden of influenza. Here we use the ONM survey to assess who is testing for influenza, and identify which populations are represented, or not, in existing influenza surveillance.

Methods

Survey Population

The ONM survey was deployed on the SurveyMonkey digital platform. Participants were recruited via end

page river sampling, a sampling method that prompts an optional survey after completion of an unrelated survey on SurveyMonkey.¹⁰ With over two million daily visitors to SurveyMonkey, the survey is able to capture a random sample of U.S. residents, collecting between 5,000-15,000 responses per week. The survey collected robust demographic data via multiple choice and multi-select questions. The data collected via this survey has been previously validated in other studies.^{8,9} Data from the 2021-2022, 2022-2023, and 2023-2024 respiratory seasons is included in this analysis. Respiratory seasons are defined as Morbidity and Mortality Weekly Report (MMWR) week 40 (approximately October 1) through March 31, with exact dates of collection in Supplemental Table 1. Influenza seasons were truncated to March 31, rather than MMWR week 20, for consistency as data collection ended March 31, 2024.

Analysis

Respondents were asked “In the past 30 days, have you been tested for influenza (flu)?” with participants being able to select either “Yes” or “No”. A series of demographic questions were asked, and we collapsed the self-reported industry responses into two categories, healthcare workers and non-healthcare workers. “In the past 30 days, have you been tested for COVID-19?” was captured as well. Self-reports of at-home tests are included in these “Yes” responses. For descriptive analyses, we assessed two influenza testing groups: tested for influenza and only tested for influenza. Tested for influenza included anyone who answered “Yes” to “In the past 30 days, have you been tested for influenza (flu)?”. Only tested for influenza was a subset of this group, which removed anyone who also reported “Yes” to testing for COVID-19 also. An inverse probability of survey selection weighting scheme targeting the U.S. census estimated population was applied to all results in the study.^{8 10} A weighted multivariate logistic regression model was conducted for each influenza season to assess the likelihood of having been tested for influenza. The models assessed the likelihood of having been tested for influenza in the past thirty days by income, adjusting for age, gender, race, education level, health insurance type, healthcare worker status, and having been tested for COVID-19 in the past 30 days. Descriptive proportions and regression models were assessed for each influenza season, and not across the study period in its entirety. RStudio version 2024.12.1+563 was used to conduct the analyses. This study was approved by Boston Children’s Hospital Institutional Review Board and received a waiver of informed consent (IRB-P00023700).

Results

Survey Population

During the study period, 813,234 total responses were collected. The weighted demographic breakdown of the 2021-2022, 2022-2023, and 2023-2024 influenza seasons were similar. For all three seasons, more respondents identify as female than male (Table 1). Across all seasons, the largest proportion of respondents was the 65 and older group (respectively 19.3%, 19.5%, 19.5%); the smallest proportion were those under the age of 18 (respectively 7.1%, 6.5%, 7.1%). Across all seasons, the largest proportion of respondents completed high school or earned their G.E.D (respectively 33.3%, 33.2%, 32.8%); the smallest proportion are those who did not complete high school (respectively 8.9%, 8.7%, 9.4%). The majority of respondents received insurance via a plan through your spouse, parent, employer (respectively 39.8%, 36.9%, 35.0%), and the smallest proportion received insurance through TRICARE (respectively 1.9%, 1.9%, 1.8%). Full results of weighted proportions for industry are available in Supplemental Table 2.

Table 1: Weighted Demographic Characteristics of Study Population across Three Influenza Seasons

Demographics		Season ^a					
		2021 - 2022		2022 - 2023		2023 - 2024	
		N = 335964		N = 334584		N = 267940	
Gender		N	Weighted %	N	Weighted %	N	Weighted %
Gender	Male	129233	47.1%	100980	47.1%	66401	47.1%
	Female	200684	50.6%	160850	50.8%	105135	50.6%
	Not listed / non-conforming	6047	2.3%	5276	2.1%	4094	2.2%
Race							
Race	White	217482	62.1%	160169	61.8%	102610	61.7%
	Black	46759	16.7%	39214	16.9%	26417	17.1%
	Hispanic	43561	12.5%	35636	12.6%	23210	12.5%
	Asian	16029	5.7%	12326	5.4%	9119	5.4%
	No Answer	12133	3.0%	87239	3.3%	108268	3.3%
Education							
Education	Did not complete high school	10668	8.9%	9871	8.7%	7893	9.4%
	High school or G.E.D.	57899	33.3%	51033	33.2%	36531	32.8%
	Associate's degree	32592	9.1%	25602	9.5%	16269	9.4%
	Some college	66617	19.5%	51577	19.4%	33148	19.2%
	College graduate	91664	18.2%	70289	18.3%	44833	18.3%
	Post graduate degree	76524	10.9%	58734	10.9%	36956	10.9%
Age							
Age	13-17	4457	7.1%	3745	6.5%	2997	7.1%
	18 -24	21420	11.2%	16655	11.1%	11628	10.9%
	25 - 34	43489	16.7%	33772	16.8%	22153	16.7%
	35 - 44	56378	15.5%	44276	15.6%	28582	15.5%
	45 - 54	67123	14.9%	51021	15.0%	33070	14.9%
	55 - 64	73204	15.4%	57222	15.5%	36723	15.5%
	65 and over	69893	19.3%	60415	19.5%	40477	19.5%
Income							
Income	Under \$15,000	30200	12.8%	25095	13.4%	16376	14.2%
	Between \$15,000 and \$29,999	35390	13.2%	26565	12.9%	16002	12.4%
	Between \$30,000 and \$49,999	46445	15.4%	34833	15.4%	20741	15.3%
	Between \$50,000 and \$74,999	50944	15.1%	36881	15.0%	22096	15.1%
	Between \$75,000 and \$99,999	42361	11.5%	29940	11.3%	17337	11.0%
	Between \$100,000 and \$150,000	52730	12.9%	37042	12.9%	21364	12.9%
	Over \$150,000	55466	12.2%	28954	12.2%	22557	12.2%
	No Answer	22423	6.9%	105274	6.9%	133151	7.0%
Insurance							
Insurance	Plan through your spouse, parent, employer	151845	39.8%	99236	36.9%	54920	35.0%
	Other (please specify)	20200	6.7%	8921	3.8%	-	-
	Plan you purchased yourself	37674	10.3%	27863	10.5%	16670	10.5%
	Medicare	67835	21.5%	56337	23.1%	35013	23.3%
	Medicaid or Medical	26810	9.9%	24050	11.7%	15039	11.9%
	TRICARE	6333	1.9%	4737	1.9%	2672	1.8%
	Not covered by health insurance	19231	7.7%	13817	7.1%	9405	8.0%
	No Answer	6034	2.2%	99623	5.1%	135905	9.5%
Industry							
Industry	Non-Healthcare ^b	76586	78.7%	133084	79.0%	177869	79.9%
	Healthcare	25770	21.3%	44387	21.0%	57672	20.1%

Table 1 examines the demographic characteristics of those who answered the survey during the 2021 – 2022, 2022 – 2023, and 2023 – 2024 respiratory seasons utilizing a weighting scheme targeting the U.S. census.

^a Please refer to table 1 of the appendix for the date range of the 2021-2022, 2022-2023, and 2023 - 2024 seasons

^b Non-Healthcare is a condensed group that consists of all occupations except healthcare. To see the complete breakdown of Non-Healthcare occupations refer to Table 2 in the Appendix.

During the 2021-2022 season, 4.2% of the population had tested for influenza and 0.4% had only tested for influenza. Slightly more tested during 2022-2023 at 9.1% and 1.5% only tested for influenza. In the 2023-2024 season, 8.9% of the population tested for influenza and 2.0% had only tested for influenza. The proportion of individuals who had not completed high school and tested for influenza and only tested for influenza was higher than the other educational groups. Those who made under \$15,000 reported more testing in both tested for influenza (respectively 7.1%, 15.0%, 14.2%) and only tested for influenza (respectively 0.8%, 2.3%, 2.7%) than higher income groups (Table 2). Overall, the proportion of individuals with Medicaid or Medical tested for influenza (respectively 6.7%, 14.4%, 13.2%) and only tested for influenza (respectively 0.6%, 2.1%, 2.6%) at higher levels (Table 2). There was an observed increase in the proportion of those who did not complete high school and who only tested for influenza (respectively 0.6%, 2.3%, 3.3%) from 2021 - 2024 (Table 2). Supplemental Table 3 contains influenza testing and only influenza testing among all the industry options.

Table 2: Weighted Demographic Characteristics of Individuals who Tested for Influenza and Only Tested for Influenza across Three Seasons

Demographics	Season		2021 - 2022		2022-2023		2023 - 2024	
			Tested for influenza ^a		Tested for influenza ^a		Tested for influenza ^a	
			N	Weighted % (95% C.I.)	N	Weighted % (95% C.I.)	N	Weighted % (95% C.I.)
Gender	Male		4463	4.4% (4.2% - 4.7%)	392	0.4% (0.3% - 0.5%)	8041	9.3% (8.9% - 9.8%)
	Female		6976	3.9% (3.6% - 4.1%)	544	0.3% (0.3% - 0.4%)	12862	8.8% (8.4% - 9.2%)
	Not listed / non-conforming		294	5.0% (3.6% - 6.5%)	35	0.8% (0.2% - 1.3%)	591	11.4% (9.0% - 13.8%)
							85	1.6% (0.7% - 2.6%)
Race	White		5639	3.1% (2.9% - 3.3%)	378	0.2% (0.2% - 0.3%)	9733	7.2% (6.9% - 7.6%)
	Black		2798	6.8% (6.2% - 7.4%)	265	0.7% (0.5% - 0.9%)	4982	13.9% (13.0% - 14.8%)
	Hispanic		2298	6.1% (5.5% - 6.7%)	221	0.6% (0.4% - 0.8%)	4176	12.5% (11.6% - 13.4%)
	Asian		462	3.4% (2.7% - 4.2%)	58	0.5% (0.2% - 0.7%)	748	7.4% (6.1% - 8.8%)
	No Answer		536	4.7% (3.7% - 5.7%)	49	0.6% (0.2% - 0.9%)	7236	10.1% (8.9% - 11.3%)
							1216	1.6% (1.1% - 2.1%)
Education	Did not complete high school		684	5.7% (4.5% - 6.8%)	82	0.6% (0.2% - 1.0%)	1359	12.4% (10.6% - 14.2%)
	High school or G.E.D.		2971	5.2% (4.7% - 5.7%)	270	0.5% (0.3% - 0.6%)	5630	10.9% (10.2% - 11.7%)
	Associate's degree		1335	4.2% (3.6% - 4.8%)	104	0.3% (0.2% - 0.5%)	2253	9.0% (8.0% - 9.9%)
	Some college		2569	4.0% (3.6% - 4.4%)	222	0.4% (0.2% - 0.5%)	4625	9.0% (8.3% - 9.6%)
	College graduate		2409	2.7% (2.4% - 3.0%)	175	0.2% (0.1% - 0.3%)	4464	6.5% (6.0% - 7.0%)
	Post graduate degree		1765	2.4% (2.1% - 2.7%)	118	0.2% (0.1% - 0.3%)	3163	5.7% (5.2% - 6.2%)
							475	0.9% (0.7% - 1.1%)
							1936	5.7% (5.0% - 6.4%)
Age	13-17		201	4.2% (2.7% - 5.8%)	25	0.5% (-0.1% - 1.0%)	396	10.1% (7.3% - 12.9%)
	18-24		1086	5.4% (4.6% - 6.2%)	110	0.5% (0.2% - 0.8%)	1735	10.8% (9.5% - 12.1%)
	25-34		2319	6.2% (5.6% - 6.8%)	170	0.5% (0.3% - 0.6%)	3992	12.8% (11.8% - 13.8%)
	35-44		2471	4.9% (4.5% - 5.4%)	164	0.4% (0.2% - 0.5%)	4533	10.8% (10.0% - 11.6%)
	45-54		2392	3.9% (3.5% - 4.3%)	185	0.3% (0.2% - 0.4%)	4040	8.3% (7.7% - 9.0%)
	55-64		1857	2.8% (2.5% - 3.2%)	142	0.2% (0.2% - 0.3%)	3724	6.9% (6.3% - 7.5%)
	65 and over		1407	2.3% (2.0% - 2.6%)	175	0.3% (0.2% - 0.4%)	3074	5.6% (5.1% - 6.1%)
							537	1.0% (0.8% - 1.2%)
Income	Under \$15,000		2002	7.1% (6.3% - 7.9%)	217	0.8% (0.5% - 1.1%)	3640	15.0% (13.8% - 16.2%)
	Between \$15,000 and \$29,999		1782	5.4% (4.8% - 6.1%)	162	0.5% (0.3% - 0.7%)	2999	12.0% (11.0% - 13.0%)
	Between \$30,000 and \$49,999		1879	4.4% (3.9% - 4.9%)	158	0.4% (0.5% - 0.6%)	3247	9.5% (8.7% - 10.3%)
	Between \$50,000 and \$74,999		1687	3.7% (3.3% - 4.1%)	145	0.3% (0.2% - 0.4%)	2897	8.0% (7.3% - 8.7%)
	Between \$75,000 and \$99,999		1206	3.2% (2.8% - 3.6%)	82	0.3% (0.1% - 0.4%)	2041	7.4% (6.6% - 8.2%)
	Between \$100,000 and \$150,000		1288	2.8% (2.4% - 3.1%)	92	0.2% (0.1% - 0.3%)	2175	6.3% (5.6% - 6.9%)
	Over \$150,000		607	2.8% (2.4% - 3.1%)	60	0.2% (0.1% - 0.3%)	2183	6.3% (5.6% - 6.9%)
	No Answer		1201	3.3% (2.7% - 3.9%)	55	0.3% (0.1% - 0.5%)	7693	7.1% (6.1% - 8.1%)
Insurance	Plan through your spouse, parent, employer		4180	3.2% (2.9% - 3.4%)	265	0.2% (0.2% - 0.3%)	6536	7.1% (6.7% - 7.6%)
	Other (please specify)		819	4.5% (3.8% - 5.3%)	81	0.5% (0.2% - 0.7%)	789	9.2% (7.6% - 10.7%)
	Plan you purchased yourself		1515	4.7% (4.1% - 5.2%)	141	0.4% (0.3% - 0.6%)	2446	9.1% (8.3% - 10.3%)
	Medicare		2263	4.2% (3.8% - 4.6%)	242	0.4% (0.3% - 0.6%)	4470	9.5% (8.9% - 10.1%)
	Medicaid or Medical		1659	6.7% (5.9% - 7.5%)	130	0.6% (0.3% - 0.8%)	3357	14.4% (13.2% - 15.6%)
	TRICARE		262	4.8% (3.4% - 6.1%)	19	0.4% (0.0% - 0.8%)	501	11.6% (9.2% - 14.0%)
	Not covered by health insurance		777	4.7% (3.9% - 5.5%)	70	0.5% (0.2% - 0.7%)	1112	8.6% (7.3% - 9.8%)
	No Answer		257	4.7% (3.3% - 6.2%)	23	0.5% (0.0% - 0.9%)	7664	9.3% (7.9% - 10.7%)
Healthcare	Healthcare		2166	4.3% (3.9% - 4.7%)	147	0.3% (0.2% - 0.5%)	3851	9.7% (9.0% - 10.4%)
	Non-Healthcare		6269	4.2% (4.0% - 4.4%)	478	0.3% (0.3% - 0.4%)	10772	9.0% (8.6% - 9.4%)
							1745	1.5% (1.3% - 1.6%)
							6192	8.9% (8.4% - 9.5%)
							1203	1.7% (1.5% - 2.0%)

Table 2 displays the demographic characteristics of those who Tested for influenza and those who tested only for influenza during the 2021 – 2022, 2022 – 2023, and 2023 – 2024 respiratory seasons utilizing a weighted scheme targeting the U.S. census

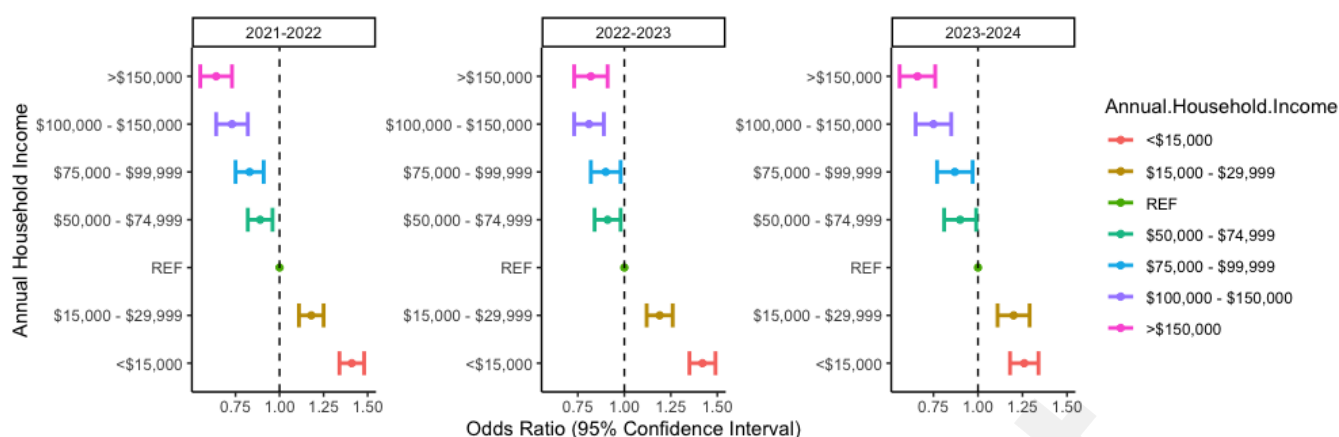
Tested for influenza group includes all individuals who answered “Yes” to “In the past 30 days, have you been tested for influenza(flu)?”

Only Tested for influenza includes only individuals who answered “Yes” to “In the past 30 days have you been tested for influenza (flu)” and did not answer “Yes” to “In the past 30 days, have you been tested for COVID-19?”

Multivariate Logistic Regressions

Likelihood to have been tested for influenza in the past 30 days decreased consistently as income increased, when adjusting for other variables. Those below the reference annual household income (\$30,000 and \$49,999) had higher odds of having been tested for influenza than those with higher incomes (Figure 1). As household income increased, the odds of having been tested for influenza decreased. This trend was observed consistently across the 2021-2022, 2022-2023, and 2023-2024 influenza seasons, with slightly variant magnitudes (Figure 1). Those with an income under \$15,000 were most associated (AOR=1.41 95%CI 1.34-1.48; AOR=1.42 95%CI 1.35-1.49; AOR=1.25 95%CI 1.18-1.34) with being tested for influenza and those with an income over \$150,000 were least associated (AOR=0.64 95%CI 0.55-0.86; AOR=0.82 95%CI 0.73-0.91; AOR=0.66 95%CI 0.56-0.76) in each in respective influenza season (2021-2022; 2022-2023; 2023-2024). The full results of the regressions can be found in Supplement 4.

Figure 1: AOR for Likelihood to Have Been Tested for Influenza by Income Controlling for Demographics and Likelihood to test for COVID-19



An online cross-sectional study of U.S. residents thirteen and older was done to assess self-reported influenza testing in the last thirty days for the 2021-2022 ($N=335,964$), 2022-2023 ($N=209,646$), and 2023-2024 ($N=269,624$) seasons. A weighted multivariate logistic regression was used to assess likelihood of influenza testing by income when controlling for demographics and COVID-19 testing. In all three seasons, those with lower incomes were observed to have a higher likelihood of testing for influenza and those with higher incomes were less likely.

Discussion

In each of the included influenza seasons, only a small amount of the population reported testing for influenza. Although we observed some increases in influenza testing over time, this population still remains small within the overall sample, and compared to COVID-19 testing levels. Advances in diagnostics, such as the FDA approved COVID-19 and influenza at-home in February of 2023, may provide some insights into increases in testing for influenza in the 2023-2024 season.⁴ However, it does not capture those only testing for influenza, and their reasoning.

Overall, those who did not complete high school, made under \$15,000, and had income-assisted insurance had higher proportions of influenza testing. While there is minimal study into who is influenza testing and why, our findings suggest that individuals with low socioeconomic status, particularly income, are more likely to test than their higher income counterparts. One potential explanation is that the population testing for influenza may need evidence of a healthcare visit, positive test result, or diagnosis to receive sick-time or paid-time-off benefits. They may also be testing for influenza more than higher income counterparts that have flexibility, such as remote work options, or employment benefits regarding sick leave.^{11, 12, 13, 14} By adjusting the multivariate regression for healthcare worker status, we accounted for some of those who may also require influenza testing for work. The observation of lower income and higher likelihood of influenza testing differs from other studies, which have found higher income individuals generally have perceived better access and uptake of respiratory disease testing, particularly for COVID-19.^{8 15}

This study encompasses strengths in its methodology that lend to the validity of the observed results. Data used for this study was collected from a previously validated, nationally representative survey, allowing us to generalize the observed results.^{8, 9} The inclusion of data spanning three influenza seasons further supports the empirically observed trends as they were consistent across time. Furthermore, the study period captures any potential differences season-to-season and any changes due to changes in the COVID-19 pandemic.¹⁶ This study is also subject to limitations. Firstly, being cross-sectional, the trends observed are insights into different individuals at certain points in time, rather than longitudinally assessing a consistent cohort each season. This means that our insights are broader, and not assessing specific individuals' influenza testing and income over time. Additionally, access to reliable internet is required for conducting the survey so populations that do not have reliable access are not captured. Similar to many health surveys, older women with higher income and higher educational attainment were more likely to complete the survey. Furthermore, health surveys generally capture an audience who may be more health-minded. The survey may also be subject to misclassification as participants are asked not only to self-report, but to recall testing that occurred in the last 30 days, and not an immediate time frame. Moreover, participants may not know what illnesses they were tested for, particularly in a clinical setting.

The findings of this study help further illuminate trends around testing and care seeking among low income individuals. As the public health community continually seeks to improve countermeasures for the prevention and mitigation of respiratory diseases, it is vital that we understand trends in who is testing for disease, and why. Different access and uptake of testing by disease may be influenced by economic factors like employment and income. These differences are important to understand for future public health efforts, such as modifying messaging around influenza testing, increasing affordable access to influenza testing, and creating policies to ease the burden of testing across illnesses when it is required to receive sick leave . Further studies are needed to understand the full scope of social and economic factors influencing testing behavior for respiratory diseases in the United States. Additionally, studying differences across respiratory diseases, rather than pan-respiratory may provide insights that support targeted interventions. As public health continues to strive for more robust disease mitigation and response, it becomes increasingly important not only to understand differences in access to testing, but disparities in who has the need for testing and official diagnoses and the implications on the healthcare system and disease surveillance overall.

Acknowledgements

The authors wish to acknowledge the following members of the Boston Children's Hospital team for their support on this project: Kara Sewalk, John Lawless, Amelia Thyen, and Mahlet Kelecha. We also want to acknowledge the SurveyMonkey team for their support in data collection.

Conflicts of Interest:

None declared

Abbreviations:

ILI: Influenza-like Illness

U.S.: United States

ONM: Outbreaks Near Me

MMWR: Morbidity and Mortality Weekly Report

Data Availability

The data sets analyzed during this study are available from the corresponding author on reasonable request.

Funding

This work was supported by The Centers for Disease Control and Prevention [grant numbers 75D30123C16026, 75D30121C11606], National Philanthropic Trust [grant number n/a], and Tides Foundation [grant number TF2008-094054].

References

1. Al-Tawfiq JA, Zumla A, Gautret P, et al. Surveillance for emerging respiratory viruses. *Lancet Infect Dis*. 2014;14(10):992-1000. doi:10.1016/S1473-3099(14)70840-0
2. Brammer L, Budd A, Cox N. Seasonal and pandemic influenza surveillance considerations for constructing multicomponent systems. *Influenza Other Respir Viruses*. 2009;3(2):51-58. doi:10.1111/j.1750-2659.2009.00077.x
3. 2021 National Healthcare Quality and Disparities Report. Agency for Healthcare Research and Quality (US); 2021. Accessed March 6, 2025. <http://www.ncbi.nlm.nih.gov/books/NBK578529/>
4. Commissioner O of the. FDA Authorizes First Over-the-Counter At-Home Test to Detect Both Influenza and COVID-19 Viruses. FDA. August 9, 2024. Accessed March 6, 2025. <https://www.fda.gov/news-events/press-announcements/fda-authorizes-first-over-counter-home-test-detect-both-influenza-and-covid-19-viruses>
5. Home Test to Treat program extends nationwide. National Institutes of Health (NIH). December 6, 2023. Accessed March 6, 2025. <https://www.nih.gov/news-events/news-releases/home-test-treat-program-extends-nationwide>
6. McNeil C, Verlander S, Divi N, Smolinski M. The Landscape of Participatory Surveillance Systems Across the One Health Spectrum: Systematic Review. *JMIR Public Health Surveill*. 2022;8(8):e38551. doi:10.2196/38551
7. Wójcik OP, Brownstein JS, Chunara R, Johansson MA. Public health for the people: participatory infectious disease surveillance in the digital age. *Emerg Themes Epidemiol*. 2014;11(1):7. doi:10.1186/1742-7622-11-7
8. Rader B. Use of At-Home COVID-19 Tests — United States, August 23, 2021–March 12, 2022. *MMWR Morb Mortal Wkly Rep*. 2022;71. doi:10.15585/mmwr.mm7113e1
9. Rader B, White LF, Burns MR, et al. Mask-wearing and control of SARS-CoV-2 transmission in the USA: a cross-sectional study. *Lancet Digit Health*. 2021;3(3):e148-e157.

doi:10.1016/S2589-7500(20)30293-4

10. Survey methodology: How SurveyMonkey gets its data. SurveyMonkey. Accessed March 6, 2025. <https://www.surveymonkey.com/mp/survey-methodology/>

11. Federal Employees - Sick Leave for Personal Medical Needs. U.S. Office of Personnel Management. Accessed March 6, 2025. <https://www.opm.gov/policy-data-oversight/pay-leave/leave-administration/fact-sheets/personal-sick-leave/>

12. Khalid MB, Era Dabla Norris, Salma. Who will Bear the Brunt of Lockdown Policies? Evidence from Tele-workability Measures Across Countries. IMF. Accessed March 6, 2025. <https://www.imf.org/en/Publications/WP/Issues/2020/06/12/Who-will-Bear-the-Brunt-of-Lockdown-Policies-Evidence-from-Tele-workability-Measures-Across-49479>

13. Hill HD. Paid Sick Leave and Job Stability. *Work Occup.* 2013;40(2):10.1177/0730888413480893. doi:10.1177/0730888413480893

14. How to Talk to Your Employer About Taking Time Off for Family and Medical Reasons. DOL. Accessed March 6, 2025. <https://www.dol.gov/agencies/whd/fmla/how-to-talk-to-your-employer-about-leave>

15. Ali SH, Tozan Y, Jones AM, Foreman J, Capasso A, DiClemente RJ. Regional and socioeconomic predictors of perceived ability to access coronavirus testing in the United States: results from a nationwide online COVID-19 survey. *Ann Epidemiol.* 2021;58:7-14. doi:10.1016/j.annepidem.2021.03.001

16. CDC. The Changing Threat of COVID-19. National Center for Immunization and Respiratory Diseases. January 31, 2025. Accessed March 7, 2025. <https://www.cdc.gov/ncird/whats-new/changing-threat-covid-19.html>

Supplementary Files

Multimedia Appendixes

Untitled.

URL: <http://asset.jmir.pub/assets/1f129043ab1d93fbeb71074f43b70ad.docx>