

Healthcare-Seeking Behavior for Respiratory Illness Among Flu Near You Participants in the United States During the 2015–2016 Through 2018–2019 Influenza Seasons

Kristin Baltrusaitis,¹ Carrie Reed,² Kara Sewalk,³ John S. Brownstein,^{3,4,5} Adam W. Crawley,⁶ and Matthew Biggerstaff²

¹Center for Biostatistics in AIDS Research, Harvard T. H. Chan School of Public Health, Boston, Massachusetts, USA, ²Influenza Division, National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia, USA, ³Computational Epidemiology Laboratory, Boston Children's Hospital, Boston, Massachusetts, USA, ⁴Department of Pediatrics, Harvard Medical School, Boston, Massachusetts, USA, ⁵Department of Biomedical Informatics, Harvard Medical School, Boston, Massachusetts, USA, and ⁶Ending Pandemics, San Francisco, California, USA

Background. Flu Near You (FNY) is an online participatory syndromic surveillance system that collects health-related information. In this article, we summarized the healthcare-seeking behavior of FNY participants who reported influenza-like illness (ILI) symptoms.

Methods. We applied inverse probability weighting to calculate age-adjusted estimates of the percentage of FNY participants in the United States who sought health care for ILI symptoms during the 2015–2016 through 2018–2019 influenza season and compared seasonal trends across different demographic and regional subgroups, including age group, sex, census region, and place of care using adjusted χ^2 tests.

Results. The overall age-adjusted percentage of FNY participants who sought healthcare for ILI symptoms varied by season and ranged from 22.8% to 35.6%. Across all seasons, healthcare seeking was highest for the <18 and 65+ years age groups, women had a greater percentage compared with men, and the South census region had the largest percentage while the West census region had the smallest percentage.

Conclusions. The percentage of FNY participants who sought healthcare for ILI symptoms varied by season, geographical region, age group, and sex. FNY compliments existing surveillance systems and informs estimates of influenza-associated illness by adding important real-time insights into healthcare-seeking behavior.

Keywords. influenza-like illness; respiratory illness; healthcare-seeking behavior; digital epidemiology; citizen science; influenza surveillance.

In the United States, the Centers for Disease Control and Prevention (CDC) has a comprehensive national influenza surveillance system that collects, compiles, and analyzes information from 5 different categories of surveillance: virology, outpatient illness, mortality, hospitalization, and geographical spread [1]. This information is available through FluView, a weekly influenza surveillance report, and FluView Interactive, an online application [2]. Together, these systems provide an indication of where, when, and what influenza viruses are circulating, but they do not provide the number of influenza illnesses across the United States during a season. Furthermore, these systems capture influenza activity almost

exclusively among individuals who seek medical care [3]. In addition to describing activity, CDC estimates the number of influenza-associated illnesses, medical visits, hospitalizations, and deaths (ie, the disease burden) that occur in the United States in a given season, and during the 2018–2019 influenza season, CDC began publishing preliminary weekly in-season estimates of influenza burden [4]. These estimates are based on laboratory-confirmed influenza-associated hospital rates from the Influenza Hospital Surveillance Network (FluSurv-NET) and results from healthcare-seeking behavior surveys [5–7]. The surveys currently used to estimate burden were conducted through a module in the Behavioral Risk Factor Surveillance Survey (BRFSS) in select states during the 2009 pandemic as well as the 2010–2011 influenza season [8–10].

The care-seeking surveys have not been conducted since the 2010–2011 season, and over the last decade, telephone-based surveys have been subject to declining response and cooperation rates [11, 12]. Since this time, online participatory syndromic surveillance systems have emerged as a method to collect health-related information in near real time and reach populations that may not be typically captured through traditional surveillance systems [13]. Through these systems, participants volunteer to report health information via online or

Received 26 February 2020; editorial decision 21 July 2020; accepted 27 July 2020; published online August 6, 2020.

Correspondence: Kristin Baltrusaitis, PhD, Center for Biostatistics in AIDS Research, Harvard T. H. Chan School of Public Health, 651 Huntington Ave, FXB 509, Boston, MA 02115 (kbaltrus@sdac.harvard.edu).

The Journal of Infectious Diseases® 2022;226:270–7

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DOI: 10.1093/infdis/jiaa465

mobile communication technologies on a weekly basis. In 2015, Flu Near You (FNY), the US-based system, implemented follow-up survey questions that asked if and where participants received medical attention for reported symptoms. In this article, we summarize the healthcare-seeking behavior of FNY participants in the United States who reported symptoms consistent with either influenza-like illness (ILI) or acute respiratory infection (ARI) during 4 influenza surveillance seasons (2015–2016, 2016–2017, 2017–2018, and 2018–2019) to see if information collected through this system is consistent with past trends and can be used to update information on US healthcare-seeking behaviors, which is 10 years old. Specifically, we assess and compare monthly and seasonal trends across different demographic and regional subgroups and compare age-adjusted estimates to data collected from BRFSS.

METHODS

Data

FNY is a participatory syndromic surveillance system that collects health-related information from volunteers across the United States [14]. Volunteers register for FNY using its website, a mobile application, or Facebook. At registration, FNY users provide basic demographic information including sex, month and year of birth, and zip code. Following registration, FNY users receive either an email reminder or a push notification to their mobile phone each Monday with a link to a symptom report where they indicate the presence or absence of symptoms that they or any registered household members experienced in the past week. The symptom list includes fever, headache, diarrhea, fatigue, nausea, rash, cough, sore throat, body aches, chills/night sweats, shortness of breath, and runny nose. All FNY users reporting symptom(s) are asked to provide the date of symptom(s) onset, if they or their household member received medical care for the symptom(s), and whether this care was received from a doctor's office, urgent care clinic, emergency room (ER), hospital, or other facility. Respondents can select only 1 location of care. Prior to the 2017–2018 season, other facility was removed as a place of care option for web-based submission. However, this option was not removed for the mobile phone application.

For this study, ILI was defined as a symptom report of fever plus cough and/or sore throat, and ARI was defined as a symptom report of a combination of at least 2 of the following symptoms: fever, cough, sore throat, runny nose, shortness of breath, or body aches. Only registered FNY participants, defined as registered users and their household members, who submitted at least 2 reports, either of “no symptoms” or “one or more symptoms,” during the study time period, October 2015 through May 2019, were included in the analyses because participants who only report once are more likely to report symptoms [15]. We did not account for potential correlation between household members or adjust for missing reports. Our

study of FNY data received approval from the Boston Children Hospital's Institutional Review Board.

Statistical Analysis

Influenza surveillance seasons were defined as Morbidity and Mortality Weekly Report weeks 40 through 20, which correspond to October through mid-May. Within each influenza season, we also determined the epidemic period using the moving epidemic method implemented through the R package “mem” [16]. The epidemic period for each season was defined as the shortest duration that included the most ILI activity for the weighted percentage of patient visits to healthcare providers for ILI from CDC US Outpatient Influenza-like Illness Surveillance Network (ILINet) [2, 17, 18].

We calculated the percentage of individuals who sought healthcare for ILI symptoms in the overall FNY population, as well as by age group (<18, 18–49, 50–64, 65+ years old), sex (male, female), census region (Northeast, Midwest, South, West), and place of care (doctor's office, urgent care, clinic, ER, hospital, other) across 4 influenza surveillance seasons (2015–2016, 2016–2017, 2017–2018, 2018–2019) and outside of the influenza surveillance season (aggregated across 2016, 2017, and 2018 off seasons). Because the age distribution of the FNY population differs from the US population [15], we applied inverse-probability weighting to calculate age-adjusted estimates, corresponding 95% confidence intervals (CIs), and *P* values for the overall, sex, and census region populations using the R package “survey” and the US Census Bureau's 2013–2017 American Community Survey 5-Year Estimates [19, 20]. Differences across groups were evaluated using adjusted χ^2 tests, taking into account the age adjustment. We repeated these comparisons for the epidemic period within each season (see [Supplementary Material](#)).

We also qualitatively assessed the monthly trends in the percentage of FNY participants who sought healthcare for ILI symptoms from October 2015 through May 2019. Although FNY collects symptom reports each week, we aggregated the weekly symptom report data by month (based on the calendar month of the start of the reporting week). We compared these monthly trends across different reporting entry criteria: 1 report during the study period, at least 2 reports, and at least 10 reports ([Supplementary Material](#)). Relevant analyses were repeated for the percentage of FNY participants who sought healthcare for ARI symptoms ([Supplemental Material](#)). All analyses were performed using R version 3.3.2 [21].

RESULTS

Seasonal Estimates

On average, 28 781 (standard deviation [SD], 3410) FNY participants submitted a total of 357 334 (SD, 20 905) reports each influenza surveillance season. Of these reports, 1.32%–2.21% corresponded to ILI symptoms and 4.28%–6.21%

Table 1. Flu Near You Participants Who Sought Healthcare for Influenza-Like Illness Symptoms

Variable	2015–2016	2016–2017 ^a	2017–2018	2018–2019	BRFSS ^b 2010–2011		BRFSS ^b 2009–2010	
					Adults	Children	Adults	Children
Overall ^c	22.8 (21.8–23.8)	35.6 (34.1–37.2)	28.9 (27.7–30.2)	30.2 (28.8–31.6)	45.2 (41.3–49.2)	56.6 (53.8–59.5)	40 (38–42)	56 (55–58)
Age group, y								
<18	29.6 (27.1–32.1)	40.4 (36.9–44.0)	33.7 (30.9–36.6)	37.7 (34.7–40.8)	...	56.6 (53.8–59.5)	...	56 (55–58)
18–49	20.8 (19.3–22.3)	35.0 (32.4–37.5)	27.7 (25.7–29.7)	29.2 (26.9–31.4)	42.7 (37.4–48.1) ^e	...	37 (35–40) ^e	...
50–64	21.9 (20.3–23.5)	33.2 (30.8–35.6)	28.6 (26.6–30.5)	26.9 (24.7–29.2)	47.2 (42.7–51.9) ^e	...	43 (40–46) ^e	...
65+	27.7 (25.0–30.4)	38.1 (34.6–41.6)	29.1 (26.3–31.8)	29.8 (26.8–32.8)	60.0 (53.6–66.1)	...	56 (53–60)	...
P value ^d	<.001	.006	.002	<.001				
Sex ^e								
Male	21.2 (19.5–22.9)	30.2 (27.7–32.8)	27.0 (25.0–29.1)	28.5 (26.2–30.9)	34.7 (28.8–41.1) ^e	54.1 (50.1–58.1)	33 (30–36)	55 (53–57)
Female	23.4 (22.1–24.6)	38.0 (36.1–39.9)	30.1 (28.5–31.6)	30.6 (28.9–32.3)	53.8 (49.7–57.8)	58.6 (54.5–62.6)	45 (43–47) ^e	57 (55–60)
P value ^d	.042	<.001	.023	.167				
Census region ^c								
Northeast	23.1 (20.7–25.4)	36.7 (33.1–40.3)	29.0 (26.1–31.8)	32.9 (29.7–36.0)	...	...	44 (40–49) ^f	58 (54–62) ^f
Midwest	22.4 (20.3–24.6)	36.0 (32.8–39.2)	27.9 (25.3–30.4)	29.0 (26.0–31.9)	...	...	39 (36–43) ^f	48 (45–51) ^f
South	26.7 (24.7–28.8)	42.5 (39.6–45.4)	35.4 (32.9–37.9)	36.9 (34.0–39.7)	...	...	42 (39–45) ^f	66 (63–68) ^f
West	20.1 (18.4–21.7)	27.1 (24.4–29.9)	24.5 (22.4–26.6)	23.9 (21.5–26.2)	...	...	33 (30–37) ^f	50 (47–53) ^f
P value ^d	<.001	<.001	<.001	<.001				

Date are percent (95% confidence intervals) by selected demographics for 4 influenza surveillance seasons: 2015–2016, 2016–2017, 2017–2018, and 2018–2019, and corresponding behavioral risk factor surveillance survey estimates.

^aErrors in Flu Near You data collection occurred between October 2016 and December 2016 resulting in an underestimation in the weekly number of symptom reports.

^bBehavioral Risk Factor Surveillance Survey (BRFSS).

^cAge adjusted.

^dP value from adjusted χ^2 test.

^eP < .05 compared to reference group.

^fP < .05 compared using χ^2 test.

corresponded to ARI symptoms across the influenza surveillance seasons, whereas 1.62%–2.91% corresponded to ILI symptoms across the epidemic period (Supplementary Table 1 and Supplementary Table 2). Table 1 displays the FNY ILI age-adjusted healthcare-seeking percentages with 95% CIs along with previously published BRFSS estimates [9, 10]. The overall age-adjusted percentage of FNY participants who sought healthcare for ILI symptoms varied by season ($P < .01$) and was 22.8% for the 2015–2016, 35.6% for the 2016–2017, 28.9% for the 2017–2018, and 30.2% for the 2018–2019 influenza surveillance seasons. Overall, the healthcare-seeking behaviors differed significantly across age groups during all seasons (all $P < .01$), and healthcare seeking was highest for the <18 and 65+ years age groups. Across each season, women had a greater age-adjusted ILI healthcare-seeking percentage compared with men. However, this difference was not significant at the .05 level during the 2018–2019 influenza surveillance season ($P = .167$). Age-adjusted healthcare-seeking percentages differed significantly across census regions during each season (all $P < .01$). Specifically, FNY participants from the South census region had the highest age-adjusted ILI healthcare-seeking percentages while FNY participants from the West census region had the lowest age-adjusted ILI healthcare-seeking percentages. Although care seeking is generally lower in FNY compared to BRFSS, many trends (higher care seeking in <18 and 65+ years age groups, lower care seeking in the West census region) were similar. Healthcare-seeking percentages and trends during the epidemic period were similar to the percentages observed during the entire influenza season (Supplementary Table 2).

Healthcare-seeking percentages outside of the influenza season for ILI and seasonal age-adjusted healthcare-seeking percentages for ARI symptoms both during and outside the season are shown in Supplementary Table 1. The age-adjusted percentage of FNY participants who sought healthcare for ILI symptoms outside of the influenza season (24.8%) was significantly less than all influenza seasons (range, 28.9%–35.6%, all $P < .01$), except the 2015–2016 influenza season, which had a significantly smaller age-adjusted percentage (22.8%, $P = .02$). Although the trends in healthcare-seeking percentages across

age groups were similar during and outside of the influenza surveillance season, there was no significant difference in healthcare-seeking percentages between men and women outside of the influenza surveillance season. Census region trends observed during seasons were also not consistent outside of the influenza surveillance season.

Across all influenza surveillance seasons, fewer FNY participants sought healthcare for ARI symptoms (16.5%–22.0%) compared to those reporting ILI symptoms. Similar to ILI, the oldest and youngest age groups sought healthcare more than participants between the ages of 18 and 64 years, and more women sought healthcare compared with men. However, trends by census region were not consistent with those observed with ILI care seeking, and the overall percentages did not differ outside of the influenza surveillance season, except during the 2016–2017 influenza season.

The number and percent of FNY participants who sought healthcare for ILI symptoms by place of care are shown in Table 2. Across all seasons, approximately 54%–59% of FNY participants, who reported that they sought healthcare for ILI symptoms, sought care at doctors' offices, 24%–35% sought care at urgent care facilities, 5%–7% sought care at ERs, 3%–5% sought care at clinics, and approximately 1% sought care at hospitals; place of care was similar among FNY participants who sought care for ARI symptoms (Supplementary Table 3). During the 2015–2016 and 2016–2017 influenza surveillance seasons, approximately 8% of FNY participants sought care at an "other" facility, however, less than 1% of participants reported seeking care at an "other" facility during the 2017–2018 and 2018–2019 influenza seasons. This change was likely due to the removal of "other" as an option for web-based submissions at the start of the 2017–2018 season.

Monthly Trends

Figure 1 shows the monthly time series of the percentage of FNY participants with ILI symptoms who sought healthcare for the overall population along with the weighted percentage of patient visits to healthcare providers for ILI from CDC ILINet [2]. Although the timing of the peak percentage of FNY participants

Table 2. Number and Percent of Flu Near You Participants Who Sought Healthcare for Influenza-like Illness Symptoms by Place of Care

Place of Care	2015–2016	2016–2017	2017–2018	2018–2019	Outside of Influenza Surveillance Season
Total visits	1893	1584	1847	1516	1310
Doctor's office	1070 (56.52)	907 (57.26)	1050 (56.85)	826 (54.49)	777 (59.31)
Urgent care	462 (24.41)	379 (23.93)	585 (31.67)	528 (34.83)	335 (25.57)
Clinic	70 (3.7)	61 (3.85)	62 (3.36)	76 (5.01)	50 (3.82)
ER ^a	111 (5.86)	85 (5.37)	126 (6.82)	74 (4.88)	76 (5.8)
Hospital	27 (1.43)	15 (0.95)	10 (0.54)	11 (0.73)	8 (0.61)
Other ^b	153 (8.08)	137 (8.65)	14 (0.76)	1 (0.07)	64 (4.89)

Data are No. (%).

^aEmergency Room.

^bOther facility was removed as a place of care option for web-based submission prior to the 2017–2018 season.

who sought healthcare varied each season, it typically followed ILINet's peak. During the 2015–2016 influenza season, the percentage of FNY participants with ILI symptoms who sought healthcare peaked between April and July. However, during the 2016–2017, 2017–2018, and 2018–2019 influenza seasons, the percentage of FNY participants with ILI symptoms who sought healthcare peaked during the influenza season. As shown in [Supplementary Figure 1](#), healthcare-seeking percentages for ARI symptoms were much lower than those for ILI symptoms, and the seasonal trend resembles a less distinct version of those trends seen for ILI symptoms.

[Figure 2](#) shows the monthly distribution of place of care for individuals who reported seeking medical care for ILI. Unlike care seeking for ILI, the distribution of place of care did not have distinct seasonal trends.

DISCUSSION

In this analysis, we report on the use of FNY, an online participatory cohort, to estimate healthcare seeking in the United States. This report demonstrates that FNY provides a flexible

platform to assess care-seeking behavior, which may provide particular value given the lack of recent care-seeking data from sources such as BRFSS. We found that while healthcare seeking for ILI among FNY participants was dependent on age, sex, census region of residence, and symptoms several clear trends emerged. In particular, doctors' offices were the most frequent location of care for those reporting ILI, although the use of urgent care centers increased during the 2017–2018 influenza season. In addition, we found lower estimates of healthcare seeking than have been previously reported in the United States for those reporting ILI. These findings have proven useful to CDC efforts to understand healthcare-seeking behaviors and the burden of influenza in the United States. Furthermore, these real-time trends may be useful in hospital surge planning and other efforts to understand place of care.

FNY has several benefits compared to traditional phone surveys, including the BRFSS [8–10]. First, FNY has been consistently collecting healthcare seeking and place of care data from participants from every state and age group since the 2015–2016 season. Therefore, it can assess how healthcare-seeking

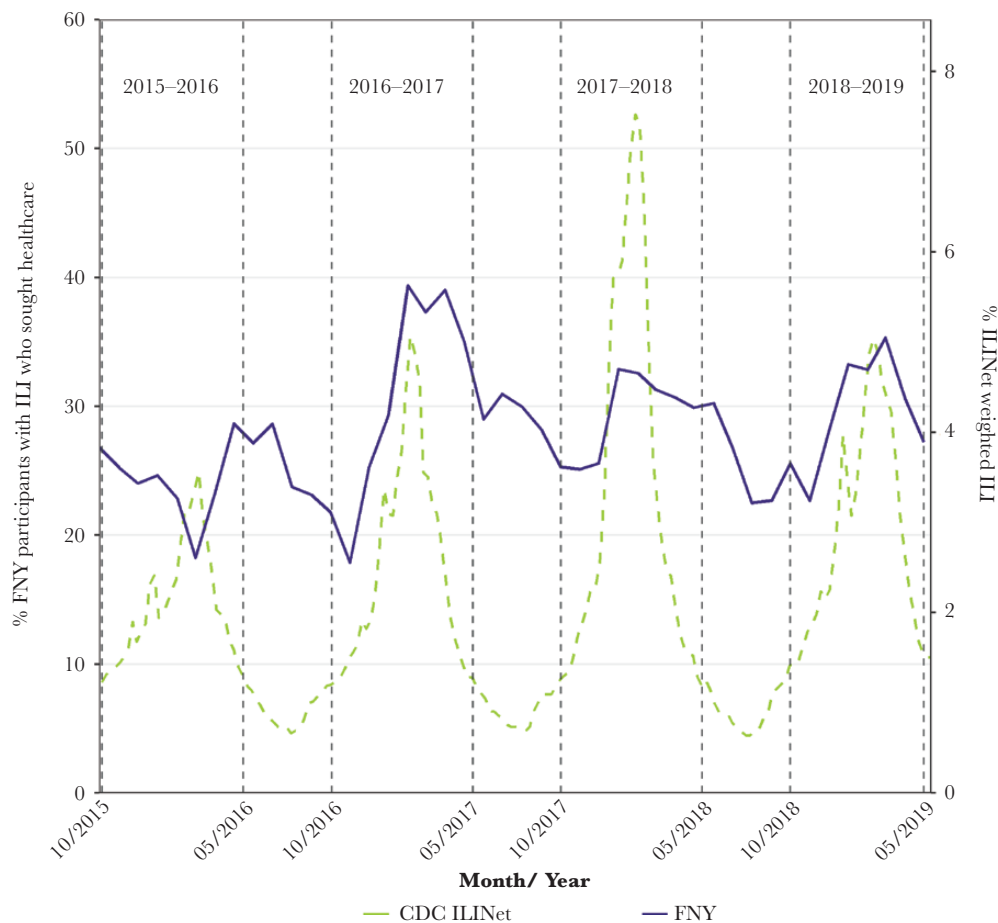


Figure 1. Overall percentage of Flu Near You (FNY) participants with influenza-like illness (ILI) who sought healthcare and weighted percentage of patient visits to healthcare providers for ILI from Centers for Disease Control and Prevention US Outpatient Influenza-like Illness Surveillance Network (ILINet). Note, errors in FNY data collection occurred between October 2016 and December 2016 resulting in an underestimation in the weekly number of symptom reports.

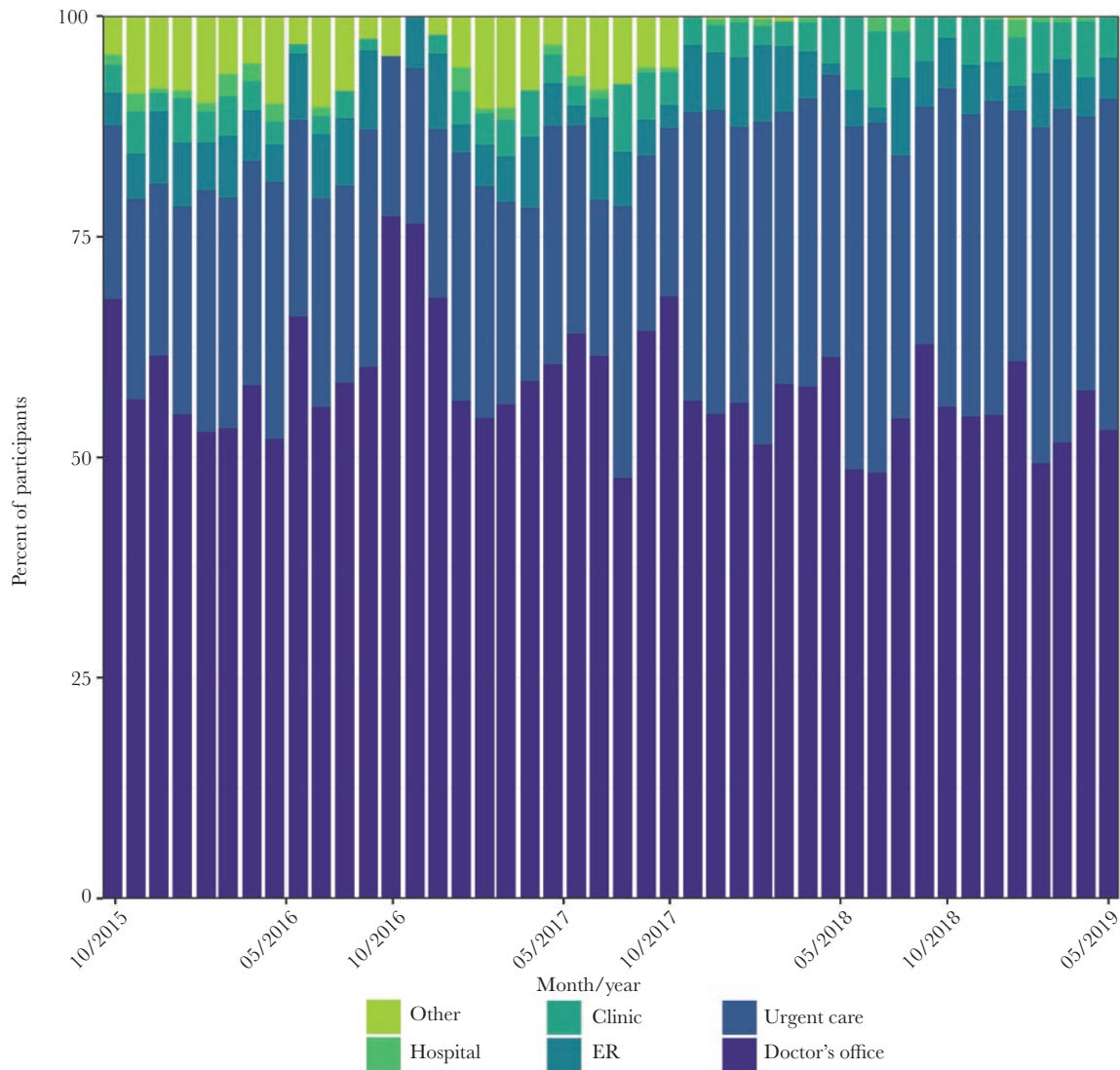


Figure 2. Distribution of place of care for Flu Near You participants who reported seeking healthcare for influenza-like illness symptoms. Abbreviation: ER, emergency room.

behaviors change over time, are impacted by demographic characteristics, and vary between seasons with differing severity. For example, this analysis found that a majority of participants sought care at doctors' offices but that visits to urgent care centers increased starting with the 2017–2018 influenza season, which was a high-severity influenza season [22]. A previous study has also shown that the percentage of FNY participants who sought healthcare for ILI symptoms varied regionally in the United States [23].

Second, FNY collects information on healthcare-seeking behavior for anyone reporting 1 or more symptoms. This feature allows healthcare seeking to be compared for different combinations of symptoms beyond ILI. For example, as shown in [Supplementary Table 1](#), FNY participants with ARI symptoms reported much lower percentages of healthcare seeking (16.5%–22%) when compared to participants with ILI (23%–36%). This finding was similar to a study in the United Kingdom that

showed that participants in an online participatory cohort were more likely to seek medical care for ILI symptoms compared to ARI symptoms [24].

Because traditional ILI surveillance relies on reports of medically attended ILI from healthcare providers, understanding the healthcare-seeking behavior of individuals can provide a more comprehensive picture of ILI disease burden in the community. While CDC has a robust and comprehensive national influenza surveillance system, it captures influenza activity mainly among individuals who seek healthcare. This study found that 64%–75% of FNY participants with ILI do not seek healthcare and, therefore, are unlikely to be captured in this surveillance. In addition, preliminary weekly in-season estimates of influenza burden published by CDC are based on healthcare-seeking data collected during or the season after the 2009 pandemic. Since that time, healthcare-seeking behaviors in the United States may have changed, and the use of care-seeking

information from past seasons precludes the ability to detect and incorporate population-level changes in healthcare-seeking behavior in response to unusual or high-severity influenza seasons. Incorporation of more routine and sustained sources of healthcare-seeking behavior, such as those illustrated by FNY in this study, can potentially provide near real-time estimates of care seeking and inform influenza disease burden estimates.

This report found lower healthcare seeking for ILI in the United States than previous studies. Although our overall estimates ranged from 25% to 36%, compared to 45% of adults and 57% of children seeking care for ILI during the 2010–2011 season as measured in BRFSS, age group, sex, and census specific healthcare-seeking patterns found in this analysis were similar to trends seen in previous seasons. One potential contributing factor to the differences in estimates is that FNY has a different demographic profile compared with the BRFSS survey population. For example, females and middle-aged participants are overrepresented in FNY. In addition, FNY participants are highly educated compared to the general US population and have higher vaccination rates [15]. Furthermore, the 2010–2011 BRFSS ILI module included adult responses from only 31 states and the District of Columbia (DC) and pediatric responses from 25 states and DC.

Beyond the United States, a recent meta-analysis of healthcare-seeking estimates from different countries reported an overall pooled healthcare-seeking rate of 52% (95% CI, 46%–59%) [25]. Because this meta-analysis is from multiple countries and seasons, it fails to capture the potential seasonal, regional, and age group dynamics in healthcare-seeking behavior, as well as the presence or absence of universal health coverage. The European counterpart to FNY, Influenzanet, has reported a range of healthcare-seeking percentages between 25% and 70%, varying by country [26].

There are several limitations to this study. FNY relies on self-reported data from volunteers that is subject to recall and social desirability bias. As mentioned above, FNY is also not representative of the US population [15]. Specifically, persons under 18 years of age are under-represented in the FNY population. While we adjusted for age differences for the seasonal estimates, the figures that display healthcare-seeking patterns over time were not adjusted. In addition, participant reporting is not consistent throughout the influenza season [15]. To maintain consistency across all seasons, we included only registered FNY participants who submitted at least 2 symptom reports over the study period. As shown in [Supplementary Figure 2](#), only slight differences exist in the percentage of individuals who sought healthcare between FNY participants who submitted at least 2 reports and FNY participants who submitted at least 10 reports. Finally, there were errors in FNY data collection from October 2016 through December 2016 resulting in an underestimation in the weekly number of symptom reports. This error may contribute the observed troughs in the time series during

this period. Importantly, the healthcare-seeking percentages during the 2016–2017 epidemic period, which did not include weeks with data collection error, were similar to the percentages during the entire 2016–2017 influenza season.

The percentage of FNY participants who seek healthcare for ILI symptoms varies by season, geographical region, age group, and sex. FNY complements existing sentinel surveillance systems and informs estimates of the disease burden by adding important real-time insights into healthcare-seeking behavior.

Supplementary Data

Supplementary materials are available at *The Journal of Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes

Acknowledgments. The authors acknowledge all the participants who contributed their time and information to the Flu Near You system.

Disclaimer. The findings and conclusions in this comment are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Financial support. This work was supported by the National Institute of Health, National Institute of General Medical Sciences (grant number T32GM074905 to K. B.).

Potential conflicts of interest. All authors: No reported conflicts of interest. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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