Vaccine 40 (2022) 325–333

Contents lists available at ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

Public health spending, primary care, and perceived risk promoted vaccination against H1N1

Anna R. Zhao [a,*], David M. Bishai [b]

[a] Johns Hopkins University, 3505 N. Charles St, Baltimore, MD 21218, United States
[b] Johns Hopkins Bloomberg School of Public Health, 120 South Hays Rd.m, Baltimore, MD 21014, United States

ARTICLE INFO

Article history:
Received 6 June 2021
Received in revised form 19 November 2021
Accepted 22 November 2021
Available online 10 December 2021

Keywords:
Vaccinate
H1N1 pandemic
Health policy
Vaccine
COVID-19 pandemic
H1N1 flu survey
Logistic regression
Public health
Pandemic
Physicians
Primary care

ABSTRACT

The purpose of this study is to examine factors affecting the intent to vaccinate during the 2009 H1N1 pandemic and to leverage the results to inform public health policy decisions aimed at increasing vaccine uptake during the COVID-19 pandemic. Using the National 2009 H1N1 Flu Survey data and state-level administrative data, we employ logistic regression and mediation models to estimate the association between vaccine uptake and state level public health spending, political ideology, and H1N1 case and death rates as well as a set of individual and household characteristics. We find that higher public health spending can significantly increase the intent to vaccinate, mainly through raising concerns about the pandemic and promoting vaccine relevant doctor patient interactions. We conclude that physicians, especially primary care physicians, should play more important roles in the ongoing vaccination efforts against the COVID-19 virus.

1. Introduction

As of writing this paper, there have been approximately 44.2 million cases and 711 thousand deaths in the United States due to COVID-19 [1]. Characteristics of the virus, such as airborne transmission, has made its spread vicious and rapid [2]. After one year of the pandemic, 187.2 million Americans have been fully vaccinated, but there are serious concerns about vaccine hesitancy, defined by the World Health Organization [WHO] as a “delay in acceptance or refusal of vaccination despite availability of vaccination services” [1,3]. The Biden administration has listed addressing vaccine uptake as a major goal in its COVID-19 response plan and is increasing public health spending to support public education campaigns regarding the vaccine [4]. For these policies to be effective, it is imperative to target public health spending on the most important factors influencing vaccine uptake. For example, there are already calls for increased involvement of primary care physicians in the ongoing vaccination process in order to overcome vaccine hesitancy [5].

Although COVID-19 is unprecedented in recent history and poses unique challenges to vaccination, valuable lessons from past pandemics, most notably H1N1, can help understand factors contributing to public acceptance of the vaccines and inform approaches to promoting vaccination against the COVID-19 virus. The 2009 H1N1 pandemic, also known as the swine flu, has some similarity to the COVID-19 pandemic in terms of global spread and the presence of vaccine-based countermeasures. There were around 60.8 million cases of the H1N1 virus in the United States in 2009, and while the mortality rate was not as severe as that of COVID-19, H1N1 elicited dramatic nation-wide public health responses and involvement by high-levels of the federal government [6]. The H1N1 pandemic response also faced the problem of vaccine hesitancy [7]. At the beginning of the pandemic, approximately half of the public indicated they would receive the vaccine, but a year later, only 24% of adults had received the vaccine – a percentage that is even lower than the uptake rate of the seasonal influenza vaccine [7]. Political affiliation also played an important role in vaccine hesitancy during both pandemics. In the H1N1 pandemic, Democrats had higher intent to vaccinate than Republicans, a phenomenon that has also been observed during the COVID-19 pandemic [8].

* Corresponding author.
E-mail addresses: azhao13@jhu.edu (A.R. Zhao), dbishai1@jhu.edu (D.M. Bishai).

https://doi.org/10.1016/j.vaccine.2021.11.064
0264-410X/

There is a sizable literature examining the potential factors that could have affected vaccine uptake during the H1N1 pandemic [7,9–11], including pregnancy, socio-demographic characteristics such as race and gender, and level of trust towards the vaccine [10–12]. In this paper, we control for these individual characteristics and a rich set of others but focus on the role of state level public health spending, and highlight two main channels through which it affects vaccination, namely by increasing patient-doctor interaction and raising concerns about the pandemic. Compared with individual characteristics, public health spending and the two mediating factors have more direct implications for policy design.

2. Methods

Fig. 1 shows our conceptual framework. Our main variables of interest, *Public Health Spending* and the two mediators, are bordered by ovals. We control for other state level variables as they might influence both vaccine uptake and public health spending. For example, *Obama Vote Share* precedes public health spending and could therefore potentially affect both local public health spending and intent to vaccinate. Political affiliation has been shown to affect the amount of public health spending at a local level as in the case of the Prevention and Public Health Fund [the Fund]. Republicans were against authorizing the Fund while Democrats were supportive of it [13]. By including the variable *Obama Vote Share* in the regression, we control for the potential confounding effects it may have. Since we examine individuals' intent to vaccinate, we also control for a rich set of individual characteristics. The control variables are bordered by parallelograms.

3. Data

The data used in this study was obtained from the publicly available National 2009 H1N1 Flu Survey [NHFS] conducted by the NORC at the University of Chicago on behalf of the CDC [14]. The survey was designed to examine the public's attitudes towards the H1N1 vaccine during the 2009–10 flu season. Survey questions included the vaccination status of both adults and children, flu-related behaviors, opinions about the safety of the vaccine and its effectiveness, pre-existing conditions such as respiratory illness, and individual demographic characteristics. The survey sampled 56,656 adults and 14,288 children across all 50 states and the District of Columbia and was conducted from October 2009 through June 2010 through random telephone digit dialing. In this study, we only use the responses of adults, i.e., individuals aged 18 and above.

Sample weights are provided in the 2009 NHFS data file. Because the weights are determined by independent variables, non-weighted regressions are used throughout this study leading to consistent estimators with smaller standard errors [15]. The summary statistics using the weighted data are similar in magnitude to the non-weighted summary statistics.

State level per capita public health spending data is obtained from the State Health Access Data Assistance Center [SHADAC] [16]. Each state's H1N1 case and death rates are calculated using population data from the 2010 U.S. census and the number of H1N1 cases and deaths in 2009 from each state's public health department. Data on state level voting results during the 2008 presidential election is obtained from the Federal Election Commission [17]. We use the percentage of votes for Obama to represent the degree to which a state is blue.

4. Main regression model

The main regression specification is a logit model:

$$y^{*} = \beta_0 + \beta_1 X + u$$

where y^{*} is the latent variable representing the intent to receive the H1N1 vaccine. There is no intent to receive the vaccine, or $y = 0$, if $y^{*} \leq 0$, and an intent to receive the vaccine, or $y = 1$, if $y^{*} > 0$. In the NHFS data, respondents were asked about their H1N1 vaccination history, as well as their intent to receive the vaccine, for which the responses included definite intent, probable intent, improbable intent, and definite no intent. *Intent to Vaccinate* equals 1 if the response was definite or probable intent or if the respondent has already received the vaccine and equals 0 otherwise.

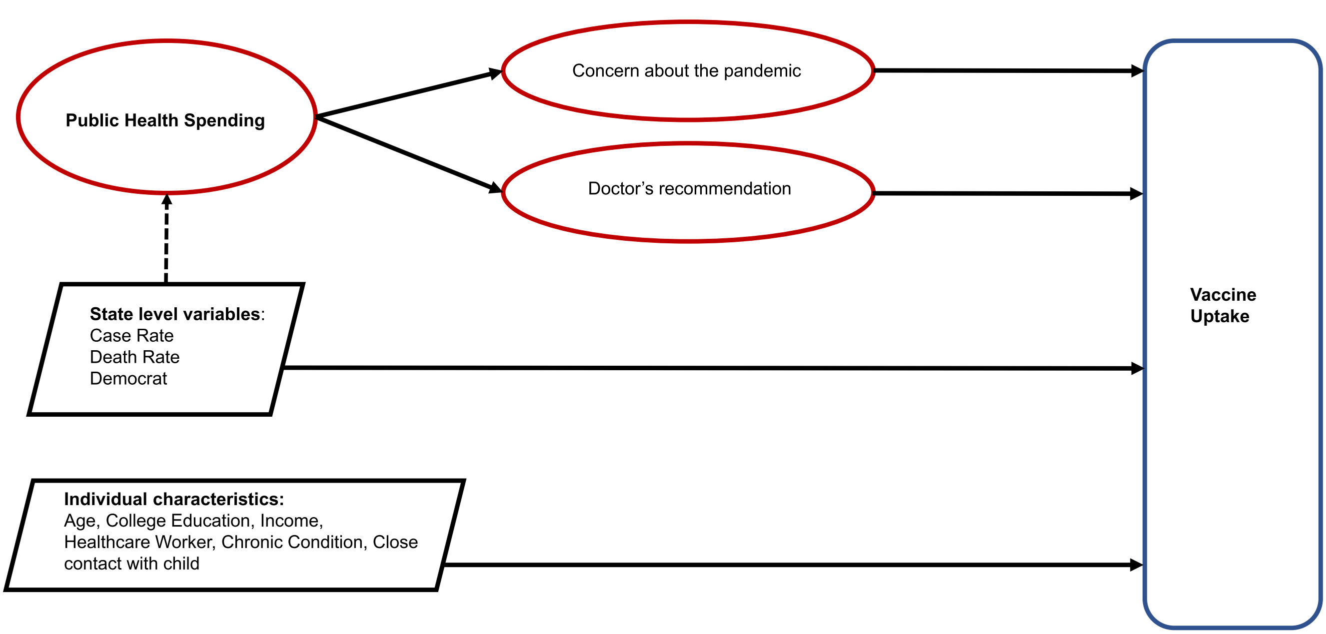

Fig. 1. Variable Relationships in the Conceptual Model

The explanatory variables *X* are chosen based on the previous literature and our focus on public health spending. The first set of explanatory variables is about individual characteristics. *Doctor's Recommendation* indicates whether or not an individual has received a recommendation for the H1N1 vaccine. It equals 1 if a recommendation was received and 0 if no recommendation was received. *Concern About H1N1* measures an individual's level of concern about the H1N1 pandemic, drawn from answers to the following interview question, "How concerned are you about the H1N1 flu." It takes values of 1 to 4 for answers of "not at all concerned," "not very concerned", "somewhat concerned," and "very concerned**.**" Similarly, *Knowledge About the Virus* measures one's subjective knowledge about the H1N1 flu based on answers to the question, "How much, if anything, do you know about the 2009 H1N1 flu." It takes values of 1–3 for answers of "none", "a little," and "a lot." *Chronic Condition*, a binary variable, measures whether an individual has a chronic medical condition including asthma or other lung condition, diabetes, a weakened immune system, or heart, kidney, liver, neurological or neuromuscular conditions. The previous literature has shown that these conditions influence the intent to receive the H1N1 vaccine [7,9–11]. *Contact with Child* is a binary variable measuring whether an individual has regular close contact with a child under six months old, and healthcare worker is a binary variable that equals 1 if a respondent is a health worker. *Age* measures an individual's age and is coded as dummy variables for five groups [18–34, 35–44, 45–54, 55–64, and 65 and older] where the first group [18–34] is the reference group. Finally, *Level of Education* is a binary variable that equals 1 if the respondent has received college education and 0 otherwise.

The second category of explanatory variables includes household characteristics. Specifically, *Household Income* is coded as dummy variables for seven income brackets [below $10,000, $10,001-$15,000, $15,001 - $25,000, $25,001 - $35,000, $35,001 - $50,000, $50,001 - $75,000, and $75,001 - $100,000] where the lowest income bracket is used as a reference group.

The third category of explanatory variables includes state characteristics, including the amount of per capita public health spending in 2009 [*Public Health Spending*], the H1N1 death rate [*H1N1 Death Rate*], and a state's political orientation [*Obama Vote Share*], which equals the percentage of votes Barack Obama received in the 2008 presidential election.

We assume that the error term *u* follows an extreme value distribution. The model presented in Table 2 accounts for clustering of the error terms at the state level to control for the two-level hierarchical structure. This allows for correlated residuals across individuals within the same state. During a robustness check, we compared estimation results from both clustered and unclustered models and found that all statistically significant findings were consistent with each other across both models.

Furthermore, we separately ran a two-level multilevel regression model with random intercept and found that the results were also similar to the main specification in Table 2.

We also conduct mediation analyses using a linear specification to explore the associations through which *Public Health Spending* can affect *Intent to Vaccinate*. Fig. 1 shows the associations of the two mediators *Doctor's Recommendation* and *Concern About H1N1*. For each mediator, the analysis involves three sets of regressions; we first regress the intent on vaccinating on *Public Health Spending* with and without the mediator *Concern About H1N1* or *Doctor's Recommendation*, and then regress the mediator on *Public Health Spending*. Associations of the two mediators exist when *Public Health Spending* is significant in influencing the mediator, and when the effect of *Public Health Spending* on the outcome *Intent to Vaccinate* decreases as the mediator is included in the main regression.

5. Results

Table 1 provides the summary statistics of the variables discussed above, Table 2 presents the estimation results of six model specifications for the logistic regression, and Table 3 presents the estimated relative risks of the logistic regression. The following discussion will be based on Tables 2 and 3.

The six models in Tables 2 and 3 share a common set of explanatory variables but differ in the inclusion of *Obama Vote Share, Concern About H1N1*, *Doctor's Recommendation*, and *H1N1 Death Rate*. The estimated marginal effects of individual characteristics are similar across all six models, showing that the effects of these characteristics are robust to the model specifications. We will use Model [VI], which considers the effect of all individual and state-level variables, as the main specification in discussing the marginal effects which are presented in Table 3. For other variables such as *Public Health Spending*, we will rely on cross-model comparisons of the estimation results to draw conclusions.

Because we are using cross-sectional data, the results of the regression and mediation should be interpreted as identifying associations rather than causal relationships between intent to vaccinate and the individual and state-level variables. Further, the estimated effects of the individual and state-level variables are on vaccine intent. Since not all individuals intent on receiving a vaccine follow through, these effects could differ from the effects on actual vaccine uptake [18].

To examine the differences between the effects, we ran another regression using a new, binary dependent variable, *Already Vaccinated*, where 1 represents individuals who have already received the vaccine and 0 represents all other individuals. We find that the relative risks of each variable on *Public Health Spending* across the two regressions are in the same direction with similar magnitudes and significance levels [Table 5].

Since the data were collected over a period of nine months, the intent to vaccinate might vary over time. However, as shown in Table 6, controlling the survey month does not affect the estimation results and is therefore not included in the main specification.

6. Effects of individual and household characteristics

Individuals with chronic medical conditions [*Chronic Condition*] or those regularly coming into close contact with children [*Contact with Child*] less than six months old are about 1.1 to 1.3 times more likely than others to be intent on vaccinating [RRR = 1.10, 95% Confidence Intervals [CI] [1.08, 1.12]; RRR = 1.27, [1.08, 1.14] respectively]. Similarly, an individual with a college degree is about 1.1 times more likely to be intent on vaccinating [RRR = 1.06, [1.03, 1.09]]. Healthcare workers are about 1.3 times [RRR = 1.27, [1.24, 1.30]] more likely than others to get vaccinated, and individuals who have received a physician recommendation for the H1N1 vaccine are about 1.9 times more likely to be intent on vaccinating [RRR = 1.85, [1.80, 1.90]], demonstrating the importance of exposure to medical experts in promoting vaccination.

Age is another important factor influencing the intent to vaccinate, and its effects are nonlinear. Evaluating the relative risks of different age intervals [35–44, 45–54, 55–64, 65 and up], we find that when an individual is between 35 and 54, they are less likely to be intent on vaccinating compared to individuals 18 to 34 [RRR for 35–44 = 0.94, [0.91, 0.97]; RRR for 45–54 = 0.93, [0.90, 0.96]]. As age increases above 55, individuals become more likely to be intent on vaccinating than individuals 18 to 34 [RRR > 1]. *Household Income* also has a significant and nonlinear effect on the vaccination intent. We find that relative to the lowest income bracket of less than $10,000, individuals with higher income are less likely to be intent on vaccinating [RRR < 1]. However, the relationship

Table 1
Summary statistics.

Variable	Description	Obs	Mean	Std. Dev.	Min	Max
Intent to Vaccinate	Intent to receive the vaccine (=1 if already received, definite intent, or probable intent, =0 if have not received, no intent, or improbable intent)	31,576	0.44	0.49	0	1
Income Range less than or equal to $10,000	Income level up to 10 K (=1 if within range, =0 if income not within this range), 8% of respondents in range Reference group for other Income variables	31,576	0.082	0.27	0	1
Income Range $10,001–15,000	Income level between 10,001–15,000 (=1 if within range, =0 if income not within this range), 5% of respondents in range	31,576	0.051	0.22	0	1
Income Range 15,001–25,000	Income level between 15,001–25,000 (=1 if within range, =0 if income not within this range), 11% of respondents in range	31,576	0.11	0.31	0	1
Income Range 25,001–35,000	Income level between 25,001–35,000 (=1 if within range, =0 if income not within this range), 11% of respondents in range	31,576	0.097	0.30	0	1
Income Range 35,001–50,000	Income level between 35,001–50,000 (=1 if within range, =0 if income not within this range), 11% of respondents in range	31,576	0.15	0.36	0	1
Income Range 45,001–75,000	Income level between 50,001–75,000 (=1 if within range, =0 if income not within this range), 11% of respondents in range	31,576	0.18	0.38	0	1
Income Range 75,001–100,000	Income level between 75,001–100,000 (=1 if within range, =0 if income not within this range), 11% of respondents in range	31,576	0.33	0.47	0	1
Concern about H1N1	Concern regarding the H1N1 pandemic (=1 if no Concern, =2 if not very concerned, =3 if somewhat concerned, =4 if very concerned)	31,576	2.66	0.88	1	4
Doctor's recommendation	Recommendation by a doctor to receive the H1N1 vaccine (=1) or no recommendation for the H1N1 vaccine (=0)	31,576	0.23	0.42	0	4
Knowledge about virus	Knowledge regarding the H1N1 virus (=1 None, =2 a little, =3 a lot)	31,576	2.31	0.61	1	3
Ages 18–34	Participants aged 18–34 (=1 if participants are within the age range, =0 if not), 19.54% of respondents	31,576	0.20	0.40	0	1
Ages 35–44	Participants aged 35–44 (=1 if participants are within the age range, =0 if not), 14.60% of respondents	31,576	0.15	0.35	0	1
Ages 45–54	Participants aged 45–54 (=1 if participants are within the age range, =0 if not), 19.58% of respondents	31,576	0.20	0.40	0	1
Ages 55–64	Participants aged 55–64 (=1 if participants are within the age range, =0 if not), 20.68% of respondents	31,576	0.21	0.41	0	1
Ages 65+	Participants aged 65+ (=1 if participants are within the age range, =0 if not), 25.59% of respondents	31,576	0.26	0.44	0	1
Chronic Condition	Presence of a chronic medical condition (i.e. lung condition, heart condition, kidney condition) = 0 if no presence, =1 if yes	31,576	0.31	0.46	0	1
Contact with child	If an individual is in regular close contact with a child under 6 months old = 0 if no regular contact, =1 if yes	31,576	0.07	0.26	0	1
Healthcare Worker	If an individual is a healthcare worker = 0 if not, =1 if yes	31,576	0.11	0.32	0	1
Level of Education	Whether or not an individual has received a college education (=1 if yes, =0 if not)	31,576	0.43	0.49	0	1
Public health spending	The public health spending rate in each state	31,576	0.0406	0.031	0.004	0.17
Obama vote share	The percentage of votes for Barack Obama (multiplied by 10)	31,576	5.2	1.1	3.3	9.2
H1N1 death rate	H1N1 deaths per capita in each state	31,576	0.011	0.0061	0	0.029

between *Intent to Vaccinate* and *Household Income* is U-shaped and is monotonically increasing once income reaches the bracket $45,001–75,000, which also corresponds to the median income in the sample.

The relative risks of *Concern About H1N1* and *Knowledge About the Virus* are both above 1 and significant at 1% level. A one-scale increase in *Concern About H1N1* means an individual is 1.5 times [RRR = 1.47, [1.45, 149]] more likely to be intent on vaccinating, and a one-scale increase in *Knowledge About the Virus* indicates an individual is 1.1 times [RRR = 1.06, [1.04, 1.08]] more likely to be intent on vaccinating. The relative scale of the two effects shows that *Concern About H1N1* might be more important than *Knowledge About the Virus* in influencing the intent to vaccinate.

7. Effects of state-level characteristics

The state level *H1N1 Death Rate* has a positive and weakly significant effect on the intent to vaccinate, with the RRR being significant at 5% or 10% level in some specifications [III, VI]. *Obama Vote Share* has a positive and significant effect on the intent to vaccinate: individuals in states with votes for Obama 10 percentage points higher than others are 1.03 times [RRR = 1.03, [1.01, 1.05]] more likely to be intent on vaccinating. Therefore, individuals living in blue states tend to have a greater intent to vaccinate than those in red states.

8. Effects of public health spending

The impact of public health spending on vaccination depends to a large extent on whether a certain set of other control variables are included in the regression. In Model [I], the RRR of *Public Health Spending* is greater than 1 [RRR = 2.56, [1.21, 5.40]] and significant – a result that is consistent with the literature [10]. However, in Models [II] – [VI] where *Obama Vote Share* is included, the effect of *Public Health Spending* becomes much smaller and statistically insignificant. In contrast, the effect of *Obama Vote Share* is always significant. Although there is a positive correlation between *Obama Vote Share* and *Public Health Spending*, i.e., states leaning more towards democrat tend to spend more on public health, a variance inflation factor [VIF] analysis indicates that there is little to no multicollinearity in the model. Thus, when *Obama Vote Share* is not controlled for, the effects of *Public Health Spending* on vaccination are partly capturing the effects of *Obama Vote Share* and are over-estimated.

As control variables *Concern About H1N1* and *Doctor's Recommendation* are added to the model, i.e., going from Models [II] to [III] and [IV], the RRR of *Public Health Spending* decreases. When both *Concern About H1N1* and *Doctor's Recommendation* are included, the RRR of *Public Health Spending* decreases to nearly 1 [RRR = 1.07, [0.56, 2.05]]. Moreover, as shown in Table 4, when *Concern About H1N1* and *Doctor's Recommendation* are separately

Table 2
Estimation Results: Effect of Individual- and State-level Factors on Intent to Vaccinate, Logistic Model

	(I)	(II)	(III)	(IV)	(V)	(VI)
Public health spending	1.75**	1.01	0.59	0.71	0.32	0.29
	(0.73)	(0.74)	(0.71)	(0.75)	(0.77)	(0.72)
Concern about H1N1			0.83***		0.80***	0.80***
			(0.016)		(0.016)	(0.016)
Doctor's Rec for vaccine				1.63***	1.59***	1.59***
				(0.031)	(0.033)	(0.033)
Obama Vote Share		0.054***	0.065***	0.046**	0.044**	0.056***
		(0.021)	(0.022)	(0.020)	(0.022)	(0.022)
H1N1 death rate	1.93	4.12	8.96***	3.65		8.76***
	(3.40)	(3.33)	(3.40)	(3.01)		(3.28)
Knowledge about Virus	0.27***	0.27***	0.19***	0.21***	0.14***	0.13***
	(0.020)	(0.021)	(0.021)	(0.023)	(0.022)	(0.023)
Income Range $10,001–15,000	−0.16***	−0.16***	−0.10*	−0.15***	−0.091	−0.093
	(0.049)	(0.049)	(0.053)	(0.058)	(0.062)	(0.062)
Income Range 15,001–25,000	−0.25***	−0.25***	−0.14***	−0.25***	−0.16***	−0.16***
	(0.051)	(0.051)	(0.052)	(0.057)	(0.053)	(0.053)
Income Range 25,001–35,000	−0.39***	−0.39***	−0.30***	−0.37***	−0.28***	−0.28***
	(0.047)	(0.047)	(0.046)	(0.051)	(0.051)	(0.051)
Income Range 35,001–50,000	−0.45***	−0.46***	−0.29***	−0.44***	−0.29***	−0.29***
	(0.052)	(0.052)	(0.052)	(0.060)	(0.059)	(0.058)
Income Range 45,001–75,000	−0.43***	−0.44***	−0.25***	−0.46***	−0.27***	−0.27***
	(0.052)	(0.052)	(0.047)	(0.053)	(0.048)	(0.048)
Income Range 75,001–100,000	−0.34***	−0.35***	−0.14***	−0.37***	−0.17***	−0.17***
	(0.053)	(0.052)	(0.052)	(0.059)	(0.059)	(0.058)
Ages 35–44	0.027	0.029	−0.16***	0.050	−0.13***	−0.13***
	(0.033)	(0.033)	(0.033)	(0.037)	(0.035)	(0.035)
Ages 45–54	−0.028	−0.026	−0.22***	0.035	−0.15***	−0.15***
	(0.032)	(0.032)	(0.033)	(0.035)	(0.036)	(0.036)
Ages 55–64	0.20***	0.20***	0.022	0.23***	0.063	0.061
	(0.040)	(0.041)	(0.042)	(0.044)	(0.046)	(0.046)
Ages 65+	0.28***	0.28***	0.16***	0.32***	0.21***	0.21***
	(0.037)	(0.036)	(0.035)	(0.036)	(0.036)	(0.036)
Chronic Condition	0.50***	0.50***	0.42***	0.29***	0.22***	0.22***
	(0.024)	(0.024)	(0.026)	(0.025)	(0.027)	(0.027)
Contact with Child	0.43***	0.44***	0.36***	0.33***	0.26***	0.26***
	(0.030)	(0.031)	(0.034)	(0.035)	(0.037)	(0.037)
Healthcare worker	0.71***	0.71***	0.73***	0.58***	0.60***	0.61***
	(0.033)	(0.033)	(0.037)	(0.035)	(0.040)	(0.040)
Level of education	0.071**	0.062**	0.12***	0.071**	0.13***	0.13***
	(0.029)	(0.030)	(0.028)	(0.029)	(0.027)	(0.027)
_cons	−1.04***	−1.30***	−3.44***	−1.43***	−3.34***	−3.50***
	(0.084)	(0.13)	(0.15)	(0.14)	(0.14)	(0.15)
N	42,898	42,898	42,843	39,748	39,700	39,700

Standard robust errors clustered at the state-level in parentheses.
* $p < .10$, ** $p < .05$, *** $p < .01$.

regressed on *Public Health Spending*, the effect of spending is positive and significant, suggesting that public health expenditures might have contributed to increased intent to vaccinate through raising concerns about H1N1 and increasing vaccination relevant doctor patient interactions. A Sobel-Goodman test shows that 64% and almost 57% of the effects of *Public Health Spending* on the intent to vaccinate are mediated through *Concern About H1N1* and *Doctor's Recommendation* respectively. Because we are estimating association rather than causal effects, the mediation effect represents the associations of the mediators.

It is possible that states increased their public health spending in response to the H1N1 pandemic, so that *Public Health Spending* might be correlated with unobserved factors about the pandemic that affected the vaccine uptake. To address this concern, we explored additional associations of the mediators using public health spending levels in 2008, the year prior to the H1N1 pandemic. The mediation effect of *Concern About H1N1* slightly decreases to 59% while the effect of *Doctor's Recommendation* remains relatively the same at 58%. Again, these mediation effects represent the associations of the mediators.

9. Discussions and conclusions

While this study examines factors that influence the intent to vaccinate during the H1N1 pandemic, the findings have important policy implications for promoting vaccination against the COVID-19 virus. Now, as back in 2009, there are uncertainties and doubts about the effectiveness and risks associated with the newly available vaccines. If the vaccination rate against COVID-19 is as low as that during the H1N1 pandemic, which was slightly over 40%, the US may not reach the threshold required for herd immunity [19]. With the Biden Administration committing significant public health spending towards the vaccination campaign in its COVID-19 response plan, it is imperative that the spending target the most effective measures [4].

Among the individual characteristics examined, our results demonstrate that concern about the H1N1 pandemic is more effective than knowledge about the virus at increasing the intent to vaccinate. The narratives surrounding COVID-19 indicate that there is indeed a lack of concern in certain demographics about the serious consequences of COVID-19, and risk perception studies reveal

Table 3
Estimation Results: Relative Risks of Intent to Vaccinate Based on Individual- and State-level Factors, Logistic Model.

	(I)		(II)		(III)		(IV)		(V)		(VI)	
	RRR (SE)	95% CI	RRR (SE)	95% CI	RRR (SE)	95% CI	RRR (SE)	95% CI	RRR (SE)	95% CI	RRR (SE)	95% CI
Public health spending	2.56** (0.98)	[1.21, 5.40]	1.70 (0.67)	[0.79, 3.66]	1.30 (0.44)	[0.67, 2.51]	1.38 (0.51)	[0.67, 2.84]	1.09 (0.38)	[0.55, 2.15]	1.07 (0.35)	[0.56, 2.05]
Concern about H1N1					1.54*** (0.014)	[1.51, 1.57]			1.47*** (0.012)	[1.45, 1.49]	1.47*** (0.012)	[1.45, 1.49]
Doctor's Rec for vaccine							2.05*** (0.030)	[1.99, 2.11]	1.85*** (0.024)	[1.80, 1.90]	1.85*** (0.024)	[1.80, 1.90]
Obama Vote Share			1.03*** (0.15)	[1.01, 1.05]	1.03*** (0.14)	[1.01, 1.05]	1.02** (0.12)	[1.00, 1.04]	1.02** (0.12)	[1.00, 1.04]	1.29** (0.13)	[1.06, 1.56]
H1N1 death rate	2.64 (4.77)	[0.076, 91.32]	8.75 (15.37)	[0.28, 273.43]	72.54*** (117.50)	[3.03, 1737.38]	5.05 (7.19)	[0.31, 82.04]			32.24** (47.03)	[1.85, 562.50]
Knowledge about Virus	1.16*** (0.013)	[1.13, 1.18]	1.16*** (0.013)	[1.13, 1.18]	1.096*** (0.012)	[1.07, 1.12]	1.11*** (0.013)	[1.08, 1.13]	1.06*** (0.011)	[1.04, 1.08]	1.06*** (0.011)	[1.04, 1.08]
Income Range $10,001–15,000	0.92*** (0.023)	[0.88, 0.96]	0.92*** (0.023)	[0.87, 0.96]	0.96* (0.022)	[0.92, 1.00]	0.93*** (0.025)	[0.88, 0.98]	0.96* (0.024)	[0.91, 1.01]	0.96* (0.024)	[0.91, 1.01]
Income Range 15,001–25,000	0.88*** (0.023)	[0.84, 0.93]	0.88*** (0.023)	[0.84, 0.93]	0.95** (0.022)	[0.90, 0.99]	0.89*** (0.023)	[0.84, 0.93]	0.95** (0.022)	[0.91, 0.99]	0.95** (0.022)	[0.90, 0.99]
Income Range 25,001–35,000	0.81*** (0.020)	[0.78, 0.85]	0.81*** (0.020)	[0.77, 0.85]	0.88*** (0.019)	[0.84, 0.92]	0.84*** (0.020)	[0.80, 0.88]	0.89*** (0.020)	[0.86, 0.93]	0.89*** (0.020)	[0.86, 0.93]
Income Range 35,001–50,000	0.78*** (0.021)	[0.74, 0.83]	0.78*** (0.021)	[0.74, 0.83]	0.88*** (0.021)	[0.84, 0.93]	0.80*** (0.023)	[0.76, 0.85]	0.89*** (0.023)	[0.85, 0.94]	0.89*** (0.022)	[0.85, 0.93]
Income Range 45,001–75,000	0.79*** (0.022)	[0.75, 0.84]	0.79*** (0.022)	[0.75, 0.83]	0.90*** (0.020)	[0.87, 0.94]	0.80*** (0.020)	[0.76, 0.84]	0.90*** (0.019)	[0.86, 0.93]	0.90*** (0.019)	[0.86, 0.93]
Income Range 75,001–100,000	0.83*** (0.023)	[0.80, 0.88]	0.83*** (0.022)	[0.79, 0.87]	0.95** (0.022)	[0.91, 1.00]	0.83*** (0.024)	[0.79, 0.88]	0.94** (0.024)	[0.90, 0.99]	0.94** (0.024)	[0.90, 0.99]
Ages 35–44	1.02 (0.019)	[0.98, 1.05]	1.02 (0.019)	[0.98, 1.05]	0.92*** (0.015)	[0.89, 0.96]	1.02 (0.020)	[0.99, 1.06]	0.94*** (0.016)	[0.91, 0.98]	0.94*** (0.016)	[0.91, 0.97]
Ages 45–54	0.99 (0.018)	[0.95, 1.02]	0.99 (0.018)	[0.95, 1.02]	0.90*** (0.016)	[0.86, 0.93]	1.01 (0.018)	[0.98, 1.05]	0.93*** (0.017)	[0.90, 0.96]	0.93*** (0.017)	[0.90, 0.96]
Ages 55–64	1.11*** (0.024)	[1.07, 1.16]	1.12*** (0.024)	[1.07, 1.16]	1.01 (0.021)	[0.97, 1.05]	1.12*** (0.024)	[1.07, 1.17]	1.02 (0.021)	[0.98, 1.07]	1.02 (0.021)	[0.98, 1.07]
Ages 65+	1.17*** (0.023)	[1.12, 1.21]	1.17*** (0.023)	[1.12, 1.21]	1.08*** (0.018)	[1.04, 1.11]	1.18*** (0.021)	[1.14, 1.22]	1.10*** (0.018)	[1.06, 1.13]	1.10*** (0.018)	[1.06, 1.13]
Chronic Condition	1.29*** (0.016)	[1.26, 1.33]	1.30*** (0.016)	[1.26, 1.33]	1.21*** (0.014)	[1.18, 1.24]	1.15*** (0.013)	[1.12, 1.17]	1.10*** (0.012)	[1.08, 1.12]	1.10*** (0.013)	[1.08, 1.12]
Contact with Child	1.23*** (0.016)	[1.20, 1.27]	1.24*** (0.016)	[1.21, 1.27]	1.16*** (0.015)	[1.13, 1.19]	1.16*** (0.017)	[1.12, 1.19]	1.11*** (0.015)	[1.08, 1.14]	1.11*** (0.015)	[1.08, 1.14]
Healthcare worker	1.41*** (0.019)	[1.37, 1.44]	1.41*** (0.019)	[1.37, 1.45]	1.37*** (0.019)	[1.34, 1.41]	1.28*** (0.017)	[1.25, 1.31]	1.27*** (0.017)	[1.24, 1.30]	1.27*** (0.017)	[1.24, 1.30]
Level of education	1.04** (0.016)	[1.01, 1.07]	1.04** (0.017)	[1.00, 1.07]	1.07*** (0.015)	[1.04, 1.10]	1.04** (0.015)	[1.01, 1.07]	1.06*** (0.014)	[1.03, 1.09]	1.06*** (0.014)	[1.03, 1.09]
N	42,898		42,898		42,843		39,748		39,700		39,700	

Robust standard errors clustered at the state-level in parentheses.
*p < .10, ** p < .05, *** p < .01.

there is a correlation between vaccine hesitancy and a belief that COVID-19 is less threatening [8]. Individuals who refuse the vaccine believe that the COVID-19 virus is harmless and as a result, there is no need for the vaccine [20]. There are also widespread reports in the news media about young people holding "COVID parties," about hospitalized COVID patients who refuse to acknowledge its existence, and about people denying that they can contract COVID [21,22]. Partly propagated by political leaders [23], such lack of concern represents a major roadblock to vaccination against COVID-19.

When communicating with the public, public health officials should emphasize the seriousness of the pandemic by bringing attention to the death rate – shown in our results to have a significant effect on vaccine uptake – and the struggles and stories of patients who have contracted COVID-19. Associating names and faces with the pandemic rather than statistics can help people realize that the consequences of the pandemic are real and affecting the lives of everyday people [24]. News media can also aid in the effort to spread stories and raise concern about the pandemic by providing affected families and doctors with a platform to make their voices heard. Past public health communication campaigns, such as Tips from Former Smokers, can inform current communication methodology and spending allocation [25].

However, solely relying on communication by government agencies and news media is not enough. Although there were federal vaccine recommendations in place in 2009 for the seasonal and H1N1 flu, only 36.2% and 29.5% of covered adults were aware of this recommendation [26]. Interactions with a healthcare provider through a recent appointment or through a direct recommendation significantly increased awareness [26]. In our study, we found that receiving a doctor's vaccination recommendation significantly increased the intent to vaccinate against H1N1, suggesting that, in the case of COVID-19, receiving medical advice from trusted medical experts might significantly increase the probability of vaccination. There are widespread reports about distrust of the government, especially in minority communities that have been hardest hit during the pandemic [25]. Their distrusts often result in disregard towards public health advice and vaccine hesitancy. In contrast, these communities tend to trust doctors, as the physicians who reach out are those who often communicate with them and who are relatable and culturally similar to them [25]. These doctors, by providing trusted information about vaccines, can be more effective in reducing misconceptions and misinformation and increasing vaccine uptake. However, primary care physicians [PCP] are to a large extent excluded in the current COVID-19 vaccine distribution processes [5]. Their absence is reflective

Table 4
Mediation Results of Concern about H1N1 and Doctor's Recommendation for Vaccine on Intent to Vaccinate.

	(1) Concern about H1N1	(2) Concern about H1N1	(3) Doctor's Recommendation	(4) Doctor's Recommendation
Public health spending	0.64**	0.59*	0.38***	0.26
	(0.25)	(0.33)	(0.12)	(0.13)
Obama Vote Share		0.0034		0.0088
		(0.011)		(0.0046)
Income Range $10,001–15,000	−0.085***	−0.085***	0.0058	0.0057
	(0.026)	(0.026)	(0.010)	(0.010)
Income Range 15,001–25,000	−0.13***	−0.13***	0.0070	0.0071
	(0.023)	(0.023)	(0.011)	(0.011)
Income Range 25,001–35,000	−0.12***	−0.12***	−0.0060	−0.0062
	(0.023)	(0.023)	(0.0099)	(0.0099)
Income Range 35,001–50,000	−0.21***	−0.22***	−0.0035	−0.0035
	(0.026)	(0.026)	(0.0095)	(0.0094)
Income Range 45,001–75,000	−0.23***	−0.23***	0.0070	0.0067
	(0.026)	(0.026)	(0.0099)	(0.0099)
Income Range 75,001–100,000	−0.22***	−0.23***	0.022**	0.020**
	(0.024)	(0.024)	(0.0092)	(0.0091)
Ages 35–44	0.23***	0.23***	−0.0091	−0.0088
	(0.015)	(0.015)	(0.0069)	(0.0069)
Ages 45–54	0.24***	0.24***	−0.033***	−0.033***
	(0.015)	(0.015)	(0.0061)	(0.0061)
Ages 55–64	0.24***	0.24***	−0.0066	−0.0063
	(0.014)	(0.014)	(0.0073)	(0.0073)
Ages 65+	0.17***	0.17***	−0.016**	−0.016**
	(0.019)	(0.019)	(0.0069)	(0.0069)
Chronic Condition	0.17***	0.17***	0.15***	0.15***
	(0.010)	(0.010)	(0.0057)	(0.0057)
Contact with Child	0.15***	0.15***	0.10***	0.10***
	(0.016)	(0.016)	(0.0075)	(0.0074)
Healthcare worker	0.10***	0.10***	0.14***	0.14***
	(0.014)	(0.014)	(0.0071)	(0.0070)
College Degree	−0.025**	−0.026**	0.0087*	0.0071
	(0.0099)	(0.0099)	(0.0050)	(0.0050)
_cons	2.54***	2.52***	0.14***	0.11***
	(0.034)	(0.064)	(0.010)	(0.024)
N	42,971	42,971	39,873	39,873

Standard errors in parentheses.
*$p < .10$, ** $p < .05$, *** $p < .01$.

Table 5
Estimation Results of Individual- and State-level Factors on Dependent Variables Intent to Vaccinate and Already Vaccinated.

	Coefficient Estimates		RRR	
	Intent to Vaccinate	Already Vaccinated	Intent to Vaccinate	Already Vaccinated
Public health spending	0.29	0.69	1.07	1.36
	(0.72)	(0.97)	(0.35)	(0.69)
Concern about H1N1	0.80***	0.56***	1.47***	1.35***
	(0.016)	(0.021)	(0.012)	(0.015)
Doctor's Rec for vaccine	1.59***	2.10***	1.85***	3.09***
	(0.033)	(0.040)	(0.024)	(0.078)
Obama Vote Share	0.056***	0.041*	1.03**	1.024
	(0.022)	(0.025)	(0.010)	(0.013)
H1N1 death rate	8.76***	12.64**	32.24**	324.50**
	(3.28)	(5.45)	(47.03)	(875.40)
Knowledge about Virus	0.13***	0.28***	1.06***	1.16***
	(0.023)	(0.027)	(0.011)	(0.018)
Income Range $10,001–15,000	−0.093	−0.025	0.96*	0.97
	(0.062)	(0.089)	(0.024)	(0.047)
Income Range 15,001–25,000	−0.16***	−0.059	0.95**	0.98
	(0.053)	(0.071)	(0.022)	(0.037)
Income Range 25,001–35,000	−0.28***	−0.11	0.89***	0.95
	(0.051)	(0.068)	(0.020)	(0.035)
Income Range 35,001–50,000	−0.29***	−0.12	0.89***	0.94
	(0.058)	(0.080)	(0.022)	(0.041)
Income Range 45,001–75,000	−0.27***	−0.014	0.90***	0.99
	(0.048)	(0.060)	(0.019)	(0.033)
Income Range 75,001–100,000	−0.17***	0.099	0.94**	1.05
	(0.058)	(0.062)	(0.024)	(0.035)
Ages 35–44	−0.13***	−0.15***	0.94***	0.92***
	(0.035)	(0.045)	(0.016)	(0.023)

(continued on next page)

Table 5 (*continued*)

	Coefficient Estimates		RRR	
	Intent to Vaccinate	Already Vaccinated	Intent to Vaccinate	Already Vaccinated
Ages 45–54	−0.15***	−0.16***	0.93***	0.91***
	(0.036)	(0.044)	(0.017)	(0.022)
Ages 55–64	0.061	0.17***	1.02	1.09***
	(0.046)	(0.049)	(0.021)	(0.028)
Ages 65+	0.21***	0.32***	1.095***	1.18***
	(0.036)	(0.042)	(0.018)	(0.027)
Chronic Condition	0.22***	0.29***	1.10***	1.17***
	(0.027)	(0.033)	(0.013)	(0.020)
Contact with Child	0.26***	0.31***	1.11***	1.15***
	(0.037)	(0.050)	(0.015)	(0.025)
Healthcare worker	0.61***	1.00***	1.27***	1.55***
	(0.040)	(0.048)	(0.017)	(0.030)
Level of education	0.13***	0.22***	1.06***	1.12***
	(0.027)	(0.035)	(0.014)	(0.021)
_cons	−3.50***	−4.40***		
	(0.15)	(0.18)		
N	39,700	31,711	39,700	31,711

Robust standard errors clustered at the state-level in parentheses.
*p < .10, ** p < .05, *** p < .01.

Table 6
Estimation Results of Individual- and State-level Factors on Intent to Vaccinate for Specification Controlling for Month.

	Without Month	With Month
Public health spending	0.29	0.36
	(0.72)	(0.73)
Concern about H1N1	0.80***	0.78***
	(0.016)	(0.016)
Doctor's Rec for vaccine	1.59***	1.64***
	(0.033)	(0.034)
Obama vote share	0.056***	0.056***
	(0.022)	(0.022)
H1N1 death rate	8.76***	8.69***
	(3.28)	(3.30)
Knowledge about Virus	0.13***	0.11***
	(0.023)	(0.023)
Income Range $10,001–15,000	−0.093	−0.092
	(0.062)	(0.062)
Income Range 15,001–25,000	−0.16***	−0.16***
	(0.053)	(0.054)
Income Range 25,001–35,000	−0.28***	−0.29***
	(0.051)	(0.051)
Income Range 35,001–50,000	−0.29***	−0.30***
	(0.058)	(0.059)
Income Range 45,001–75,000	−0.27***	−0.29***
	(0.048)	(0.048)
Income Range 75,001–100,000	−0.17***	−0.18***
	(0.058)	(0.058)
Ages 35–44	−0.13***	−0.12***
	(0.035)	(0.036)
Ages 45–54	−0.15***	−0.15***
	(0.036)	(0.036)
Ages 55–64	0.061	0.069
	(0.046)	(0.045)
Ages 65+	0.21***	0.21***
	(0.036)	(0.036)
Chronic Condition	0.22***	0.23***
	(0.027)	(0.028)
Contact with Child	0.26***	0.26***
	(0.037)	(0.037)
Healthcare worker	0.61***	0.62***
	(0.040)	(0.040)
Level of education	0.13***	0.13***
	(0.027)	(0.027)
Month		−0.070***
		(0.0054)
_cons	−3.50***	−3.05***
	(0.15)	(0.16)
N	39,700	39,700

Robust standard errors clustered at the state-level in parentheses.
*p < .10, **p < .05, ***p < .01.

of the broader lack of integration between PCPs and the public health system [27,28]. While extensive research has shown the importance of and the need for better collaboration between the two in improving overall health of the population [27], our study demonstrates that public health spending can be the most effective when it helps increase vaccination relevant doctor patient interactions.

There are several limitations to this study. The response rate in the NHFS survey was low – only 34.7% of contacted landlines and 27.0% cell phones responded to the survey. Our results might be subject to selection bias; it is possible that vaccine uptake is different between non-respondents and respondents. A number of variables, such as knowledge of the H1N1 virus, are self-reported, and measurement errors might arise from over-confidence and from low health literacy. It is also possible that there are unobserved variables that influence the intent to vaccinate and are correlated with the observable variables in the model resulting in omitted-variable bias. Examples include public health messaging, social capital, and political will. States with high public health spending and more concern about H1N1 might also have more social capital, so that the estimated coefficients could be biased.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

I thank Professors Adam Chen, Muhammad Husain, and John McGready for their guidance and helpful comments.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

[1] CDC. COVID Data Tracker [Internet]. Centers for Disease Control and Prevention. 2020 [cited 2021 Apr 27]. Available from: https://covid.cdc.gov/covid-data-tracker.

[2] Rajgopal T. COVID-19: Epidemiology and Public Health Aspects. Indian J Community Med Off Publ Indian Assoc Prev Soc Med 2020;45(2):111–6.
[3] Lazarus JV, Ratzan SC, Palayew A, Gostin LO, Larson HJ, Rabin K, et al. A global survey of potential acceptance of a COVID-19 vaccine. Nat Med 2021;27 (2):225–8.
[4] Biden JR. National Strategy for the COVID-19 Response and Pandemic Preparedness [Internet]. White House; 2021 [cited 2021 Apr 27]. Available from: https://www.whitehouse.gov/wp-content/uploads/2021/01/National-Strategy-for-the-COVID-19-Response-and-Pandemic-Preparedness.pdf.
[5] Abelson R. Primary Care Doctors Feel Left Out of Vaccine Rollout - The New York Times [Internet]. New York Times. 2021 [cited 2021 Apr 27]. Available from: https://www.nytimes.com/2021/02/10/health/covid-doctors-vaccine.html.
[6] CDC. 2009 H1N1 Pandemic [Internet]. Centers for Disease Control and Prevention. 2019 [cited 2021 Apr 27]. Available from: https://www.cdc.gov/flu/pandemic-resources/2009-h1n1-pandemic.html.
[7] Ramanadhan S, Galarce E, Xuan Z, Alexander-Molloy J, Viswanath K. Addressing the Vaccine Hesitancy Continuum: An Audience Segmentation Analysis of American Adults Who Did Not Receive the 2009 H1N1 Vaccine. Vaccines. 2015;3(3):556–78.
[8] Fridman A, Gershon R, Gneezy A. COVID-19 and vaccine hesitancy: A longitudinal study. PLOS ONE 2021;16(4):e0250123.
[9] Quinn SC, Kumar S, Freimuth VS, Kidwell K, Musa D. Public Willingness to Take a Vaccine or Drug Under Emergency Use Authorization during the 2009 H1N1 Pandemic. Biosecurity Bioterrorism Biodefense Strategy Pract Sci 2009;7 (3):275–90.
[10] Rönnerstrand B. Contextual generalized trust and immunization against the 2009 A(H1N1) pandemic in the American states: A multilevel approach. SSM - Popul Health 2016;2:632–9.
[11] Santibanez TA, Singleton JA, Santibanez SS, Wortley P, Bell BP. Socio-demographic differences in opinions about 2009 pandemic influenza A (H1N1) and seasonal influenza vaccination and disease among adults during the 2009–2010 influenza season. Influenza Other Respir Viruses 2013;7 (3):383–92.
[12] Ding H, Santibanez TA, Jamieson DJ, Weinbaum CM, Euler GL, Grohskopf LA, et al. Influenza vaccination coverage among pregnant women–National 2009 H1N1 Flu Survey (NHFS). Am J Obstet Gynecol 2011;204(6):S96–S106.
[13] Fraser MR. A Brief History of the Prevention and Public Health Fund: Implications for Public Health Advocates. Am J Public Health 2019;109 (4):572–7.
[14] NIS - Datasets and Related Documentation for the National Immunization Survey, 2005 to Present [Internet]. 2019 [cited 2021 Apr 28]. Available from: https://www.cdc.gov/nchs/nis/data_files_h1n1.htm
[15] Winship C, Radbill L. Sampling Weights and Regression Analysis [Internet]. Sociological Methods & Research; 1994 [cited 2021 Oct 5]. Available from: https://journals.sagepub.com/doi/10.1177/0049124194023002004#.
[16] Table | Per person state public health funding | State Health Access Data Assistance Center [Internet]. [cited 2021 Apr 28]. Available from: http://statehealthcompare.shadac.org/table/117/per-person-state-public-health-funding#2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52/a/2/154
[17] Federal Elections Data [Internet]. Federal Election Commission; 2008 [cited 2021 Jan 13]. Available from: https://www.fec.gov/documents/1666/federalelections2008.xls.
[18] Harris Katherine M, Maurer Jürgen, Lurie Nicole. Do People Who Intend to Get a Flu Shot Actually Get One? J Gen Intern Med 2009;24(12):1311–3.
[19] Final estimates for 2009–10 Seasonal Influenza and Influenza A (H1N1) 2009 Monovalent Vaccination Coverage – United States, August 2009 through May, 2010. | FluVaxView | Seasonal Influenza (Flu) | CDC [Internet]. 2019 [cited 2021 Apr 28]. Available from: https://www.cdc.gov/flu/fluvaxview/coverage_0910estimates.htm.
[20] Troiano G, Nardi A. Vaccine hesitancy in the era of COVID-19. Public Health 2021;194:245–51.
[21] Pietsch B. Texas Hospital Says Man, 30, Died After Attending a 'Covid Party.' The New York Times [Internet]. 2020 Jul 12 [cited 2021 Apr 28]; Available from: https://www.nytimes.com/2020/07/12/us/30-year-old-covid-party-death.html.
[22] Rott N. COVID-19 Denial Still Rampant In Some Coronavirus Hot Spots [Internet]. NPR.org. 2020 [cited 2021 Apr 28]. Available from: https://www.npr.org/2020/11/19/936248527/covid-19-denial-still-rampant-in-some-virus-hotspots.
[23] Thompson D. What Young, Healthy People Have to Fear From COVID-19 [Internet]. The Atlantic. 2020 [cited 2021 Apr 28]. Available from: https://www.theatlantic.com/ideas/archive/2020/09/what-young-healthy-people-have-fear-covid-19/616087/.
[24] Pinsker J. What Do You Tell Someone Who Still Won't Stay Home? The Atlantic [Internet]. 2020 Mar 19 [cited 2021 Jan 2]; Available from: https://www.theatlantic.com/family/archive/2020/03/convince-family-take-coronavirus-seriously/608356/.
[25] Tips From Former Smokers [Internet]. [cited 2021 Mar 18]. Available from: https://www.cdc.gov/tobacco/campaign/tips/index.html.
[26] Maurer Jürgen, Uscher-Pines Lori, Harris Katherine M. Awareness of government seasonal and 2009 H1N1 influenza vaccination recommendations among targeted US adults: The role of provider interactions. Am J Infect Control. 2010;38(6):489–90.
[27] Levesque J-F, Breton M, Senn N, Levesque P, Bergeron P, Roy DA. The Interaction of Public Health and Primary Care: Functional Roles and Organizational Models that Bridge Individual and Population Perspectives. Public Health Rev. 2013;35(1):1–27.
[28] Pratt Rebekah, Gyllstrom Beth, Gearin Kim, Lange Carol, Hahn David, Baldwin Laura-Mae, et al. Identifying Barriers to Collaboration Between Primary Care and Public Health: Experiences at the Local Level. Public Health Rep Wash DC 2018;133(3):311–7.