The Role of Social Networks in Influenza Vaccine Attitudes and Intentions Among College Students in the Southeastern United States

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Abstract

Purpose: To investigate whether support for vaccines among one's health discussants is associated with beliefs in vaccine safety and intention to vaccinate among college students.
Methods: Ordered logistic regression analysis was conducted of data collected from 1,019 undergraduates at a large public university in 2009 and 2010.
Results: Having health discussion networks that support vaccination is a significant predictor of beliefs of H1N1 vaccine safety (aOR 2.32) and intention (aOR 1.78) in 2009 and influenza vaccine safety (aOR 1.85) and intention (aOR 1.74) in 2010. These relationships are strongest among parents, friends, and spouses.
Conclusions: Perceptions of flu vaccine attitudes among health discussants were strongly related to vaccination intent and beliefs about flu vaccine safety among survey respondents.
Implications and Contribution: Our study provides further evidence that people's vaccine attitudes and behavior are associated with the attitudes of people in their social network. These results suggest that health discussants play an important role in the vaccination process and should be considered in future survey and experimental research on attitudes toward vaccination.

Recent surveys have documented high levels of doubt concerning the safety of vaccines (e.g., [1]). These concerns may hinder uptake of the influenza vaccine. For instance, despite strenuous efforts to promote vaccination during the H1N1 pandemic, a combination of limited availability and concerns about the safety of the H1N1 vaccine limited inoculation rates to an estimated 24% through February 2010 [2]. One important mechanism by which beliefs and attitudes about vaccines may be transmitted is social networks (e.g., [3, 4]). Our objective is to determine whether increased support for vaccines among one's health discussion network will be associated with more positive perceptions of vaccine safety and an increased likelihood of vaccination.

Methods

We surveyed undergraduates at a public university in the Southeastern United States. The study was conducted during two time periods, December 2009 (n=368) and November/December 2010 (n=650), using a convenience sampling technique. Students were told they could refuse to answer any questions. The surveys covered multiple topics, were administered online, and required about an hour. Students received extra credit for an introductory political science class. The study was approved by the university's IRB.

Demographics closely matched the university's student body—more likely to be women (61% in 2009, 67% in 2010) and highly diverse (e.g., 37% black in 2009, 36% in 2010).

Our key independent variable was constructed from social network data we collected using a standard name generator process. We asked respondents to describe up to four individuals with whom they discuss health matters and whether they think that person supports vaccination for H1N1 (2009) or seasonal flu (2010). Our dependent variables are per-

ceptions of vaccine safety and vaccination intent.

Key independent variable

Network support: "Do you think that person supports others getting vaccinated for the {H1N1 flu, which is sometimes called 'swine flu' / seasonal flu during this flu season (fall 2010–spring 2011)}? Responses for each discussion network member were "Yes" (1), "Maybe" (0), or "No" (-1), which we summed for all members of the discussion network, creating a variable that ranges from -4 (four discussants oppose vaccination) to 4 (four support vaccination). [1]

Dependent variables

Vaccine safety: "Just based on what you know, how safe do you believe the vaccine for {the H1N1 virus, which is known as the swine flu,/influenza} will generally be for most people to take?" Responses were measured on a four-point scale from "not at all safe" (1) to "very safe" (4).

Vaccination intent: "How likely is it that you will get a {H1N1/influenza} shot during this season?" Responses were measured on a six-point scale ranging from "very unlikely" (1) to "very likely" (6).

Results

Our respondents reported concerns about the safety of influenza vaccines in both samples. In the 2009 survey, 30% said the H1N1 vaccine was "not

[1]Not all subjects reported discussion networks of four people. To account for differences in network size, we also computed an alternate measure of social network support consisting of the *proportion* of health discussants who supported or opposed vaccination. Our results and conclusions are virtually identical under this alternate specification, which ranges from -1 (all discussants oppose vaccination) to 1 (all members discussants support vaccination). These results are presented in a web appendix available at `http://www.dartmouth.edu/~nyhan/`.

very safe" or "not at all safe." Vaccination rates were similarly low (only 10% reported having received the H1N1 vaccine). Respondents in 2010 were more likely to describe the seasonal influenza vaccine as safe—only 12% described it as "not very safe" or "not at all safe"—but self-reported vaccination rates were only modestly higher (18%).

Respondents' health discussion networks were often perceived as against vaccination. In 2009, 25% reported having oppositional networks (i.e., more of their discussants opposed H1N1 vaccination than supported it), whereas 45% reported having supportive networks. In 2010, less hostility was reported toward seasonal influenza vaccination. Fifteen percent (15%) reported having oppositional networks, whereas 56% reported having networks that were supportive.

Our analysis uses ordered logistic regression with controls for trust, political views, and demographics.[2] The models in Tables 1 and 2 used data from both the 2009 H1N1 and 2010 seasonal influenza surveys with coefficients in adjusted odds ratio form. In each instance, we report the complete model estimated.

Table 1 considers the association between *Network support* and *Vaccine safety* and *Vaccination intention* for H1N1 and seasonal influenza. Across all four models, those with more pro-vaccination discussion networks reported higher beliefs in vaccine safety and greater intent to vaccinate. For the 2009 H1N1 survey, *Network support* is a highly significant predictor of *Vaccine safety* (aOR=2.32, 95% CI: 1.89–2.84) and *Vaccination intention* (aOR=1.78, 95% CI: 1.47–2.16). In the 2010 seasonal influenza survey, the results are similarly positive and significant for *Vaccine safety* (aOR=1.85, 95% CI: 1.57–2.19) and *Vaccination intention* (aOR=1.74, 95% CI: 1.47–2.06).

Table 2 disaggregates *Network support* to distinguish between *Spousal support*, *Parental support*, *Friend support*, and *Relative support*.[3] We find that

[2]The web appendix provides more details on these control variables and the statistical procedures used in the analysis.

[3]These variables are constructed identically to *Network support*. See the web appendix

Table 1: Ordered logistic regressions of influenza vaccine beliefs and intentions by health discussant type

	Vaccine safety		*Vaccination intention*	
	2009	2010	2009	2010
Network support	2.32*	1.85*	1.78*	1.74*
	[1.89,2.84]	[1.57,2.19]	[1.47,2.16]	[1.47,2.06]
Health trust	1.58*	1.31*	1.55*	1.19
	[1.19,2.10]	[1.06,1.62]	[1.14,2.11]	[0.96,1.48]
Government trust	1.29	1.56*	1.04	1.03
	[0.93,1.79]	[1.19,2.05]	[0.75,1.42]	[0.78,1.37]
Ideology	1.20*	1.03	0.96	1.11
	[1.03,1.40]	[0.92,1.17]	[0.82,1.12]	[0.98,1.26]
Age	0.97	1.01	1.02	1.00
	[0.92,1.02]	[0.97,1.05]	[0.96,1.09]	[0.95,1.04]
Male	1.34	1.70*	1.32	1.26
	[0.81,2.21]	[1.14,2.54]	[0.82,2.15]	[0.85,1.88]
Black	0.51*	0.75	1.46	1.11
	[0.30,0.86]	[0.50,1.13]	[0.87,2.46]	[0.74,1.66]
Asian	0.71	1.02	4.08*	3.11*
	[0.36,1.39]	[0.60,1.74]	[2.11,7.89]	[1.79,5.40]
Multiracial	0.73	0.62	0.47	1.46
	[0.33,1.64]	[0.21,1.81]	[0.18,1.25]	[0.53,4.04]
Hispanic	0.66	0.80	1.78	1.45
	[0.31,1.40]	[0.48,1.36]	[0.80,3.92]	[0.87,2.43]
Science courses	0.88	1.15	1.03	0.95
	[0.72,1.08]	[0.99,1.35]	[0.84,1.27]	[0.81,1.12]
Log-likelihood	-274.70	-436.31	-378.93	-609.85
N	307	525	281	429

This table reports adjusted odds ratios and 95% confidence intervals from the full models estimated in ordered logistic regressions. Cutpoints are omitted. * $p < .05$

support for vaccination among several types of discussants is significantly associated with vaccine attitudes. Respondents who perceived their par-

Table 2: Associations between influenza vaccine attitudes and discussant type

	Vaccine safety		*Vaccination intention*	
	2009	2010	2009	2010
Spousal support	5.59*	2.40*	1.57	2.49*
	[2.49,12.57]	[1.25,4.59]	[0.66,3.72]	[1.12,5.56]
Parental support	2.46*	1.96*	2.19*	1.78*
	[1.75,3.46]	[1.53,2.52]	[1.56,3.08]	[1.37,2.31]
Friend support	2.12*	2.17*	1.52*	1.90*
	[1.45,3.09]	[1.60,2.96]	[1.04,2.22]	[1.40,2.57]
Relatives support	1.51	1.25	1.49	1.20
	[0.90,2.52]	[0.81,1.91]	[0.89,2.49]	[0.80,1.82]
Health trust	1.54*	1.38*	1.45*	1.27*
	[1.20,1.96]	[1.14,1.68]	[1.10,1.90]	[1.05,1.54]
Government trust	1.30	1.44*	1.08	0.96
	[0.96,1.77]	[1.12,1.86]	[0.81,1.45]	[0.74,1.24]
Ideology	1.18*	1.01	0.94	1.11
	[1.03,1.36]	[0.90,1.13]	[0.82,1.08]	[0.99,1.25]
Age	1.00	1.01	1.03	1.00
	[0.95,1.05]	[0.97,1.06]	[0.97,1.09]	[0.96,1.05]
Male	1.46	1.66*	1.12	1.35
	[0.93,2.30]	[1.15,2.39]	[0.72,1.76]	[0.94,1.93]
Black	0.56*	0.77	1.35	1.07
	[0.35,0.91]	[0.53,1.13]	[0.83,2.20]	[0.74,1.56]
Asian	0.81	0.86	3.56*	3.45*
	[0.44,1.48]	[0.53,1.40]	[1.95,6.50]	[2.13,5.57]
Multiracial	0.68	0.75	0.48	1.38
	[0.32,1.43]	[0.26,2.13]	[0.19,1.23]	[0.52,3.66]
Hispanic	0.71	0.68	1.64	1.24
	[0.36,1.43]	[0.41,1.13]	[0.76,3.51]	[0.76,2.00]
Science courses	0.92	1.10	1.03	0.97
	[0.76,1.10]	[0.95,1.28]	[0.85,1.25]	[0.84,1.13]
Log-likelihood	-325.48	-507.09	-435.66	-719.76
N	358	610	326	503

This table reports adjusted odds ratios and 95% confidence intervals from the full models estimated in ordered logistic regressions. Cutpoints are omitted. * $p < .05$

ents, spouses or friends as pro-vaccination are more likely to say influenza vaccines are safe and reported higher vaccination intent. By contrast, perceived vaccination support among other related discussants is not statistically significant.

for further details.

Discussion

Our results suggest that health discussion networks may play a key role in the transmission of information and attitudes about vaccines. Respondents who believe the members of their health discussion networks support vaccination have more positive views of vaccine safety. Similarly, network support for vaccination is associated with vaccination intentions. Among discussants, spouses, parents and friends appear to be most influential. The primary limitations of our work is that the data were gathered from a convenience sample and that we cannot observe the flow of vaccine information within discussion networks. Future research should seek to replicate the association we have documented, particularly in experimental studies that can make strong causal inferences.

References

[1] Gust, DA, Darling N, Kennedy A, and Schwartz B. Parents with doubts about vaccines: Which vaccines and reasons why. Pediatrics 2008;122:718–25.

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[4] Valente, TW. Social Networks and Health: Models, Methods, and Applications. Oxford University Press; 2010.

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Web appendix for "The Role of Social Networks in Influenza Vaccine Attitudes and Intentions Among College Students in the Southeastern United States"

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This web appendix provides additional detail on measures and results presented in the article "The Role of Social Networks in Influenza Vaccine Attitudes and Intentions Among College Students in the Southeastern United States."

1 Survey instrument and measures

We collected social network data using a name generator process that is often used to collect information on survey respondents' contacts. Following a standard approach, we asked respondents to identify up to four individuals with whom they discuss health matters and to describe their relationship with that person. The potential relationships were described as "Parent," "Friend," "Spouse," "Sibling," or "Relative." Our 2009 question battery included a question which asked "Do you think that person supports others getting vaccinated for the H1N1 flu, which is sometimes called 'swine flu'?" [Yes (1)/Maybe (0)/No (-1)]. The procedures were the same in the Fall 2010 sample, but the question on vaccine attitudes was changed to "Do you think that person supports others getting vaccinated for the seasonal flu during this flu season (fall 2010-spring 2011)?" [Yes (1)/Maybe (0)/No (-1)]. We created our *Network support* measure by summing the responses to this question for up to four health discussants named by the respondent. We also created measures of *Spousal support*, *Parental support*, *Friend support*, and *Relative support* by disaggregating *Network support* by type of relationship (we combined siblings and relatives).

We also control for two measures of institutional trust. First, trust in health organizations may influence beliefs about vaccines. We measure trust in the health establishment with a battery of questions that ask "How much do you trust the institutions listed to do the right thing most of the time?" on a seven-point scale from "Distrust fully" (1) to "Trust fully" (7). The institutions listed were: Centers for Disease Control, nurses, hospitals, doctors, pharmaceutical companies, scientists, the public health office in your hometown, and health insurance companies. We measure *Health trust* as the average of these items (Cronbach's alpha: 0.86 in 2009, 0.85 in 2010). In addition, since public health campaigns are often promoted by government agencies, trust in government may affect willingness to be vaccinated. We measure *Government trust* with a question asking "How much of the time do you think you can trust the federal government in Washington to make decisions in a fair way?" Responses were measured on a five-point scale from "Never" (1) to "Very often" (5).

Additionally, we measured several other demographic attributes and attitudes that may influence attitudes towards vaccines. First, *ideology* influence attitudes toward government health policies. We measure it on a seven-point scale from "Very liberal" (1) to "Very conservative" (7). The models reported below also control for *Age* and include indicator variables for respondents who are *Female*, *Black*, *Asian*, *Multiracial*, or *Hispanic*. Finally, while our respondents have similar levels of educational achievement, some may be more inclined to accept evidence of vaccine safety as a result of taking science courses. We control for the number of *Science courses* taken by

the respondent on a five-point scale ranging from 0 (no college-level science courses) to 4 (four or more).

2 Statistical analysis

Since our dependent variables (*Vaccine safety* and *Vaccine intention*) are ordinal, we use ordered logistic regression models. Ordered logistic models assume the log-odds that the dependent variable takes the category k or less are independent of k. This is known as the "proportional odds" assumption.

3 An alternate measure of network support

The article reports results using a measure of *Network support* that ranges from -4 to 4. These values represent net support or opposition to vaccination among the respondent's health discussants (up to four could be named). One concern is that this measure may be distorted by differences in the size of respondents' discussion networks. Based on the helpful suggestion of a reviewer, we therefore created an alternate measure representing the *proportion* of a respondent's health discussion network supporting or opposing vaccination (ranging from -1 where all network members oppose to 1 where all network members support). We then estimated identical models to those presented in Table 1 of the article. As in the text, the results are reported below in adjusted odds ratio form. Our findings are virtually identical those reported in the article—the proportion of network support for vaccination

reported by a respondent is strongly associated with *Vaccine safety* and *Vaccination intention* in both the 2009 and 2010 data.

Table 1: Ordered logistic regressions of influenza vaccine beliefs and intentions by health discussant type

	Vaccine safety		*Vaccination intention*	
	2009	2010	2009	2010
Network support (prop.)	4.92*	3.71*	3.38*	2.90*
	[3.32,7.30]	[2.69,5.12]	[2.34,4.89]	[2.12,3.95]
Health trust	1.60*	1.39*	1.53*	1.25*
	[1.21,2.12]	[1.12,1.71]	[1.13,2.09]	[1.00,1.55]
Government trust	1.34	1.49*	1.03	0.98
	[0.96,1.86]	[1.13,1.96]	[0.75,1.42]	[0.74,1.30]
Ideology	1.20*	1.06	0.95	1.14*
	[1.03,1.40]	[0.94,1.20]	[0.82,1.11]	[1.01,1.30]
Age	0.97	1.01	1.01	0.99
	[0.92,1.03]	[0.96,1.05]	[0.95,1.08]	[0.95,1.03]
Male	1.31	1.61*	1.29	1.25
	[0.80,2.16]	[1.08,2.40]	[0.79,2.10]	[0.84,1.86]
Black	0.51*	0.78	1.52	1.10
	[0.31,0.86]	[0.52,1.18]	[0.90,2.56]	[0.73,1.65]
Asian	0.71	1.08	3.84*	3.38*
	[0.37,1.38]	[0.63,1.84]	[1.98,7.45]	[1.94,5.89]
Multiracial	0.84	0.65	0.51	1.49
	[0.37,1.90]	[0.22,1.88]	[0.19,1.33]	[0.53,4.16]
Hispanic	0.60	0.83	1.67	1.46
	[0.28,1.29]	[0.49,1.39]	[0.75,3.71]	[0.87,2.44]
Science courses	0.89	1.18*	1.04	0.97
	[0.73,1.09]	[1.00,1.38]	[0.84,1.28]	[0.82,1.14]
Log-likelihood	-275.59	-428.79	-374.99	-607.82
N	307	525	281	429

This table reports adjusted odds ratios and 95% confidence intervals from the full models estimated in ordered logistic regressions. Cutpoints are omitted. * $p < .05$