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ORIGINAL RESEARCH

Individual and Community Influences on Adherence to Directives in the Event of a Plague Attack: Survey Results

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ABSTRACT

Objectives: During a public health emergency, public health officials issue directives with actions people need to take to protect themselves. Past research has shown that adherence to these directives depends on individual beliefs and circumstances. This report presents new research about the effects of community factors on adherence.

Methods: A random digit-dial survey of 936 residents in the St Louis, Missouri, area was conducted in 2008 to assess barriers to and facilitators of adherence to directives issued in response to a hypothetical scenario involving the intentional release of the bacterium that causes plague. Community factors were assessed using characteristics of census tracts for individual respondents. Multilevel modeling was used to understand how individual and community factors contributed to the likelihood of adherence.

Results: The majority of participants indicated that they would adhere to 3 distinct directives. Community poverty and ethnic homogeneity as well as individual-level barriers were negatively associated with adherence to a 6-day quarantine. Having children younger than 18 years and being away from home when the directive was called were negatively associated with adherence to a 10-hour quarantine. Logistical concerns were negatively associated with visiting a point of dispensing for prophylactic antibiotics.

Conclusions: Our findings establish an empirical basis for the influence of community factors on adherence to public health directives. The influence of community and individual factors on adherence varies across directives. Consequently, communication strategies to disseminate directives and organizational strategies to support them must vary according to the nature of the directives.

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Key Words: social determinants, public health directive adherence, infectious disease outbreak, multilevel modeling
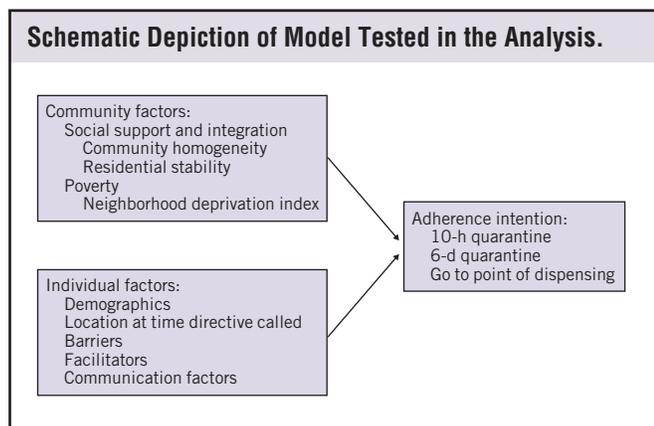
As events surrounding the outbreak of the novel H1N1 influenza A (aka swine flu) attest, a vital element in government response to a potential infectious disease outbreak is emergency response communication. The release of information from government agencies comes in part in the form of public health directives with protective actions for members of the public to stay safe. Effective communication affects the extent to which members of the public adhere to these directives, a crucial factor contributing to the success of emergency response efforts. Formative research about audiences and the communities where they live is an important step in the design and development of effective emergency risk communication strategies. While the literature offers evidence of the influence of individual beliefs and circumstances to inform communication efforts to encourage adherence to directives, the influence of community factors has only recently begun to be investigated. This report describes a formative research study that sought to assess individual and community factors that are likely to facilitate or hinder adherence to public health directives. The study explored a hypothetical emergency in-

volving the intentional release of *Yersinia pestis*, the bacterium that causes plague.

Our conceptual approach is shaped by the social ecological model, which suggests intertwined determinants of health outcomes at individual, interpersonal, and community levels and social structural factors.[1] Our focus lies with individual and community-level processes, keeping social structural influences in mind. Our work looks to social determinants scholarship for conceptual clarity in describing mechanisms linking community characteristics to health outcomes, contributing to concrete measurement, analysis, and causal claims in multilevel research.[2,3]

Past research provides evidence of the influence of individual-level factors on adherence to recommendations and directives during infectious disease outbreaks such as SARS. Studies have found that demographic characteristics affect adherence. For example, younger individuals,[4,5] those with low incomes, or members of ethnic minorities[6] are less likely to adhere to medication regimens. Psychosocial factors that have been found to increase ad-

FIGURE

Schematic Depiction of Model Tested in the Analysis.

Community factors:
 Social support and integration
  Community homogeneity
  Residential stability
 Poverty
  Neighborhood deprivation index

Individual factors:
 Demographics
 Location at time directive called
 Barriers
 Facilitators
 Communication factors

Adherence intention:
 10-h quarantine
 6-d quarantine
 Go to point of dispensing

herence include an adequate understanding of and reason for a directive[7-10]; understanding of the threat[9-11]; expectations that following a directive will protect individuals[8,11-14]; and high self-efficacy to carry out the directive.[15] Normative belief that others in the workplace or environment are participating in the directed behavior increases adherence.[16]

Research about public expectations for emergency response communication offers evidence suggesting that the public will follow directives if they receive ongoing, timely, and clear information about the threat and actions they can take to keep themselves and their loved ones safe; know their family is safe; and have confidence in agencies responding to the emergency.[17]

Recent studies have begun to explore and find evidence linking community-level constructs to adherence. The question of how community factors influence health behaviors and outcomes has emerged from the epidemiological study of social determinants.[2,18] Conceptually the field posits distinct influence of community characteristics above and beyond individual characteristics. A classic study found independent effects of neighborhoods (varying for example in level of average income) on health behaviors such as smoking and diet, controlling for individual co-variates such as household income, and education level using multivariate analytical methods.[19] The field has identified a variety of factors found to be associated with health outcomes, including economic disparity, social exclusion, job security, health transportation, and social support.[20] The challenge for research in this area has been for researchers to specify theoretical pathways of influence, enabling measurement and analytical strategies commensurate with the theory.[3] The complex and multifactorial influence of social and other environmental factors is exemplified in the model Social Determinants of Health and Environmental Health Promotion.[21] This model suggests that social and economic inequalities (fundamental factors) create spatial concentrations of poverty and ethnic groups in communities with limited access to resources, including public services available to respond to emergencies such as disease outbreaks. Communities with few re-

sources and services exhibit correspondingly greater stressors, and diminished social support and integration, influencing health behaviors. These constructs correspond to the adaptive capacities theorized as contributing to community resilience and improved outcomes following disasters.[22]

Researchers have also begun to explore the influence that social determinants and community characteristics have on adherence to public health directives. Past research has shown that adequate community resources, such as community organizations with local knowledge and links to health departments can ensure community-tailored emergency plans and increase public confidence and adherence.[23] Adherence to some directives such as evacuation requires community resources without which community members may be less able to adhere.[24]

Social support and integration may affect the likelihood of adherence through multiple pathways, for example, through social networks and normative processes. Belonging to a close-knit subculture enhances the odds of hearing, and subsequently following, a warning.[25] Other research found that a strong bond between community members[26,27] and reciprocity[28] makes adherence more likely. More homogeneous communities have higher levels of community values and belonging and higher rates of political participation and may be more likely to adhere to directives than more heterogeneous communities.[29,30] In addition, members of communities with higher residential stability have an increased feeling of belonging and a sense of community.[31]

In this preliminary exploration of influences of community factors on adherence to directives, we have sought to identify prominent factors that represent salient features of the complex pathways introduced in the literature and distilled into a parsimonious model (see Figure). Our model draws in large measure from prior formative qualitative research conducted by the authors[32] and from literature on individual- and community-level determinants of adherence and the social determinants literature. In our model, individual-level factors include demographic characteristics, circumstances when a directive is called, barriers to and facilitators of adherence, and communication variables. Community-level factors include poverty and social support and integration. We suggest that greater levels of poverty, operationalized as neighborhood deprivation, may decrease adherence to directives through diminished community services. In addition, enhanced social support and integration, operationalized as residential stability and ethnic homogeneity, may make adherence more likely through social networks or norms.

METHODS
Participants
An independent research company under subcontract conducted a random-digit dial survey to achieve a representative cross-section of residents of St Louis City and St Louis County, Missouri, from May 28 to June 22, 2008. Adults aged 18 years and older were considered eligible for the survey. Time of day and day of week were varied across call attempts to maximize

the opportunity for completing an interview. Interviews were conducted using a computer-assisted telephone interviewing system. Interviewers received written materials on the survey and formal training. A total of 1013 interviews were completed.

Measurements
Individual Measures
The survey instrument began with a brief description of a terrorist attack involving the intentional release and subsequent spread of the bacterium that causes plague. This topic was selected because the characteristics of the epidemiology and control of plague (person-to-person transmission, rapid treatment requirements, identification as a potential agent of bioterrorism) allowed for a robust exercise of potential community responses to a public health emergency. Similarities to other infectious diseases and consequently lessons learned are applicable for other scenarios (eg, pandemic influenza). The survey asked about three public health directives: six-day quarantine beginning at night, 10-hour quarantine beginning on a weekday morning, and going to a point of dispensing (POD) for prophylactic antibiotics. The directives were formulated to be realistic and clearly different from each other to enable the discovery of distinct determinants of adherence to a range of directives.

Participants were asked how likely they would be to adhere to the different directives. The six-day quarantine variable was measured using a four-point scale from "not at all likely" to "very likely" dichotomized to "very likely" and "not very likely" for analysis based on the distribution of participant responses. The 10-hour quarantine adherence was analyzed as a dichotomous variable compiled from three items on where the respondent was likely to be at 10 AM on a weekday (stay at home or not; stay at work or not; and stay put or try to go somewhere else). The POD adherence variable was developed from two questions: if participants themselves would go to a POD in the event of plague release and if they would take their family to the POD. The outcome was coded as a dichotomous variable (would take self or family to POD and would not take self or family to POD). (See eAppendix for the hypothetical scenario prompts and survey items.)

Participants were then asked about barriers to or facilitators of adherence to the different directives derived from the literature and from our prior qualitative research.[33] Barriers to the six-day quarantine included inadequate household supplies like food and medication or access to health care, and were measured on a four-point scale from "not at all likely" to "very likely." Facilitators of the six-day quarantine adherence included communication-related items such as access to news media and phone and Internet contact with family and friends. Two measures of determinants of the 10-hour quarantine asked about presence of children in the home and location at 10 AM (the time the directive was released). Items assessing barriers of POD adherence included inconvenience or fear of being exposed to infection. Measurements of communication factors potentially related to all three directives included reliance on media (TV, radio, or Internet), federal government (Centers for Disease Con-

trol and Prevention or Homeland Security), and local sources (public health officials, health care providers, or emergency responders) for information about the emergency, along with trust of local sources. Information source reliance and trust were measured on a four-point scale (not at all, a little, just some, and a lot) and were dichotomized to "a lot" and "not a lot" for analysis based on the distribution of participant responses; in most cases more than half of the participants chose the response category "a lot."

The survey included common demographic items: age, education, race, gender, household income, employment status, and children younger than 18 years old in the household. Age was measured in years on a continuous scale. Education was measured by category (none, less than high school, high school graduate, vocational school after high school, some college, college graduate, postgraduate training) and was entered as dummy variables representing each category of education, with none as the reference group. Race was measured and entered into the model in four categories: White, Black or African American, Asian, and Native American. Household income was measured in dollars and categorized as above or below $40 000 for analyses. Employment status was included in the models as full-time, part-time, or unemployed.

Community Factors
A distinct challenge to the conduct of multilevel studies incorporating community-level factors is matching measurement precisely to theoretical concepts.[3] Based on available resources and our survey design, we used a common strategy characterizing theoretically-conceived community factors via scales derived from 2000 Census data.[34-36] We used data aggregated at the level of the census tract matched to each survey respondent to represent communities where respondents lived. This approach makes multilevel analysis possible, in spite of the absence of community-specific observations, but introduces two important issues. First, census-level measures at best only partially approximate the rich theoretical ideas encompassed by concepts introduced by the social determinants literature. Second, census data do not characterize all pertinent or potential candidate concepts that a model such as social determinants introduces. In the case of this study, census-based measures were selected to capture poverty and social support and integration. Where available, we used validated measures. The first measure of social support and integration was community homogeneity, based on the idea that greater social support and integration will appear where residents are alike.[37] This measure was operationalized as ethnic homogeneity using the census item assessing percent African American.[38] We calculated homogeneity as the absolute value of the percent African American in the neighborhood less 50, resulting in a variable ranging from 0 to 50, where the highest numbers indicated ethnic homogeneity. It is important to note that St Louis is a highly segregated metropolitan area.

The second indicator of social support and integration was residential stability, as indicated by the census variable percent of residents living at their current residence five years prior to the census, based on the idea that neighborhoods with more established residents will exhibit more social support and integration. Researchers have established evidence of the effects of residential stability on health outcomes[39] or health-related behaviors.[35,40]

Our measure of poverty was the validated Neighborhood Deprivation Index (NDI).[41] The NDI is a standardized measure comprising eight census variables: percent of males in management and professional occupations, percent of population living in crowded housing, percent of households in poverty, percent of female-headed households with children, percent of households receiving public assistance, percent of households earning less than $30 000 a year; percent of population earning less than a high school diploma; and percent of the population who are unemployed.[41] A high NDI score signifies a higher level of deprivation. The NDI has been used to investigate the relationships between poverty and preterm births[42,43] and mobility disability in older adults.[44]

Analysis

To capture the relationship between individual-level and community-level factors and adherence to the three directives, a multilevel model was applied, using R-lme4.[45] Multilevel models are regression models that account for variance in an outcome (in this case, likelihood of adherence) explained by factors at different levels of analysis, such as the individual and community levels.[46]

Models were built for each of the three dichotomous adherence outcomes: adherence to a six-day quarantine (yes/no), adherence to a 10-hour quarantine (yes/no), and adherence to a POD directive (yes/no). We started with a null model (no predictors), added the individual-level variables into the model, and finally added community-level factors. The potential threat of colinearity of community factors was excluded as their correlations were all less than a standard cutoff of 0.8.[47,48] To account for gaps in coverage in the survey frame and ensure that our results were generalizable to the St Louis community, we used a model-based strategy to account for any differences between the sample and the population for gender, age, education, and race in all models.[49] Model fit was assessed by comparing Aikake Information Criterion (AIC) for the null, individual-level only, and full models. A lower AIC indicated a better fit, so the model with the lowest AIC for each outcome was retained and reported as the final model.[46]

Our analysis was of complete cases. Cases with missing data for the dependent and independent variables were compared to complete cases for each of the outcomes to determine if there were any important systematic differences that would reduce the generalizability of results. Although the majority of variables showed no difference between missing and complete cases, a few significant differences were identified. Average age and proportion of males and females were significantly different ($P < .05$) for missing and complete cases in all three models, with those having missing data being 8 to 10 years older on average and a smaller proportion of males than expected having missing data for each outcome. The six-day adherence showed a smaller than expected proportion of individuals with children at home and some college groups and a greater than expected proportion of individuals in the unable to get prescription drugs category. More unemployed individuals and people who would be home at 10 AM than expected had missing data for the 10-hour outcome. Finally, a lower proportion than expected of people with children at home and higher proportions of unemployed individuals and people who rely on media were missing values in the POD adherence model. Complete data were available for 82.2% of participants not missing the six-day quarantine outcome data (n = 767), 80.2% for the 10-hour model outcome (n = 737), and 81.9% for the POD adherence outcome (n = 716).

RESULTS

During data collection, 17 453 phone numbers were used. Of these, 10 130 were not eligible (eg, businesses, nonworking numbers, or no eligible respondent); eligibility was unknown for 3332 (no answer or always busy); an interview attempt was not completed for 2978 eligible households; 1013 interviews were completed. Using the American Association of Public Opinion Research Response Rate 3 formula (2008), the response rate for this study was 29.8%, and the cooperation rate was 41.3%.

Of the 1013 respondents, 936 had legitimate St Louis-area zip codes. Of these, 933 (99.7%) responded to the six-day quarantine question, 919 (98.2%) responded to the 10-hour quarantine question, and 874 (93.4%) responded to the POD adherence question. Table 1 shows the proportion of respondents adherent and nonadherent in each of the scenarios and the distribution of community-level and demographic characteristics in each of these groups. We found several significant associations between demographic characteristics and adherence. For the six-day adherence outcome, gender was associated with adherence, with a lower percentage of men reporting adherence. For the 10-hour quarantine, age, having children younger than age 18 years, employment status, and ethnicity were all significantly associated with the likelihood of adherence. Those who were more likely to adhere did not have children and were younger, not employed, and white. No demographic characteristics were significantly associated with POD adherence in bivariate analyses.

In the bivariate analysis, several barriers were significantly related to adherence to a six-day quarantine (see Table 2). Being home at 10 AM was significantly associated with the 10-hour quarantine. One barrier (ie, concern about waiting in long lines) was related to POD adherence. Reliance on media, government, and local sources was related to POD adherence but not to a six-day or 10-hour quarantine adherence.

A comparison of model fit for the six days outcome models for the null (AIC = 898.5), individual-level only (AIC = 740.7), and full models (AIC = 738.9) indicated that the full model was the best fit. The 10-hour outcome model fit for the null (AIC = 536.7), individual-level only (AIC = 403.1), and full models (AIC = 406.4) indicated that the individual-level model was the best fit. Finally, a comparison of model fit for the null (AIC = 916.7), individual-level only (AIC = 748.1), and full models (AIC = 752.7) for the POD outcome indicated that the individual-level model was the best fit. Table 3 displays model results for the best-fitting models for each outcome.

Individual-level barriers were significant predictors of adherence to six-day quarantine. The likelihood of adherence was reduced by about 37% for individuals anticipating a need for supplies (OR = 0.63; 95% CI: 0.47-0.84) and about 34% for those finding it difficult to stay home (OR = 0.66; 95% CI: 0.50-0.89). The likelihood of adherence was also reduced by about 29% for individuals reporting continued access to phone and Internet (OR = 0.71; 95% CI: 0.54-0.93). The NDI also predicted six-day quarantine adherence, with a one-unit increase

in the index reducing the likelihood of adherence by approximately 26% (OR = 0.74; 95% CI: 0.56-0.99). Finally, neighborhood homogeneity was a significant predictor of adherence, with a slight decrease in adherence as homogeneity increased (OR = 0.98; 95% CI: 0.96-1.00).

Significant predictors of adherence to the 10-hour quarantine were the individual-level factors of being home at 10 AM and having children younger than 18 years old. Being home at 10 AM increases the likelihood of adherence more than 8-fold (OR = 8.81; 95% CI: 3.01-25.81), while having children younger than 18 years old decreases the likelihood by more than half (OR = 0.45; 95% CI: 0.25-0.81).

POD adherence was predicted by believing there will be long lines at the POD and reliance on government sources of information. Those who felt they could rely on the government for information—specifically the websites of the CDC and Department of Homeland Security—were more than one and half times as likely to go to the POD as those who did not feel like they could rely on the government (OR = 1.59; 95% CI: 1.03-

TABLE 1

Neighborhood and Individual Demographic Characteristics With Adherence Outcomes

Characteristics	Adhere 6 d (n = 765)		Not Adhere 6 d (n = 168)		P	Adhere 10 h (n = 840)		Not Adhere 10 h (n = 80)		P	Self/Family to POD (n = 691)		Self/Family Not to POD (n = 184)		P
	Mean	SD	Mean	SD		Mean	SD	Mean	SD		Mean	SD	Mean	SD	
					Individual Demographic Characteristics										
Age	53.0	17.5	53.2	18.6	.88	45.4	14.5	53.8	17.6	<.01	51.4	16.3	52.9	17.9	.29
Education															
Less than high school	5	0.7	2	1.2	.92	8	1.0	0	0.0	.26	6	0.9	2	1.1	
Some high school	33	4.3	6	3.6		39	4.7	0	0.0		28	4.1	8	4.3	
High school	169	22.1	41	24.4		184	22.0	22	27.5		152	22.0	42	22.8	
Tech/vocational	13	1.7	4	2.4		17	2.0	0	0.0		10	1.4	4	2.2	.40
Some college	172	22.5	37	22.0		190	22.7	16	20.0		149	21.6	50	27.2	
College	198	26.0	45	26.8		215	25.7	23	28.8		181	26.2	48	26.1	
Graduate school	173	22.7	33	19.6		185	22.1	19	23.8		164	23.8	30	16.3	
Gender															
Male	329	43.0	89	53.0	.02	391	43.8	27	51.3	.22	306	44.3	88	47.8	.39
Female	436	57.0	79	47.0		501	56.2	15	48.8		385	55.7	96	52.2	
Children younger than 18 y															
Yes	252	32.9	114	68.3	.76	253	30.1	42	52.5	<.01	229	33.1	61	33.2	.88
No	513	67.1	53	31.7		587	69.9	38	47.5		461	66.7	123	66.8	
Employment status															
Full time	386	50.5	93	55.4	.18	410	48.8	59	75.6	<.01	363	52.8	90	49.2	
Part time	87	11.4	14	8.3		90	10.7	11	14.1		77	11.2	18	9.8	.46
Not at all	290	37.9	59	35.1		338	40.3	8	10.3		248	36.0	75	41.0	
Race															
White	563	75.5	116	73.0	.91	616	75.3	55	70.5	.03	504	74.4	129	72.9	
Black or African American	167	22.4	39	24.5		188	23.0	19	24.4		159	23.5	44	24.9	.84
Asian	11	1.5	3	1.9		9	1.1	4	5.1		10	1.5	2	1.1	
Native American	5	0.7	1	0.6		5	0.6	0	0.0		4	0.6	2	1.1	
Household income															
<$40 k	204	31.5	58	39.5	.05	237	33.3	19	27.5	.33	189	31.8	58	36.5	.27
$40 k+	444	68.5	89	60.5		475	66.7	50	72.5		405	68.2	101	63.5	
					Neighborhood Characteristics										
	Mean	SD	Mean	SD		Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Stability	57.0	10.5	55.8	9.0	.49	56.7	10.4	60.8	7.2	.03	56.9	10.0	57.6	11.3	.69
Capacity (NDI)	−0.01	1.0	0.1	1.1	.70	-0.02	1.0	0.2	1.1	.47	−0.02	1.0	−0.04	0.99	.88
Homogeneity	37.7	14.0	37.9	14.0	.95	37.6	14.1	41.2	9.8	.15	38.0	13.8	37.1	14.8	.70

Abbreviations: NDI, Neighborhood Deprivation Index; POD, point of dispensing.

TABLE 2

Barriers and Communication Sources Entered Into Each Model

	Adhere 6 d		Not Adhere 6 d			Adhere 10 h		Not Adhere 10 h			Adhere to POD		Not Adhere to POD		
	n	%	n	%	P	n	%	n	%	P	n	%	n	%	P
Barriers and Communication Sources															
Barriers to adherence															
May be unable to get needed drugs	242	31.6	63	37.5	.17										
Would be hard to stay home	222	29.0	76	45.2	<.01										
Financial problems in 6-d quarantine	219	28.6	65	38.7	.01										
Not enough supplies	270	35.3	89	53.0	<.01										
Would be home at 10 AM						415	50.8	402	49.2	<.01					
Worried about exposure to plague by others at POD											620	89.7	166	90.2	.73
In danger from others at POD											564	81.6	151	82.1	.62
Will have to wait in long lines at POD											403	58.3	121	65.8	.03
Worried about enough medicine at POD											556	80.5	135	73.4	.13
Reliance on and Trust of Communication Sources															
More likely to stay home if phone access	497	65.0	166	98.8	.60										
More likely to stay home if news	602	78.7	127	75.6	.33										
Would rely on media sources	696	91.0	152	90.5	.84	763	90.8	72	90.0	.78	639	92.5	161	87.5	.03
Would rely on government sources	542	70.8	109	64.9	.13	587	69.9	58	72.5	.66	499	72.2	114	62.0	.002
Would rely on local sources	681	89.0	146	86.9	.38	742	88.3	71	88.8	.99	620	89.7	155	84.2	.04
Trust local sources	459	60.0	104	61.9	.59	510	60.7	47	58.8	.66	433	62.7	102	55.4	.09

Abbreviation: POD, point of dispensing.

TABLE 3

Final Models Predicting the Likelihood of Adherence

	6 d[a] (n = 767) Full Model		10 h[a] (n = 737) Individual-Level Model		POD[a] (n = 716) Individual-Level Model	
Fixed Effects	aOR	95% CI	aOR	95% CI	aOR	95% CI
Individual characteristics						
Household income<$40k	1.35	0.82-2.22	1.12	0.55-2.31	1.06	0.66-1.69
Has children at home	1.29	0.82-2.03	0.45	0.25-0.81	0.89	0.57-1.39
Employed part time	1.42	0.72-2.82	0.65	0.29-1.45	1.01	0.55-1.88
Unemployed	1.45	0.87-2.22	1.21	0.40-3.72	1.06	0.65-1.73
Communication and barriers						
Would be home at 10 AM			8.81	3.01-25.81		
Would need access to drugs	1.09	0.85-1.39				
Would be hard to stay home	0.66	0.50-0.89				
Financial reasons for not staying home	0.97	0.74-1.28				
Would need supplies	0.63	0.47-0.84				
Access to phone at home	0.71	0.54-0.93				
Access to news at home	1.50	0.99-2.28				
Rely on the media	1.15	0.57-2.33	1.19	0.45-3.20	1.64	0.86-3.14
Rely on government	1.26	0.80-1.97	1.26	0.66-2.41	1.59	1.03-2.45
Rely on local sources	1.18	0.63-2.23	0.79	0.30-2.12	1.16	0.64-2.09
Trust local sources	0.82	0.55-1.25	1.41	0.79-2.50	1.18	0.80-1.76
Worried about others at the POD					0.97	0.44-2.14
It will be crowded at the POD					0.85	0.48-1.50
There will be lines at the POD					0.60	0.39-0.91
Community-level factors						
In residence since 1995	1.02	1.00-1.04				
Neighborhood deprivation index	0.74	0.56-0.99				
Homogeneity	0.98	0.96-1.00				

Abbreviation: POD, point of dispensing.
[a] Adjusted for education, age, gender, and race.

2.45). Individuals who were worried about long lines were about 40% less likely to go to a POD than those who were not worried (OR = 0.60; 95% CI: 0.39-0.91).

COMMENT

Our analysis sought to distinguish individual and community factors contributing to the likelihood of adherence to three possible and distinct public health directives released in the event of an infectious disease outbreak. Our research builds on prior research showing the influence of individual factors and a growing literature on community factors.

The proportion of participants who indicated that they would adhere to the directives was very high, with adherence to the six-day quarantine at 82%, the 10-hour quarantine directive at 91%, and the POD directive at somewhat lower at 79%. These generally high rates of anticipated adherence constrain our analysis, as little variability in participant-reported adherence is explained by individual or community factors.

Of special interest was the finding that the influence of community and individual factors on adherence varies substantially among the three directives. This study corroborates prior research showing the influence of individual-level factors on adherence. Also, we believe that our research breaks new ground in establishing evidence for the influence of community factors. Both social support and integration (operationalized as ethnic homogeneity) and poverty (operationalized as neighborhood deprivation) were associated with six-day quarantine adherence. Neither was associated with 10-hour quarantine or POD adherence.

Neighborhood deprivation was negatively correlated with adherence to six-day quarantine, showing that individuals living in poorer communities were less likely to adhere. This finding was above and beyond the individual-level barriers (ie, difficulty remaining at home for six days and not having sufficient supplies for the duration). According to our argument, living in communities with greater average wealth facilitates adherence to a long-duration quarantine, regardless of household supplies and perceived difficulty of staying put. The finding indicates a compound effect of barriers at the individual and community levels. This finding derives in part from the characteristic of the directive itself. Requirements in terms of supplies are greatest for the six-day quarantine, and community resources such as public services are most likely to make a difference and contribute to collective adherence. In terms of social determinants, a greater degree of poverty may constrain both built environment and social context, such as community resources and public services. Arguably then, it is through these pathways that poverty at the community-level limits intention to adhere to six-day quarantine, above and beyond individual-level or household barriers to adherence.

Contrary to expectations, ethnic homogeneity was negatively associated with adherence to six-day quarantine. We hypoth-

esized that homogeneity, representing social support and integration, would increase adherence via more integrated social networks and social norms. The small and marginally significant effect we found indicates that the influence may work in the opposite direction, for instance that the social norms run counter to directives. This unexpected result speaks to the need for further exploration of these pathways. Recent scholarship has found that hypersegregation exacerbates health disparities, for example, in preterm births.[50] St Louis has been identified as a hypersegregated city for decades.[51,52] Similarly, the result linking access to phone and Internet to nonadherence is counterintuitive and contrasts with our qualitative findings.[32]

No community factors predicted either 10-hour quarantine or POD adherence. Our findings illustrate the importance of circumstances for the short-duration quarantine directive, in terms of location at the time the directive is released and household makeup. Adherence to this short-term directive is less dependent on community resources or social network processes, so these individual circumstances trump community factors. No matter the level of social or community resources, individuals at home when a daytime short-term directive is called will be about nine times more likely to adhere than individuals traveling, running errands, or at work. Also, no matter the community, individuals with children in school will be less than half as likely to adhere as those without.

Finally, the determinants found for adherence to the POD directive offer ideas for how we might plan for such an eventuality. The two determinants found in the study were at the individual level: concern about lines was the sole barrier, and reliance on government, specifically federal sources of information, proved to be the sole communication factor that influenced adherence to any of the directives. This latter finding may be because the POD directive is the only one that depends exclusively on the capabilities of government agencies. It may not be surprising that individuals considering this directive might reflect on their experience with government services. Regardless of social support and community resources (including presumably publicly-provided services), individuals less concerned about inconvenience (long lines) and those indicating a greater reliance on government sources of information were more likely to adhere.

We conclude that the extent to which individual and community factors influence adherence depends on the nature of the different directives. Community characteristics mostly influence directives that last longest and require the greatest level of sacrifice. Directives that rely most on individual circumstances will be affected most by individual factors. Directives that depend most on government response will be influenced by a combination of individual factors, including reliance on government agencies. These findings suggest that we cannot anticipate a uniform response or set of determinants for different public health directives, and that we are best positioned when we can understand how the directives are distinct and

can anticipate how best to support individuals and communities that depend on those differences.

Concerns about measurement and analysis impose some limitations on the study. The limited duration of the survey limited the number of questions we could ask. It is not clear how participant worry would have contributed to our models; other research published after our data were collected found worry to be a major predictor of adherence.[53] We have a reasonable level of confidence in the face validity of the individual-level measures, but the measurement of community factors poses more difficult challenges. Community-level constructs comprise a broad and complex range of influences that potentially affect outcomes of interest. Measurement of community factors is problematic due in part to this complexity, and the difficulty of obtaining objective measures that effectively represent or match such complex ideas.

Measurement work for community factors is an active area of research in multilevel modeling and analysis.[18] Because individual assessment of community characteristics is considered unreliable, we did not include survey questions about community factors.[54] In our study, community factors were limited to census tract data. Census data bring both advantages and disadvantages. The first advantage is that they bring objective measures at a higher level of analysis—in our case, the census tract. They are easy to acquire and manipulate for inclusion in multilevel analyses of the kind that we conducted. Finally, they provide replicable measurements and scales for use across studies, as was the case with two of the three measurements we used. The major disadvantages of census data are that they only capture a portion of the conceptual richness of community factors; even then, at best they only approximately match a limited set of constructs. In addition, we relied on eight-year-old census data that may not reflect current neighborhood conditions.

The survey data may also have been systematically biased, limiting generalizability. Social desirability is a likely concern, especially in the estimates of likelihood of adherence. In addition, a few significant differences were found between individuals with complete data and those missing data in each of the models. The sample was drawn from an urban population in the Midwest. The estimates of adherence likelihood we calculated were high, based on our reading of the literature. In addition, the statistical approach was exploratory. We selected individual-level predictors based on bivariate analyses and selected our final model based on a measure of model fit. As the literature regarding adherence to emergency directives grows, we anticipate being able to specify models a priori rather than using this approach. Further research to explore such models with other populations is in order. Our findings indicate the potential for discerning pathways of influence from community characteristics on important health outcomes such as adherence to public health directives and the need for further work in operationalizing our theoretical ideas through our measurements.

CONCLUSIONS AND PRACTICAL IMPLICATIONS

The disparate results for the three directives investigated point to distinct recommendations for public health professionals and agencies. The six-day, or long-term, quarantine was the sole directive for which community factors were found to be influential. This finding suggests that special efforts are required to identify and provide support and resources to more deprived neighborhoods to enhance likelihood of adherence to long-term quarantine. A first priority action is a focus on underserved neighborhoods for preparedness planning efforts before event onset on the part of institutions such as employers and community-based organizations and government agencies such as public health and emergency responders. Emergency response agencies in partnership with community organizations will also need to identify and support individuals and households with fewer resources, especially food and medications, wherever they may reside. Populations such as the disabled and elderly, for example, will require and benefit from proactive and anticipatory response from community service organizations from private, not-for-profit, and public sectors alike.

To enhance adherence to a short-term daytime quarantine, preparedness officials must consider strategies to address two key findings: parents with children and location when a short-term quarantine is called. For example, preparedness professionals may work with schools and school districts to complete and publicize emergency preparedness plans. Our qualitative research suggested that if parents know about and are confident in the emergency planning at their children's schools, they may be less likely to breach quarantine directives. The preparedness community must also seek to identify locations where individuals are likely to be if they are not at home when a daytime quarantine is called (eg, at work). Adherence may be enhanced if agencies work with employers to prepare emergency shelter contingency plans and ensure adequate food, water, and other needed supplies. Separate instructions will be needed for individuals who are traveling, depending on whether they are near their residence or farther from home.

To enhance adherence to the POD directives, logistics will be an important factor for the public. Our data indicate that individuals less likely to rely on government sources will be less likely to adhere. Public communication providing clear explanations and instructions for using the POD may alleviate concerns about inconvenience and safety.

In each instance noted here, our data indicate that a priority must be placed in adapting public communication about each directive for members of the public, depending on their personal and household circumstances and where they live. The data do not indicate how messages should be crafted or what channels should be used to reach these individuals. For these aspects, we refer the interested reader to other literature providing useful guidelines.[17,55]

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