Differential Willingness to Undergo Smallpox Vaccination Among African-American and White Individuals

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OBJECTIVE: To examine potential disparities in willingness to be vaccinated against smallpox among different U.S. racial/ethnic groups.

DESIGN: Cross-sectional survey using an experimental design to assess willingness to be vaccinated among African Americans compared to whites according to 2 strategies: a post-exposure "ring vaccination" method and a pre-exposure national vaccination program.

SETTING: Philadelphia County district courthouse.

PARTICIPANTS: Individuals awaiting jury duty.

MEASUREMENTS: We included 2 scenarios representing these strategies in 2 otherwise identical questionnaires and randomly assigned them to participants. We compared responses by African Americans and whites.

MAIN RESULTS: In the pre-exposure scenario, 66% of 190 participants were willing to get vaccinated against smallpox. In contrast, 84% of 200 participants were willing to get vaccinated in the post-exposure scenario ($P = .0001$). African Americans were less willing than whites to get vaccinated in the pre-exposure scenario (54% vs 77%; $P = .004$), but not in the post-exposure scenario (84% vs 88%; $P = .56$). In multivariate analyses, overall willingness to undergo vaccination was associated with vaccination strategy (odds ratio, 3.29; 95% confidence interval, 1.8 to 6.1).

CONCLUSIONS: Racial disparity in willingness to get vaccinated varies by the characteristics of the vaccination program. Overall willingness was highest in the context of a post-exposure scenario. These results highlight the importance of considering social issues when constructing bioterror attack response plans that adequately address the needs of all of society's members.

KEY WORDS: prevention; public health; vaccinations; smallpox; African Americans.

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widely discussed strategies to reduce the impact of bioterrorism involve vaccination programs against terror agents such as smallpox^{1,2} and anthrax.^{3,4} The success of any vaccination program depends upon the willingness of members of the general public to undergo vaccination.

Willingness to undergo vaccination among the general public may depend upon the specifics of the vaccination program. Among the strategies proposed in the case of smallpox, 2 have received considerable early attention: the "ring vaccination" method and a pre-attack, nationwide vaccination campaign.⁵⁻¹⁰ In a ring vaccination-type strategy, people having come within some range of an individual known to have contracted smallpox will be immunized and followed for disease, as will families and close contacts of contacts.^{11,12} The ring vaccination strategy conserves vaccine resources and minimizes vaccine side effects, but risks considerable smallpox mortality in the event of a widespread outbreak. Another option that received early attention was a voluntary nationwide immunization program prior to an outbreak.¹³⁻¹⁵ Pre-exposure, nationwide immunization has the advantages of minimizing smallpox mortality in the event of a terrorist attack but raises concerns about incurring potentially unnecessary vaccination-related risks.

Widespread racial disparities in health care and the history of lower rates of preventive care among minority populations raise the concern that willingness to undergo vaccination against bioterror agents may also be lower among minority groups.¹⁶⁻²⁰ Lower vaccination rates among minorities could result in a disproportionate burden of disease among minority populations, potentially even leading to the overall failure of vaccination programs. Understanding how uptake of vaccination may vary by vaccination strategy or by sociodemographic groups may inform the development of equitable and effective vaccination policies. Thus, the goal of this study was to assess whether willingness to be vaccinated against smallpox among the general public differed according to race or vaccination strategy.

METHODS

We conducted a cross-sectional survey using an experimental design to assess willingness to be vaccinated against smallpox according to 2 alternate strategies: 1) a nationwide vaccination strategy, prior to any exposure to the disease; and 2) a simplified ring vaccination program, in the event of outbreak and exposure to the disease. Two separate scenarios were developed to represent these 2 strategies: 1) "Recent acts of terrorism have made a lot of people think about everyone in the country getting a shot to prevent smallpox (known as a smallpox vaccine).

The threat of bioterrorism brings a new perspective to the problem of preventive care utilization. Several

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Would you be willing to be vaccinated against smallpox?" (pre-exposure); and 2) "Recent acts of terrorism have made the government and health care system develop plans to give a shot to prevent smallpox (known as a smallpox vaccine) in case people are exposed to smallpox or someone with smallpox. If you were told that you had been exposed to smallpox, would you be willing to be vaccinated against smallpox?" (post-exposure). This scenario did not include vaccination of the contacts of contacts, in order to maximize participant comprehension at all levels of educational attainment. Neither scenario provided information about possible vaccination side effects. Response items were yes, no, and not sure. A follow-up question asked about locations where participants would be willing to get the vaccine, with options of "my personal doctor's office," "government vaccination programs," "community center," and "free clinic," with participants asked to check all that applied. These sites were selected based on common locations where individuals may receive the influenza vaccine. We used a "between-subject" rather than a "within-subject" design because of concerns that inclusion of both scenarios in one survey would bias responses or confuse subjects. In addition, the questionnaire assessed basic sociodemographic characteristics, including race/ethnicity, age, gender, and education. Education measurement included the following categories: less than high school diploma, high school diploma, some college, college, some graduate school, graduate school, graduate degree, and other.

Study participants were recruited from individuals awaiting jury duty at the Philadelphia County courthouse and were randomly assigned to 1 of the 2 questionnaire versions. In Philadelphia, individuals are selected as prospective jurors through township driver's license and voter registration records. At the time, all prospective jurors were assembled in a single room; a research assistant made an announcement about the survey and randomly distributed questionnaires to volunteers. Courthouse restrictions on factors that might potentially bias jurors prevented our calculating a precise response rate. However, based on cumulative experience, we estimate that 70% of prospective jurors volunteered to participate and over 90% of indi-

viduals who volunteered completed the questionnaires. We compared our sample to Philadelphia census data²¹ to confirm that the sample was representative of the general population. Data were collected in late December 2001.

All data were examined using descriptive statistics. Because the number of individuals in racial/ethnic groups other than African Americans and whites was small, we restricted our analyses to these 2 groups. Willingness to undergo vaccination (yes vs no/not sure) was compared between scenarios using the Pearson χ^2 test. The association between sociodemographic characteristics and willingness was assessed within each scenario using the *t* test for continuous variables (e.g., age) and χ^2 tests for categorical variables (e.g., race and ethnicity). We used logistic regression to evaluate the independent contributions of variables to willingness to be vaccinated while controlling for covariates and to test for potential interactions between scenario type. Variables were retained in the regression model if they altered the coefficient for the primary predictor of interest by >15% or were specified *a priori* (e.g., education). Similar analyses were conducted to assess the correlates of willingness to be vaccinated at particular locations within the subgroup of participants who reported being willing to undergo vaccination. All *P* values are two-sided; *P* < .05 was considered statistically significant. For the comparison of willingness to undergo vaccination between African Americans and whites in the overall sample, the sample size provided over 80% power to detect a risk ratio of 0.8 or lower.

RESULTS

Of the 390 participants, 190 received the pre-exposure national vaccination program scenario and 200 received the post-exposure ring vaccination scenario. A comparison of the sample demographics to the demographics of residents of Philadelphia County²¹ is reported in Table 1.

Willingness to be vaccinated varied by scenario. In the context of a national vaccination program without prior exposure to smallpox, 66% of participants were willing to get vaccinated. In contrast, 84% of participants were willing

Table 1. Sample Comparison, Overall and by Scenario, to Philadelphia County Census Data

	All Subjects (N = 390)	Pre-exposure Scenario (N = 190)	Post-exposure Scenario (N = 200)	Philadelphia County Census Data
Mean age, y $\pm$ SD	41.3 $\pm$ 13.5	41.8 $\pm$ 13.8	40.9 $\pm$ 13.2	41.3
Race, %				
African American	42.6	40.9	44.1	43.2
White	45.4	47.7	43.2	45.0
Other*	12.0	11.4	12.7	11.8
Male, %	36.0	34.1	40.1	33.6
Education, %				
Some college or less	70.8	67.6	73.2	77.7
College or higher	29.2	32.4	26.8	22.3

* The category "other" includes Asian Americans, Hispanics, Native Americans, Pacific Islanders, and those who categorized themselves as belonging to an unspecified ethnic category.

Table 2. Willingness to Be Vaccinated Against Smallpox According to Scenario

	Pre-exposure			Post-exposure		
	Yes	No/Not Sure	P Value	Yes	No/Not Sure	P Value
African American, %	37.0	62.0	.004	47.8	54.4	.56
Some college or less, %	59.6	66.1	.42	62.5	64.5	.83
Mean age, y $\pm$ SD	41.3 $\pm$ 13.7	42.4 $\pm$ 14.0	.63	41.1 $\pm$ 13.3	40.4 $\pm$ 12.7	.81
Male, %	36.4	31.5	.53	36.5	43.3	.48

to get vaccinated in the post-exposure ring vaccination scenario ($\chi^2 = 14.9$; $P = .0001$). Factors associated with willingness to be vaccinated also varied between the 2 scenarios (Table 2). In the pre-exposure scenario, 54% of African-American participants were willing to get vaccinated, compared to 77% of white participants ($\chi^2 = 8.41$; $P = .004$). In contrast, in the post-exposure scenario, there was no significant difference between African Americans and whites in willingness to be vaccinated (84% vs 88%, respectively; $\chi^2 = 0.35$; $P = .56$). Age, education, and gender were not significantly associated with willingness to undergo vaccination in either scenario (all P values $> .18$). In multivariate analyses adjusting for age, education, and gender, overall willingness to undergo vaccination was associated with vaccination strategy (odds ratio [OR], 3.29; 95% confidence interval [CI], 1.8 to 6.1). The effect of race on willingness continued to differ by vaccination strategy, with a greater effect in the pre-exposure scenario (OR, 0.13 for African American vs white) than in the ring vaccination scenario (OR, 0.35 for African American vs white); $P = .03$ for interaction.

Among the 280 respondents who reported being willing to get a smallpox vaccine, the proportion willing to get vaccinated at a specific location ranged from 87% at their personal doctor's office to 26% at a community center. Fifty percent of respondents reported being willing to be vaccinated at a local hospital, 32% at a government program, and 29% at a free clinic. Overall, 18% of respondents were willing to get vaccinated at all 5 locations, 33% at between 2 and 4 locations, 48% at only 1 location (81% of which

were personal doctor's offices), and 1% of respondents did not select any of the locations. Location preference was associated with race but not with vaccination strategy (Table 3). In univariate and multivariate analyses, African-American respondents were significantly less likely to be willing to get vaccinated at a government program (OR, 0.32; $P = .001$), hospital (OR, 0.40; $P = .002$), or doctor's office (OR, 0.41; $P = .05$) but not at a community center (OR, 0.75; $P = .40$) or free clinic (OR, 1.24; $P = .50$). The association between African-American race and location preference did not differ significantly by version (all P values $> .1$).

DISCUSSION

Given recent concerns about bioterrorism, willingness to be vaccinated against smallpox has become an important public health issue. This study suggests that most members of the general public would be vaccinated in a pre-exposure (nationwide vaccination program) strategy, but that willingness to be vaccinated against smallpox would be greater in a post-exposure (modified ring vaccination) program. The type of vaccination program also had a significant effect on potential racial disparities in vaccination, with greater disparities in the pre-exposure than post-exposure scenario. Racial disparities were also found in the types of locations where members of the general public were willing to get vaccinated, with significant disparities for locations such as government programs and hospitals but not for locations such as community centers and free clinics.

These results extend the findings of a recent national random digit dialing survey of attitudes about smallpox vaccination.²² In that survey, 61% of respondents would undergo smallpox vaccination as a "precaution against a terrorist attack" and 88% would undergo vaccination if "cases were reported in the respondent's community," similar to our findings of 66% in a pre-exposure scenario and 84% in a post-exposure scenario. However, the prior survey did not explicitly examine racial differences in willingness to undergo vaccination or in the locations where members of the general public would be willing to go to get vaccinated.

Although pre- and post-exposure scenarios differ in several ways, 2 critical differences are how immediate the threat of smallpox is and how likely one is to benefit from vaccination. It is not surprising that across all subjects,

Table 3. Associations Between African-American Race and Willingness to be Vaccinated at Alternative Locations*

	African American Versus White		
	OR	95% CI	P value
Government program	0.32	0.16 to 0.62	.001
Hospital	0.40	0.22 to 0.72	.002
Doctor's office	0.41	0.16 to 1.00	.05
Community center	0.75	0.38 to 1.47	.40
Free clinic	1.24	0.66 to 2.03	.50

* Adjusted for age, gender, education, and version using logistic regression.

OR, odds ratio; CI, confidence interval.

willingness to be vaccinated was higher in the post-exposure scenario; the proximity of a threat may increase the likelihood of response to it. Furthermore, the absolute benefit of vaccination increases as the risk of disease increases.

There are several potential explanations for the variation in racial difference in willingness to undergo vaccination. It has been suggested that African Americans have a greater focus on the present than whites,²³⁻²⁵ a difference that might lead to a relatively greater interest in vaccination when the threat of disease is more immediate (the ring vaccination scenario) than when it is more distant (the pre-exposure scenario). The variation may also represent a difference between African Americans and whites in health beliefs specific to vaccination or smallpox.²⁶⁻²⁹ Distrust of the health care system has also been suggested to affect African Americans' medical decision-making strategies in various health care arenas and may influence willingness to follow recommendations for precautionary vaccination as well as their willingness to get vaccinated at hospitals and government programs.³⁰⁻³⁵ African-American participants may be less likely to have a personal doctor. The lack of significant racial difference in willingness to get vaccinated at community centers or free clinics may reflect greater familiarity with these facilities among African-American participants. It is important to note, however, that overall a much higher proportion of African-American participants (81%) were willing to get vaccinated in their personal doctor's office than were willing to get vaccinated in a free clinic (21%) or community center (19%).

This study has several limitations. Neither a governmental nor health care system role in a vaccination program is stated explicitly in the pre-exposure question, as they are in the post-exposure question. It is possible that the differential willingness demonstrated between scenarios is magnified by this difference. In addition, we measured only hypothetical intentions, not actual behavior. Although the connection between intentions and behavior is imperfect, measuring actual use of smallpox vaccine is not feasible at this time. Finally, our study sample, while sociodemographically diverse, is drawn from a single metropolitan area and may not have yielded results that are generalizable to the rest of the country. However, as noted above, our findings replicate a recent public opinion poll.²²

Willingness to vaccinate may vary by race and the characteristics of the vaccination program. These results highlight the importance of considering not only technical and medical issues but also social issues when constructing bioterror attack response plans that adequately address the needs of all of society's members.

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