Effective Messages in Vaccine Promotion: A Randomized Trial

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KEY WORDS

vaccines, myths, MMR, autism, false, misperceptions, misinformation

ABBREVIATIONS

aOR—adjusted odds ratio
CDC—Centers for Disease Control and Prevention
MMR—measles-mumps-rubella

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WHAT'S KNOWN ON THIS SUBJECT: Maintaining high levels of measles-mumps-rubella immunization is an important public health priority that has been threatened by discredited claims about the safety of the vaccine. Relatively little is known about what messages are effective in overcoming parental reluctance to vaccinate.

WHAT THIS STUDY ADDS: Pro-vaccine messages do not always work as intended. The effectiveness of those messages may vary depending on existing parental attitudes toward vaccines. For some parents, they may actually increase misperceptions or reduce vaccination intention.

abstract

OBJECTIVES: To test the effectiveness of messages designed to reduce vaccine misperceptions and increase vaccination rates for measles-mumps-rubella (MMR).

METHODS: A Web-based nationally representative 2-wave survey experiment was conducted with 1759 parents age 18 years and older residing in the United States who have children in their household age 17 years or younger (conducted June–July 2011). Parents were randomly assigned to receive 1 of 4 interventions: (1) information explaining the lack of evidence that MMR causes autism from the Centers for Disease Control and Prevention; (2) textual information about the dangers of the diseases prevented by MMR from the Vaccine Information Statement; (3) images of children who have diseases prevented by the MMR vaccine; (4) a dramatic narrative about an infant who almost died of measles from a Centers for Disease Control and Prevention fact sheet; or to a control group.

RESULTS: None of the interventions increased parental intent to vaccinate a future child. Refuting claims of an MMR/autism link successfully reduced misperceptions that vaccines cause autism but nonetheless decreased intent to vaccinate among parents who had the least favorable vaccine attitudes. In addition, images of sick children increased expressed belief in a vaccine/autism link and a dramatic narrative about an infant in danger increased self-reported belief in serious vaccine side effects.

CONCLUSIONS: Current public health communications about vaccines may not be effective. For some parents, they may actually increase misperceptions or reduce vaccination intention. Attempts to increase concerns about communicable diseases or correct false claims about vaccines may be especially likely to be counterproductive. More study of pro-vaccine messaging is needed. *Pediatrics* 2014;133:1–8

The measles-mumps-rubella (MMR) vaccine has attracted extensive attention in recent years owing in large part to discredited claims about its safety[1] that circulate widely among anti-vaccination activists and Web sites.[2–6] Although US MMR vaccination rates for children ages 19 to 35 months exceeded the *Healthy People 2020* target of 90% in the 2011 National Immunization Survey, 15 states had rates below that threshold.[7] Some areas have even lower immunization rates owing to clustering of unvaccinated or under-vaccinated children.[8,9] Moreover, the prevalence of concerns about the vaccine,[10,11] requests for exemptions from vaccination requirements,[9] and use of alternative schedules[12,13] suggest reason for concern about future MMR vaccination rates. For instance, parents who follow alternative schedules are more likely to refuse or delay MMR,[13,14] which is associated with increased measles risk.[15]

Maintaining high levels of MMR immunization is thus an important public health priority, especially given the increased number of measles cases observed recently in the United States.[16] The public health consequences of MMR noncompliance can also be seen in the recent measles epidemic in the United Kingdom, which infected more than 1000 people and prompted a massive vaccination campaign by public authorities.[17,18]

Given these concerns, how should physicians and public health agencies respond to parental questions about vaccine safety? This question is difficult to answer. For instance, while some have advocated that health professionals engage in dialogue with vaccine-hesitant parents,[19–21] relatively little is known about which messages are effective in overcoming parental reluctance to vaccinate.

In particular, some pro-vaccine messages may do more harm than good, especially those targeting misinformation, which is often difficult to correct.[22–24] The problem is that people often interpret evidence in a biased fashion.[25–28] As a result, corrective information about controversial issues may fail to change factual beliefs or opinions among respondents who are most likely to be misinformed.[22,29] In some cases, corrections can even make misperceptions worse.[22] Resistance to scientific evidence about health risks is also a serious concern.[30–32] It is therefore important to determine whether corrective information about MMR and other vaccines provokes a similar response. We hypothesize that respondents with the least favorable vaccine attitudes will increase their belief in false claims and decrease their intent to vaccinate in response to corrective information.

A more effective approach than describing the safety of vaccines may be to highlight risks from disease. Messages describing potential dangers put individuals into the "domain of losses," which should make them more tolerant of perceived risks than messages about the benefits of vaccines.[33] Despite significant interest in applying this approach to health,[34] only a handful of experiments have done so for vaccines.[35–38] In addition, there are many ways to communicate such dangers, including text, visuals, and narrative accounts. The relative merits of these approaches for vaccine promotion are not clear, especially given the risk that fear appeals or disturbing messages will backfire.[39,40]

In this study, we present results from a nationally representative experiment testing 4 informational approaches to encouraging MMR vaccination among parents. We evaluate the effects of these messages relative to a no-information control condition.

METHODS

Data Collection/Sample

Respondents were drawn from a nationally representative Knowledge Networks online panel recruited via random digit dialing and address-based sampling from a population probability sample.[41] The data come from online interviews with parents (age 18 years and older) with 1 or more children aged 17 years or younger living in their household. The first wave of the study was completed by 2471 respondents out of 4462 who were sampled (response rate, 55.4%). Among those, 2299 qualified for inclusion in the study (93.0%). We then re-contacted all eligible respondents from Wave 1. A total of 88% of those contacted (N = 1759) completed Wave 2. Our sample for analysis consisted of the 1759 participants who completed both waves of the study. The first wave was conducted June 10 to 23, 2011 and the second was conducted June 22 to July 5, 2011. The median number of days between waves was 12 (range, 1–22).

Study Design

The study was conducted as a 2-wave online panel. In the first wave, respondents completed pre-intervention measures of health and vaccine attitudes, which were asked in a separate wave to avoid directly affecting their responses during the second wave. We first asked a series of questions about the health status of their children. Respondents then answered 8 agree/disagree questions about attitudes toward vaccines from a previous study, which were averaged as a pre-intervention measure of vaccine attitudes.[11] Respondents were also asked if they have ever delayed or refused a recommended vaccine, how important vaccines are to them personally, and how much trust they place in various health professions and institutions.

In the second wave of the study, respondents were randomly assigned by the survey software to receive 1 of 4 pro-vaccine messages or a control message. Subjects were unaware of the other experimental conditions; researchers were blind to assignment until data were delivered. After the experimental manipulation, we then asked a series of questions designed to assess misperceptions about MMR, concerns about side effects, and intent to give MMR to future children.

Experimental Intervention

We tested the effectiveness of providing information about the safety of the MMR vaccine or the danger of contracting MMR. We specifically tested 4 strategies commonly used by public health agencies to promote vaccination: (1) correcting misinformation, (2) presenting information on disease risks, (3) using dramatic narratives, or (4) displaying visuals to make those risks more salient or accessible. To maximize the realism of our experimental stimuli, each of the first 3 interventions uses text adapted nearly verbatim from Centers for Disease Control and Prevention (CDC) materials. The first, "Autism correction," presented scientific evidence debunking the vaccine/autism link using language drawn nearly verbatim from the MMR vaccine safety page on the CDC's Web site.[42] The second intervention, "Disease risks," described symptoms and adverse events associated with MMR using text adapted nearly verbatim from the CDC's MMR vaccine information statement.[43] The third intervention, "Disease narrative," uses a CDC narrative of a mother recounting her infant son's hospitalization with measles.[44] The fourth intervention, "Disease images," presents parents with pictures of a child who has each disease.[45] Results from these interventions were contrasted with those obtained in the control condition ("Control"), which consisted of a text about the costs and benefits of bird feeding. (The interventions are presented in the Supplemental Information.)

Outcome Measures

There are 3 key outcome measures. First, we evaluated general misperceptions about vaccines causing autism ("Vaccines cause autism") by asking whether respondents agree or disagree that "some vaccines cause autism in healthy children" on a 5-point scale. The MMR side effects question ("MMR side effects") asked about the perceived likelihood that children "will suffer serious side effects" from MMR on a 6-point scale. Finally, the vaccination intent question ("MMR for next child") asked how likely they would be to give MMR to a future child on the same 6-point scale. (Note: This measure only captures self-reports of future MMR intent, not other forms of resistance such as delaying vaccination or using alternate schedules.)

Statistical Analysis

The data are analyzed by using ordered logistic regression in Stata 11 (Stata Corp, College Station, TX). We estimate the effects of assignment to each intervention condition ("intention to treat") for 3 key outcome measures, "Vaccines cause autism," "MMR side effects," and "MMR next child," by using indicators for the different interventions and preintervention indicators of respondents' attitudes toward vaccines (by tercile). Because our survey experiment is a randomized controlled trial, we can interpret the effects of the interventions in causal terms. Our statistical models account for respondent attitudes toward vaccines by also including indicators for the third of the sample with the most favorable attitudes toward vaccines (mean response of 4.4 on a 1–5 scale) and the middle third of the sample, which we describe as having somewhat favorable attitudes toward vaccines (mean of 3.8). (The third with the least favorable attitudes [mean of 3.0] is the omitted category.) To determine if intervention effects vary due to vaccine attitudes, we also test for statistical interactions between vaccine attitude groups and intervention indicators. When significant interactions are found, we present separate estimates of the effect of the interventions for each group. We also estimate adjusted Wald tests of the joint significance of the disease risk interventions to assess their effects as a group. Tabular results are presented as adjusted odds ratios (aORs) with 95% confidence intervals; we also present predicted probabilities in graphical form.

The University of Michigan's Health and Behavioral Sciences Institutional Review Board classified this study as exempt (registration number: IRB00000246). All participants provided informed consent before taking part. No adverse events were reported.

RESULTS

Table 1 presents sample demographics, which were weighted to represent the population of parents with children younger than age 18 years at home in the Knowledge Networks panel.

Because the panel is recruited via random probability sampling, our weighted sample should represent the national population of parents with children age 0 to 17 years living at home (for instance, the distribution of demographic variables are consistent with population norms). As such, we can directly extrapolate our findings to the national population.

Response to Pro-Vaccine Messages

We first examined the outcome measures that assess misperceptions about the disproven vaccines–autism link ("Vaccines cause autism") and the likelihood of serious side effects from MMR ("MMR side effects"). Although "Autism correction" was the only intervention that directly addressed such concerns, the disease risk interventions might have heightened parents' concerns or risk sensitivity. Table 2 presents ordered

TABLE 1 Sample Demographics

	Wave 1	Wave 2	Wave 2 by Experimental Condition				
			Disease Risks	Autism Correction	Narrative Danger	Disease Images	Control
Sex, %							
Female	55	56	50	58	53	58	59
Male	45	44	50	42	47	42	41
Race/ethnicity, %							
White	62	62	68	65	53	61	67
Black	12	12	9	14	19	9	7
Hispanic	19	19	16	16	22	20	21
Other	4	4	5	4	4	6	3
Multiracial	3	3	3	1	3	4	2
Education, %							
Not a high school graduate	13	14	13	12	15	6	21
High school graduate	27	26	25	24	28	27	25
Some college	29	29	31	28	25	33	28
College graduate	31	31	31	35	31	34	25
Household income, %							
Less than $30 000	30	30	25	28	34	27	37
$30 000–$59 999	25	24	28	24	21	23	25
$60 000–$99 999	25	25	26	23	27	28	22
$100 000+	21	20	21	24	17	22	16
Age, %							
Younger than 30 y	20	20	21	18	20	22	20
30–40 y	40	39	38	39	39	39	40
41 y and older	41	41	40	43	41	39	40
Region, %							
Northeast	16	16	18	20	14	15	16
Midwest	22	22	22	27	21	22	18
South	37	37	35	33	42	36	38
West	25	25	25	20	23	27	28
Number of children in household, %							
1	39	39	35	41	40	38	42
2	40	39	46	39	38	42	32
3	15	15	14	13	15	12	18
4	5	5	4	6	4	5	6
5	1	1	1	—	2	2	2
6	<1	<1	—	<1	<1	1	<1
7+	<1	<1					
Refused, %	<1	—					
N	2229	1759	337	340	371	337	374

Sample statistics are computed by using weights calculated by Knowledge Networks[41]; weights are calculated separately for each wave so that the sample reflects the population of parents of children age 0 to 17 y from the Knowledge Networks panel. Due to rounding, some percentages may not add to 100%. The number of children in household was only asked in wave 1; the proportions listed for wave 2 reflect answers from wave 1 among those who completed both waves of the survey. Pearson's χ^2 is non-significant for differences across intervention groups after a Bonferroni correction for multiple comparisons.

logistic regression models of the effect of the interventions on MMR misperceptions.

The "Autism correction" intervention successfully reduced agreement that "some vaccines cause autism in healthy children" (aOR = 0.55; 95% CI, 0.38–0.79). However, it did not significantly reduce concerns about MMR side effects. "Disease risks," which provided information about symptoms and adverse events from MMR, did not have a significant effect on either "Vaccines cause autism" or "MMR side effects." "Disease narrative," which recounts a mother's story of her infant son's hospitalization with measles, actually increased beliefs in the likelihood of serious side effects from MMR (aOR = 1.92; 95% CI, 1.33–2.77), allowing us to reject the null that the risk interventions had equal effects ($F(2, 1744) = 7.98$, $P < .01$). Likewise, whereas "Disease images" did not have a significant effect on "MMR side effects," it did increase beliefs that vaccines cause autism (aOR, 1.47; 95% CI, 1.02–2.13), although the effect was not distinct from the other risk interventions ($F(2, 1734) = 0.96$, not significant).

We could not reject the null hypothesis that intervention effects do not vary by vaccine attitude group for any intervention on "Vaccines cause autism" or "MMR side effects." We thus do not estimate the effects of the treatments separately by vaccine attitude group in Table 2. We also could not reject the null hypothesis that the effects of the 3 risk interventions were jointly 0 for "Vaccines cause autism." However, we found that they were jointly significant for "MMR side effects" owing to the "Disease narrative" effect described above ($F(3, 1743) = 6.17$, $P < .01$). (In addition to these results, pre-specified interactions between the interventions and measures of trust in health professions and institutions were not consistently significant.)

Figure 1 summarizes the effects of the interventions on vaccine misperceptions for a respondent in the least favorable vaccine attitude group using predicted probabilities from Table 2.

"Autism correction" is most effective in reducing agreement with the autism misperception. Strong agreement declines from a predicted probability of 8.9% to 5.1% (and likewise for other response options). By contrast, the predicted probability of strong agreement increases to 12.6% for "Disease images." Similarly, the predicted probability of believing serious side effects from MMR are very likely increased from 7.7% among control subjects to 13.8% in the "Disease narrative" condition.

Table 3 presents ordered logistic regression models examining how the interventions affect participants' intent

TABLE 2 Effects of Interventions on MMR Misperceptions

	Vaccines Cause Autism	MMR Side Effects
Autism correction	0.55* (0.38–0.79)	0.81 (0.57–1.15)
Disease risks	1.15 (0.79–1.67)	0.93 (0.65–1.35)
Disease narrative	1.35 (0.91–2.01)	1.92* (1.33–2.77)
Disease images	1.47* (1.02–2.13)	1.18 (0.82–1.69)
Somewhat favorable toward vaccines (baseline: least favorable)	0.22* (0.16–0.30)	0.49* (0.37–0.6)
Most favorable toward vaccines (baseline: least favorable)	0.06* (0.04–0.08)	0.23* (0.17–0.31)
N	1736	1746

Ordered logit models with coefficients expressed as aORs and 95% confidence intervals in parentheses (cutpoints omitted; $*P < 0.05$). "Vaccines cause autism" measures agreement on a 5-point scale from "Strongly disagree" (1) to "Strongly agree" (5) to the statement "Some vaccines cause autism in healthy children." "MMR side effects" measures responses on a 6-point scale from "Very unlikely" (1) to "Very likely" (6) to the question "Just based on what you know, how likely is it that children who get the measles, mumps, and rubella vaccine, which is known as the MMR vaccine, will suffer serious side effects?" The experimental interventions are provided in the Supplemental Information.

to vaccinate future children ("MMR next child"). The model in the left column of Table 3 estimates the effects of the interventions for the full sample. We then estimate separate models by vaccine attitude group to investigate how the effects of the interventions vary depending on respondents' pre-existing attitudes. (Results from a model with vaccine attitude/intervention interactions are virtually identical; we report separate models to ease interpretation.)

The model estimated among all respondents indicates that "Autism correction" resulted in parents reporting they would be less likely to vaccinate future children (aOR = 0.52; 95% CI, 0.32–0.84). No other intervention significantly increased intent to vaccinate. Likewise, we cannot reject the null hypothesis that the joint effects of the risk interventions are 0. When we estimate the model separately by vaccine attitude group, we observe that the negative effects of "Autism correction" on "MMR next child" were concentrated among respondents with the least favorable vaccine attitudes (aOR = 0.36; 95% CI, 0.20–0.64). By contrast, the effects of "Autism correction" on intent to vaccinate were positive among respondents with more favorable attitudes, although not statistically significant. Additional analyses indicate that this difference in effects between the least and most favorable groups was significant (aOR = 8.27; 95% CI, 1.19–57.49), allowing us to reject the null hypothesis that the effect of "Autism correction" did not vary by vaccine attitude group ($F(2, 1749) = 3.31$; $P < .05$). None of the other interventions significantly increased intent to vaccinate in any vaccine attitude groups, nor can we reject the null that the effects of the risk interventions are jointly 0.

The results in Table 3 are illustrated in Fig 2, which presents predicted probabilities that respondents would be very likely to vaccinate future children by experimental condition for each vaccine attitude group.

Among respondents with the least favorable attitudes toward vaccines, the predicted probability that respondents would be very likely to give MMR decreased from 70% among control subjects to 45% for those given information debunking the supposed autism link.

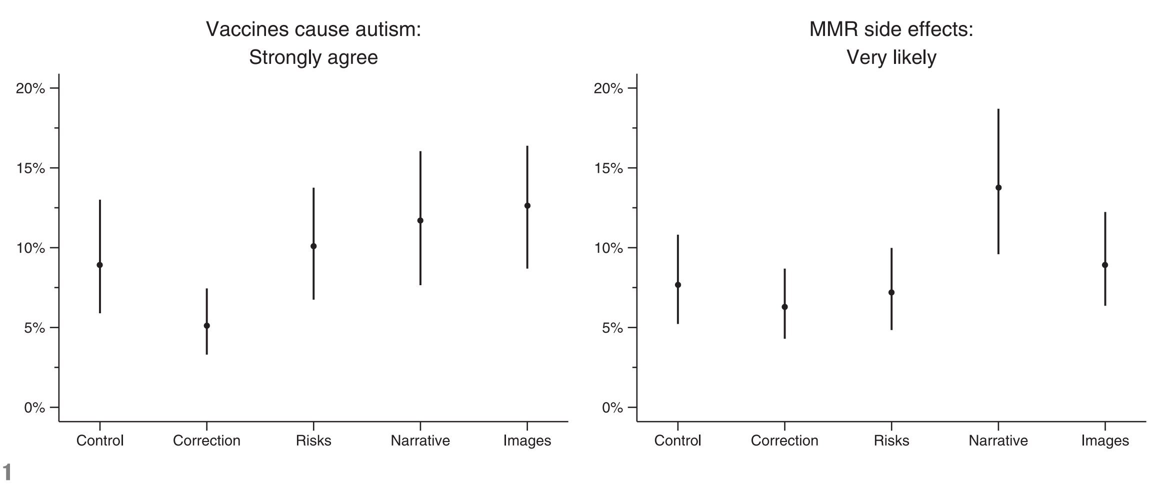

FIGURE 1
Predicted intervention effects for MMR misperceptions (parents with least favorable vaccine attitudes). The figure depicts predicted probabilities for respondents with the least favorable attitudes toward vaccines (defined based on a tercile split of responses to the vaccine attitudes scale from Freed et al, which was administered in a previous wave of the study). Predicted probabilities and bootstrapped 95% confidence intervals were estimated from the ordered logit models in Table 2 using SPost in Stata 11.[46] The left panel presents the predicted probabilities that participants would respond "Strongly agree" to the statement "Some vaccines cause autism in healthy children." Respondents were less likely to strongly agree if they received corrective information but more likely to do so if they received images of sick children. The right panel presents the predicted probabilities that respondents would say "Very likely" to the question "Just based on what you know, how likely is it that children who get the measles, mumps, and rubella vaccine, which is known as the MMR vaccine, will suffer serious side effects?" The narrative increased the predicted likelihood that respondents would believe serious side effects were very likely. Intervention text is provided in the Supplemental Information.

TABLE 3 Effects of Interventions on MMR Intention

	All	Vaccine Attitudes		
		Least Favorable	Somewhat Favorable	Most Favorable
Autism correction	0.52* (0.32–0.84)	0.36* (0.20–0.64)	1.12 (0.36–3.52)	2.98 (0.48–18.36)
Disease risks	0.98 (0.54–1.77)	0.96 (0.50–1.86)	1.23 (0.29–5.30)	0.82 (0.12–5.45)
Disease narrative	1.09 (0.62–1.94)	0.87 (0.45–1.68)	2.26 (0.60–8.45)	7.29 (0.64–82.77)
Disease images	1.29 (0.73–2.26)	1.20 (0.64–2.26)	2.00 (0.71–5.67)	0.86 (0.09–8.48)
Somewhat favorable toward vaccines (baseline: least favorable)	7.61* (4.74–12.22)			
Most favorable toward vaccines (baseline: least favorable)	16.19* (7.16–36.59)			
N	1751	678	529	544

Ordered logit models with coefficients expressed as aORs and 95% confidence intervals in parentheses (cutpoints omitted; $*P < 0.05$). "MMR intention" measures responses on a 6-point scale from "Very unlikely" (1) to "Very likely" (6) to the question "If you had another child, how likely is it that you would give that child the measles, mumps, and rubella vaccine, which is known as the MMR vaccine?" Indicators for vaccine attitudes groups (least, somewhat, and most favorable) are based on a tercile split of responses to the vaccine attitudes scale from Freed et al,[11] which was administered in a previous wave of the study. The experimental interventions are provided in the Supplemental Information.

DISCUSSION

We find that pro-vaccine messages do not always work as intended and that the effectiveness of those messages may vary depending on parental attitudes toward vaccines. Unlike several other studies of resistance to scientific evidence,[30–32] corrective information from the CDC Web site successfully corrected misperceptions about MMR causing autism. However, the correction also reduced vaccination intent among parents with the least favorable vaccine attitudes. This finding suggests respondents brought to mind other concerns about vaccines to defend their anti-vaccine attitudes, a response that is broadly consistent with the literature on motivated reasoning about politics and vaccines.[25–28] In addition, our data provide little evidence that messages emphasizing the risks of vaccine-preventable diseases were effective in promoting vaccination intent. This finding is consistent with previous studies finding mixed effects of loss-framed messages and fear appeals on vaccination and other preventive health behaviors.[34–40] However, we additionally find a danger-priming effect in which both a dramatic narrative about measles and images of sick children increased misperceptions about MMR. Finally, no intervention increased intent to vaccinate among parents who are the least favorable toward vaccines (those with more favorable attitudes were extremely likely to intend to vaccinate, reducing the scope for a positive effect).

As with any study, these results have limitations that are worth noting. First, the safety and disease risk messages tested, although drawn nearly verbatim from actual messaging by the CDC and other agencies, were not the only possible approaches to presenting information about MMR. Other messages might prove to be more effective. Second, logistical and privacy constraints limited the scope of the study to self-reported

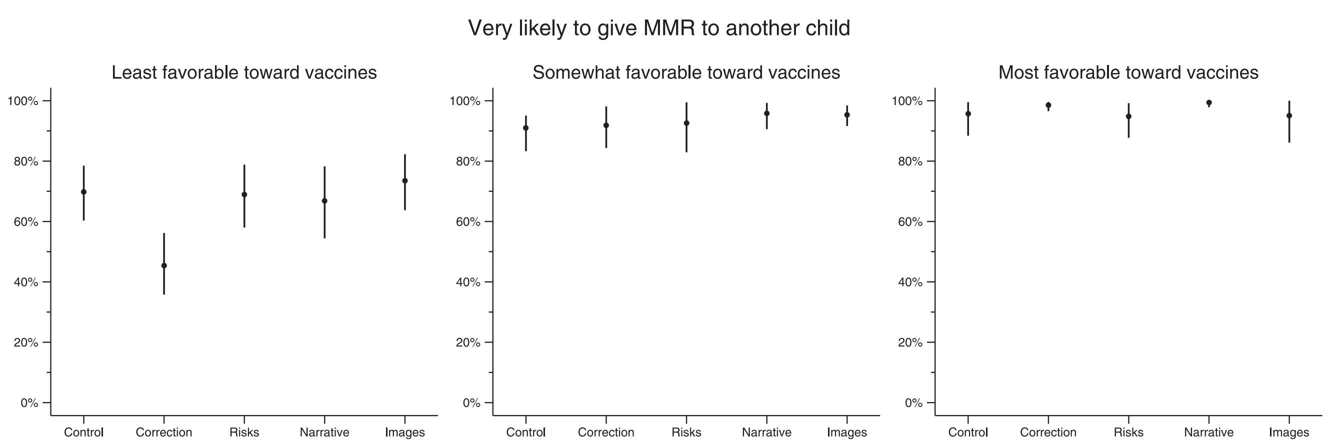

FIGURE 2
Predicted intervention effects for MMR intention. The figure depicts predicted probabilities and bootstrapped 95% confidence intervals from the ordered logit models in Table 3 generated using SPost in Stata 11.[46] The panel presents the predicted probability that respondents would answer "Very likely" to the question "If you had another child, how likely is it that you would give that child the measles, mumps, and rubella vaccine, which is known as the MMR vaccine? " for respondents with the least favorable attitudes toward vaccines, those with somewhat favorable attitudes, and those with the most favorable attitudes (the groups were defined based on a tercile split of responses to the vaccine attitudes scale from Freed et al, which was administered in a previous wave of the study). Corrective information disproving the vaccine/autism link reduced intent to vaccinate among parents with the least favorable attitudes toward vaccines; no significant effect was found among the other groups. Intervention text is provided in the Supplemental Information.

beliefs and intent to vaccinate, not actual vaccine receipt. Finally, to minimize the complexity of the research design, we did not explicitly attribute the intervention materials to external sources such as the CDC.

Nonetheless, these results have important implications for public health. First, health messages must be tested before dissemination to assess their effectiveness, especially among resistant or skeptical populations. For instance, we found that a pro-vaccination message was least persuasive among parents who had the most negative attitudes toward vaccines, the group of greatest public health concern. In particular, corrections of misperceptions about controversial issues like vaccines may be counterproductive in some populations. The best response to false beliefs is not necessarily providing correct information. Likewise, trying to scare parents with emotive stories could paradoxically increase vaccine safety concerns among those who are already hesitant to immunize.

In addition, our results demonstrate the importance of measuring beliefs and behavioral intent when assessing health interventions. Corrective information about the disproven vaccine-autism link significantly reduced misperceptions, but also reduced intention to vaccinate among parents with the least favorable vaccine attitudes. If we had not measured intent, we might have missed a potentially dangerous backfire effect.

Finally, these results suggest several avenues for future research. First, why did the narrative we tested increase beliefs in MMR side effects? Subtle narratives have been found to be persuasive because individuals "may not marshal their cognitive resources to defend against a potentially counter-attitudinal message."[47] Our narrative may have been insufficiently subtle and therefore ineffective at overcoming previous beliefs. Additionally, there is some evidence that health narratives that induce fear are less effective in changing beliefs and attitudes.[48] Future research should investigate the heterogeneity of health narrative effects further. Second, the resistance to persuasion we observe highlights the difficulty of identifying credible sources of vaccine information. Given that parents rate their children's doctor as their most trusted source of vaccine safety information, future research should explore whether pediatricians would be an especially persuasive source.[49] Third, although it is possible that alternate approaches might be more effective than our interventions, these findings suggest that any such approaches should be carefully tested.

CONCLUSIONS

None of the pro-vaccine messages created by public health authorities increased intent to vaccinate with MMR among a nationally representative sample of parents who have children age 17 years or younger at home. Corrective information reduced misperceptions about the vaccine/autism link but nonetheless decreased intent to vaccinate among parents who had the least favorable attitudes toward vaccines. Moreover, images of children who have MMR and a narrative about a child who had measles actually increased beliefs in serious vaccine side effects. These results suggest the need to carefully test vaccination messaging before making it public.

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