Right from the Source: Trust in Health Providers, Information Sources, and Vaccine Hesitancy

Nikki Melanie Eller

A thesis

submitted in partial fulfillment of the

requirements for the degree of

Master of Public Health

University of Washington

2017

Committee:

Nora B Henrikson

Douglas J Opel

Program Authorized to Offer Degree:

Health Services

University of Washington

Abstract

Right from the Source: Trust in Health Providers, Information Sources, and Vaccine Hesitancy

Nikki Melanie Eller

Chair of the supervisory committee:

Dr. Nora B Henrikson

Department of Health Services

With increases in vaccine hesitancy, public health officials seek to maintain high levels of confidence in vaccine safety and high vaccination rates. This secondary analysis of survey data from mothers of healthy newborns in Washington State examines the association between trust in health providers and vaccine information sources. We found that mothers with less trust in health providers used more sources, more informal sources, and were less likely to consider their child's pediatrician their main source of vaccine information. However, they did not report more effort to read or watch stories about vaccines than more trusting mothers, and there was no difference by trust for reporting the internet as main vaccine information source. Many new mothers seek information about vaccines, but their level of trust in health providers may influence which sources they believe.

Background:

Vaccine hesitancy has been associated with higher rates of children remaining unvaccinated in the United States and to the reemergence of vaccine-preventable diseases such as measles [1]. The World Health Organization SAGE Working Group on Vaccine Hesitancy describes vaccine hesitancy as "set on a continuum between those that accept all vaccines with no doubts, to complete refusal with no doubts, with vaccine hesitant individuals the heterogeneous group between these two extremes"[2].

The SAGE Working Group listed "confidence" as one of the key factors in vaccine decision-making, and define it as trust in the safety and efficacy of vaccines themselves, the policymakers that legislate for them, and the healthcare system and providers that administer them [3]. Confidence and trust were used interchangeably in this publication, but there are subtle differences: confidence is simply the expectation of a positive outcome, while trust includes a belief in another's good intentions, and may persist even with negative outcomes. Trust has multiple dimensions including fidelity, honesty, confidentiality, competence, and global trust, but trust in physicians tends to behave as a single construct [4]. Trust can also exist at an interpersonal or an institutional level, and a patient's trust in health providers in general may influence their trust in an individual provider, or vice-versa [4].

Qualitative studies on vaccine hesitancy often find parents' trust or lack of trust in the medical community as particularly important in vaccine decision-making [5, 6]. Generally, trust in authority figures has been declining at a national level for decades [7]. More specifically, vaccine hesitant parents are less likely to report trusting their pediatrician's advice on child nutrition and behavior and development [8], and claiming nonmedical vaccination exemptions has been correlated more broadly with distrust in the government [9]. Trust is an important component of relationships with health providers, and may impact how a parent receives information from their doctor.

Although health providers remain the most common source of vaccine information, many parents are also making use of the internet [10]. Using the search engine Google to look for information on vaccines may be more likely to propagate rather than dispel myths about vaccines, as many websites recommend against vaccination [10, 11]. In fact, use of non-physician information sources is associated with intentions to follow an alternative vaccination schedule [12], whereas parents who say that a provider influenced their views on vaccination have fuller vaccine coverage [13]. A qualitative study found parents preferred conversations with health providers over internet searches as a means to get information on vaccines [14].

In this study, we assess the association of a mother's trust in health providers and their use of alternative sources for vaccine information. We specifically sought to test the following hypotheses:

1. Mothers with lower levels of trust in health providers will list more information sources on vaccines compared to mothers with higher levels of trust.

2. Mothers' level of trust in health providers will be associated with the type of sources used for vaccine information, with low trust associated with non-provider information sources as a main source.

3. More mothers with lower levels of trust in health providers will make a point to read or watch stories about vaccines than mothers with higher levels of trust.

Methods and Materials

Measures

We conducted a secondary analysis of baseline data collected in 2012 from mothers of healthy newborns at 47 clinics in Washington State as part of an intervention to address vaccine hesitancy [15]. Surveys were conducted over the phone by trained interviewers using a standardized script 4 to 6 weeks after giving birth. Inclusion criteria were age >18, English speaking, pregnancy >35 weeks of gestation, no medical complications related to birth, and intention to receive routine well-child care from a study clinic.

As part of the original study, participants were administered questions on demographics (age, race/ethnicity, marital status, level of education, income, number of children, and length of relationship with child's doctor), vaccine hesitancy and vaccine information seeking. Maternal vaccine hesitancy was measured using the validated, 15-item Parent Attitudes about Childhood Vaccines (PACV) survey [16]. Mothers who scored 50 and above out of a possible range of 0-100 were considered to be hesitant, as validated previously in a similar population [17]. The three questions on vaccine-information seeking were adapted from the 2011 National Immunization Survey (NIS) [18]. Telephone interviewers prompted mothers with "I get vaccine information from… " and then gave them the chance to respond "yes" or "no" to the following options: "my child's pediatrician," "my family doctor," "other medical doctors or specialists," "a naturopathic doctor, homeopathic doctor, chiropractor, or acupuncturist," "health care providers other than doctors," "government agencies like the department of health or centers for disease control," "the internet," "TV, radio, books and magazines," "parents who believe their child was hurt by a vaccine," "other parents," "other friends and family," and "any other sources of information about vaccines." Free text responses in the "other" category were recoded by the study team as one of the listed sources. The interviewer read back to the respondent all of the sources of vaccine information she reported using and asked the mother to select which one was her main source of information. In the third question, participants were asked to indicate their agreement with the statement "I make a point to read or watch stories about vaccines," on a Likert scale from 0 (strongly agree) to 10 (strongly disagree). We dichotomized this response as scores of 6 and higher to those below 6, based on the distribution of the data.

Of four questions assessing trust, three were from the PACV and one was from the 2011 NIS [16, 18]. We used responses to four questions to assess parental trust in health providers. Responses to the first two PACV questions ("Overall, I trust the information I receive about shots," and "I am able to openly discuss my concerns about shots with my child's doctor") were scored on a 5-point Likert scale

from “strongly agree” to “strongly disagree.” Responses to the third PACV question (“All things considered, how much do you trust your child’s doctor?”) were scored from 0-10, with 0 representing “do not trust at all” and 10 “completely trust.” The question from the NIS (“In general, medical professionals in charge of vaccinations have my child’s best interests at heart”) also had answers on a 0-10 scale with 0 representing “strongly disagree” and 10 representing “strongly agree.”

We categorized race as self-reported white, Asian, black, or other and ethnicity as Hispanic/non-Hispanic. Marital status was dichotomized into married or cohabitating with a partner vs. single or divorced. We categorized level of education as college graduate or higher vs. less than college graduate; annual household income as $75,000 or more and those earning less. We calculated the length of a mother’s relationship with her child’s doctor in months.

Analysis

Our primary predictor of interest for all analyses was maternal trust in her child’s pediatrician and in medical professionals. We assigned points to responses on the questions assessing trust, then summed the points to make a scale (Appendix 1). We summed points from all four questions for each participant to create a scale ranging from 0, representing complete trust, to 8, representing low trust. We dichotomized responses for analysis as 0 (“trusting”) and 1 through 8 (“less trusting”) for use as the primary predictor for all models.

We tested for associations between our primary predictor and demographic covariates. We used chi-squared analysis to test for differences in categorical variables, and Fisher’s exact test for differences in race due to a small number of minority participants. A two-sample t-test that allowed for unequal variances was used to test for differences on continuous variables between mothers grouped by level of trust. Associations between reported use of information source and trust level were assessed with chi-squared analysis.

The primary outcome for hypothesis 1 was the total number of vaccine information sources. Outcomes of interest for hypothesis 2 were citing "my child's pediatrician" vs. any other vaccine information source as a main source, and "the internet" vs. any other main information source. The primary outcome for hypothesis 3 was the dichotomized amount of effort a participant reported making to read or watch stories about vaccines.

We used Poisson regression to see how trust level affected total number of information sources (hypothesis 1). Negative binomial regression was also considered, but the data fit a Poisson distribution better, as confirmed by Akaike's and Schwarz's Bayesian information criteria. For our next analyses (hypothesis 2) we used two logistic regression models to assess a possible association between trust in health care providers and main vaccine information source. Our final model also used logistic regression to test for an association between trust and a pointed effort to seek information on vaccines (hypothesis 3). We first ran unadjusted models to test for associations between trust and our outcomes, and then assessed the independent association of trust and our outcomes using multivariable regression that controlled for covariates considered *a priori* to be potential confounders. *A priori* covariates considered to be potential confounders included maternal age [19], level of education [13, 20], race and ethnicity [21, 22], marital status [22], annual household income [20, 23], number of children [13], and length of relationship with provider [19]. Robust standard error estimates were used in all models. As a sensitivity analysis, we re-ran all analyses with the trust scale as a continuous predictor.

Lastly, we conducted an exploratory analysis of patterns in the use of vaccine information sources. To do so, we first calculated pair-wise correlation coefficients between all 12 information source categories at the level of the individual. We then generated a matrix of these correlation coefficients to help visualize patterns.

Results

Sample Characteristics

The sample size was 391 mothers. The average age of respondents was 32, with 46% of the sample being a first time parent (Table 1). Most parents (73%) had completed a college degree or higher, and 67% had an annual household income of $75,000 or higher. Mothers reported an average relationship of 28 months with their child's doctor, with an inter-quartile range of 1-36 months. Nearly all of the sample was married or cohabitating (90%), and 74% self-identified as white. Eleven (3%) participants self-identified as black or African American, 50 (13%) as Asian American, 40 (10%) as mixed or another racial group, and 20 (6%) as Hispanic origin.

Survey Results

Sixty-six percent (66%) of mothers were categorized as trusting. Demographic characteristics were similar between trusting and less trusting mothers with the exception of race and ethnicity: significantly fewer less trusting mothers were white and there was a significantly higher proportion of Asians and a lower proportion of Hispanics in the less trusting group (Table 1). As expected, the proportion of mothers considered to be vaccine hesitant also varied by trust level, with 35 of the 44 vaccine hesitant mothers (80%) in the low trust group.

The most common source used for vaccine information among both trusting and less trusting mothers was "my child's pediatrician," reported by 95% of women in both groups. Of the 21 women who reported an "other" source of vaccine information, 7 cited their own training as a health provider, and 5 mentioned research studies or peer-reviewed journals. Additional answers included insurance providers, the workplace, and newspapers.

The most common *main* source of information reported was "my child's pediatrician" for the entire sample (74%), followed by "the internet" (8%). No mothers reported "parents who believe their

child was hurt by a vaccine" as their main vaccine information source. Forty-three percent (43%) of mothers reported making a strong effort to read or watch stories about vaccines.

Hypothesis 1: Mothers with lower levels of trust in healthcare providers will list more information sources on vaccines compared to mothers with higher levels of trust.

Trusting mothers reported fewer average information sources than less trusting mothers (5.3 sources vs 5.9 sources, $p<0.01$) (Table 2). This difference persisted after adjusting for maternal age, level of education, race and ethnicity, marital status, level of education, annual household income, number of children, and length of relationship with provider (Table 3). Measuring trust on a continuous scale did not change outcomes significantly (not reported). The number of sources a mother reported using also increased with her level of education and number of children.

Hypothesis 2: Mothers' level of trust in healthcare providers will be associated with the type of sources used for vaccine information, with low trust associated with non-provider information sources as a main source.

Less trusting mothers were statistically significantly more likely to report using the internet, parents who believe their child was hurt by a vaccine, other parents, other friends and family, and naturopathic doctors, homeopathic doctors, chiropractors, or acupuncturists (Figure 1). Our multivariable model predicted that trusting mothers had an 81% chance of listing her child's pediatrician as her *main* source of vaccine information (95%CI: 76-86%, $p<.05$), while the predicted probability of a less trusting mother with a similar demographic background doing the same was only 63% (95%CI: 54-71%). Odds ratios are reported in Table 4. Results were similar between unadjusted, fully adjusted models, and sensitivity analyses. None of the demographic covariates were statistically significant.

Trust was unrelated to reporting the internet as her main vaccine information source in either univariate or multivariable analyses (Table 5). However, in the fully adjusted model women of Hispanic origin were more likely to cite the internet as a main source and women who had a longer relationship

with their child's doctor were less likely to cite the internet as a main source. No black mothers chose the internet as a main information source, so we were unable to estimate an association with race for this outcome.

Hypothesis 3: More mothers with lower levels of trust in healthcare providers will make a point to read or watch stories about vaccines than mothers with higher levels of trust.

Trust was not associated with reported behavior of making a point to read or watch stories about vaccines in either univariate or multivariable analyses (Table 6). Sensitivity analysis did not change results. Reported effort did increase with the respondent's number of children.

Exploratory Data Analysis

No clear patterns emerged in exploratory analysis of correlations between the types of vaccine information sources a participant reported using (Appendix 2). The majority (82%) of correlation coefficients fell between -.1 and .1. Only two coefficients fell above .3, with use of "other parents" correlating with "friends and family" at .7, and "other parents" correlating with "parents who believe their child was hurt by a vaccine" at .4.

Discussion

We conducted a secondary analysis of survey data from mothers of healthy newborns in Washington State on their trust in physicians and vaccine information sources. We found that less trusting mothers report slightly more information sources than trusting mothers and are less likely to consider their child's pediatrician their main source of vaccine information. Less trusting mothers were more likely to make use of informal vaccine information sources, such as friends, family, other parents, and the internet as well as alternative medicine providers. Trust was unrelated to reported effort to read or watch stories about vaccines.

Though the difference in the number of vaccine information sources trusting and less trusting mothers reported using reached statistical significance, the estimated difference was only one additional source. This, coupled with the lack of a difference in reported effort to read or watch stories on vaccines suggests that while most mothers seek out information on vaccines, the weight they give to different sources may vary with the amount of trust they place in those sources.

Studies of parents of school-aged children have found similar results. An analysis of the national HealthStyles Survey conducted in 2009 found that 71% of parents with a child age 6 or younger agreed that they "have given a lot of thought to my decision concerning vaccination for my child." Parents' most frequent choices were their child's healthcare provider (82%), family (47%), and their child's other parent (23%). Ten percent of participants included the internet as one of their 3 most important sources [24]. Another survey of parents of elementary school age children found associations between vaccine information sources and nonmedical vaccination exemptions. There was no difference by exemption status in parents' report of using health care professionals for vaccine information (91% for parents with vaccinated children, 94% for parents of exempt children), but a significant difference in parents reporting that health care professionals were a good or excellent source of vaccine information (90% for parents with vaccinated children vs. 64% for parents of exempt children) [25]. In our sample, 95% of mothers reported their child's pediatrician as an information source, but when asked if this was their main information source there was a split by trust level of 80% and 61% for trusting and less trusting mothers, respectively. The HealthStyles study also found more reported use of other parents, friends, and the internet as sources of vaccine information among parents of exempt children [25]. The survey allowed parents to choose from a list of 18 information sources that they could have used, and the majority listed between 2 and 6 [20], comparable to our findings of an inter-quartile range of 4 to 7 sources. This study found an association between nonmedical exemption and use of the internet as an information source.

A nationally representative study found an association between trust in physicians and vaccine hesitancy. An analysis of the NIS 2010-2013 data reported that 95% of parents with infants who believe that vaccines are necessary and did not refuse any vaccines agreed with the statement, "In general, medical professionals in charge of vaccinations have my child's best interest at heart," compared to only 51% of parents who do not think vaccines are necessary to protect their children's health. This study also found vaccine hesitant parents were more likely to report that a practitioner of complementary or alternative medicine influenced their decision to vaccinate [26].

A parent's trust in the advice they receive from their child's pediatrician is associated with confidence in vaccines, antibiotics, over-the-counter medications, and children's vitamins [27]. Distrust in the medical establishment coincides with distrust in the government and the pharmaceutical industry [28, 29], so addressing vaccine hesitancy may require a system-level approach to improve transparency and trust in vaccine development and dispersal, as well as trust between parents and providers. Indeed, institutional and general interpersonal trust complement and influence patient-provider trust [23, 30], thus it may be difficult to address parent-provider trust without also addressing institutional trust. The Centers for Disease Control recommend additional funding for immunization-safety science, improving public awareness of the development and testing of vaccines, and engaging with community members to be part of advisory boards and to act as vaccine advocates [31]. At the provider level, a meta-analysis was unable to find evidence to support use of a single communication style, and concluded that individual differences may preclude a single effective intervention to address vaccine hesitancy [32]. Nevertheless, taking the time to address a parents' concerns about vaccine safety including the manufacturing and testing process may be beneficial.

Limitations:

As this was a secondary analysis, the measures were not designed to address these research questions. We also could not directly assess an association between trust in health providers,

information sources, and vaccine hesitancy as the questions that composed our trust scale were a subset of the tool used to assess hesitancy. Our sample had few participants at the least trusting levels of our scale, though this reflects the high levels of trust in physicians in the general population. Despite decades of declining confidence in institutions, national surveys report that 69% of Americans still rate the honesty and ethical standards of physicians as high or very high [33], and confidence in the safety of vaccines remains high overall [24]. Our data represent a random sample of mothers of healthy newborns in Washington State, but had a high proportion of white, high income, and highly educated individuals and our results may not be generalizable to men or other populations.

Another limitation is that our categories of information sources were not mutually exclusive, and may have contributed to the lack of a significant difference by trust level for using the internet as a main source, as the internet can be used to access a variety of materials. This is a weakness of many studies assessing vaccine information sources, and should be modified in future research.

Finally, as this was a cross-sectional survey we cannot establish directionality in the association between a mother's trust in her child's doctor and her use of vaccine information sources. An already established level of trust in a health provider may influence how a mother perceives them as a source of vaccine information, but a mother may also be predisposed to trust a provider who provides vaccine information she is already familiar with. As some providers refuse to see unvaccinated children, vaccine hesitant mothers may be choosing their child's pediatrician partly based on their attitudes towards vaccines [28, 34]. Longitudinal studies may lend some clarity, by providing insight into whether and how trust in health providers and vaccine information seeking may vary over time.

Implications for future research

Future studies could explore further whether a particular dimension or level of trust is especially relevant to vaccine information seeking and vaccine hesitancy. A review of interventions for improving

patients' trust in physicians found that only three randomized controlled trials had been conducted, with inconclusive results [35]. The authors recommend that future studies try interventions with both patients and providers, to increase awareness of ethics and confidentiality practices among patients, and behaviors that demonstrate caring among physicians. Allowing patients greater choice of physicians may also improve trust [35]. As our study and several others have reported greater reliance on alternative medicine providers among vaccine hesitant parents [25, 26], those providers may be a point of intervention. Although parent-provider relationships are likely to be key in decisions surrounding vaccination [6], since interviews with parents often find distrust in vaccine manufacturing processes to be an issue, interventions to improve transparency and trust in the pharmaceutical industry and regulatory agencies may be needed to fully address public perceptions of vaccine safety.

Conclusions

We found evidence that mothers who have less trust in health providers are likely to report using more sources and more informal sources of vaccine information than mothers who trust health providers. Less trusting mothers are also less likely to report their child's health provider as their main source of vaccine information than trusting mothers. We did not find a difference by trust level for reporting the internet as a main information source or making a strong effort to read or watch stories about vaccines. Future research should focus on improving trust in health providers and the system that produces vaccines as a way to address vaccine hesitancy.

Acknowledgements:

Partial support for this research came from a Eunice Kennedy Shriver National Institute of Child Health and Human Development research infrastructure grant, R24 HD042828, as well as a Human Development training grant, T32 HD007543, to the Center for Studies in Demography & Ecology at the University of Washington. The parent study was supported by a grant from the Group Health Foundation.

Table 1: Descriptive statistics of women in our sample where trusting reflects a score of 0 on the trust scale, and less trusting includes women with any non-zero score. Statistics are n (%) for categorical variables, and mean (SD) min-max for continuous.

Characteristic	Less Trusting n = 134 (%)	Trusting n = 257 (%)	Total n = 391 (%)
Maternal Age			
<30	51 (38%)	62 (24%)	113 (29%)
30-34	41 (31%)	108 (42%)	149 (38%)
≥35	42 (31%)	87 (34%)	129 (33%)
Marital Status[1]			
Single/Divorced	16 (12%)	22 (9%)	38 (10%)
Married/Partnered	118 (88%)	234 (91%)	352 (90%)
No. children, mean (SD) range	1.8 (1) 1-6	1.8 (1) 1-8	1.8 (1) 1-8
First time parent	65 (49%)	116 (45%)	181 (46%)
Education[1]			
< 4-year college degree	34 (25%)	71 (28%)	105 (27%)
4-year college or more	100 (75%)	185 (72%)	285 (73%)
Annual household income[1]			
< $75,000	45 (34%)	78 (31%)	123 (32%)
≥$75,000	86 (66%)	171 (69%)	257 (68%)
Ethnicity[1]*			
Non-Hispanic	131 (98%)	236 (92%)	367 (94%)
Hispanic	3 (2%)	20 (8%)	23 (6%)
Race[1]**			
White	88 (66%)	202 (79%)	290 (74%)
Black/African American	6 (4%)	5 (2%)	11 (3%)
Asian	27 (20%)	23 (9%)	50 (13%)
Other/Mixed	13 (10%)	27 (11%)	40 (10%)
Duration of relationship with child's doctor[1]			
<1 mo.	21 (16%)	41 (16%)	62 (16%)
1 to 12 mo.	48 (37%)	84 (33%)	132 (34%)
1 to 5 y	48 (37%)	85 (33%)	133 (35%)
>5 y	12 (9%)	46 (18%)	58 (15%)
Vaccine hesitant[2]**	35 (26%)	9 (4%)	44 (11%)

1. Information was missing for one participant on marital status, education, and ethnicity. Income information was missing from 11 individuals, and length of relationship with provider from 6.
2. Three of the four questions the trust scale was based on were items on the instrument used to assess vaccine hesitancy.

* Difference between low and high trust mothers, p<.05 from chi-squared analysis for categorical variables, t-test for continuous variables.

** p<.01

Table 2: Vaccine information seeking and information sources (survey results). Trusting reflects a score of 0 on the trust scale, and less trusting includes women with any non-zero score. P-values are from multivariable regression controlling for maternal age, level of education, race, ethnicity, marital status, annual household income, number of children, and length of relationship with provider.

Variable	Less Trusting n = 134 (%)	Trusting n = 257 (%)	Total n = 391 (%)	p-value
No. info sources, mean (SD), range	5.9 (2.1) 1-11	5.3 (2.1) 1-10	5.5 (2.1) 1-11	<.05
Makes a point to read or watch stories about vaccines[1]	57 (43%)	111 (43%)	168 (43%)	.74
Main Information Source				
Child's pediatrician	82 (61%)	206 (80%)	288 (74%)	<.05
Internet	15 (11%)	17 (7%)	32 (8%)	.09
Friends and family	5 (4%)	1 (<1%)	6 (2%)	--
Other parents	2 (1%)	0 (0%)	2 (1%)	--
Gov't agency	10 (7%)	6 (2%)	16 (4%)	--
Media other than internet	4 (3%)	7 (3%)	11 (3%)	--
Family doctor	10 (7%)	11 (4%)	21 (5%)	--
Other doctor	1 (1%)	3 (1%)	4 (1%)	--
Parents of injured children	0 (0%)	0 (0%)	0 (0%)	--
Other health care provider	1 (1%)	3 (1%)	4 (1%)	--
Alt medicine provider	3 (2%)	0 (0%)	3 (1%)	--
Other	1 (1%)	5 (2%)	6 (2%)	--

1. One missing value.

Table 3: Multivariable estimates: characteristics associated with number of vaccine information sources used (hypothesis 1).

Characteristic	Incidence Rate Ratio (95% CI)	p-value
Trust Level		
Less Trusting	Referent	0.01
Trusting	.89 (.82, .97)	
Maternal age (1 year increment)	1 (.99, 1.0)	.71
No. of Children	1.05 (1.00, 1.09)	.04
Marital Status		
Single or divorced	Referent	.67
Married or partnered	.96 (.80, 1.15)	
Education		
Less than 4-year college degree	Referent	.02
4 years college or more	1.14 (1.02, 1.28)	
Annual Household Income		
< $75,000	Referent	.27
≥ $75,000	.98 (.87, 1.04)	
Ethnicity		
Non-Hispanic	Referent	.81
Hispanic	.98 (.83, 1.16)	
Race		
White	Referent	.67
Asian	.95 (.85, 1.06)	
Black	1.02 (.77, 1.37)	
Mixed/other	1.05 (.92, 1.2)	
Duration of relationship with doctor (mo.)	1.0 (.99, 1.0)	.68

Table 4: Multivariable estimates: characteristics associated with listing child's pediatrician as main vaccine information source (hypothesis 2).

Characteristic	Odds Ratio (95% CI)	p-value
Trust Level		
Less Trusting	Referent	<.01
Trusting	2.47 (1.51, 4.04)	
Maternal age (1 year increment)	.96 (.91, 1.02)	.17
No. of Children	1.18 (.84, 1.66)	.33
Marital Status		
Single or divorced	Referent	1.0
Married or partnered	1.00 (.38, 2.64)	
Education		
Less than 4-year college degree	Referent	.79
4 years college or more	1.10 (.55, 2.19)	
Annual Household Income		
< $75,000	Referent	.28
≥ $75,000	1.40 (.76, 2.58)	
Ethnicity		
Non-Hispanic	Referent	.06
Hispanic	.40 (.16, 1.03)	
Race		
White	Referent	.25
Asian	.69 (.34, 1.37)	
Black	3.37 (.41, 27.59)	
Mixed/other	.59 (.26, 1.32)	
Duration of relationship with doctor (mo.)	1.0 (.99, 1.0)	.54

Table 5: Multivariable estimates: characteristics associated with listing the internet as main vaccine information source (hypothesis 2).

Characteristic	Odds Ratio (95% CI)	p-value
Trust Level		
Less Trusting	Referent	.09
Trusting	.52 (.24, 1.10)	
Maternal age (1 year increment)	1.04 (.96, 1.12)	.33
No. of Children	1.34 (.87, 2.06)	.19
Marital Status		
Single or divorced	Referent	.92
Married or partnered	1.07 (.26, 4.48)	
Education		
Less than 4-year college degree	Referent	.31
4 years college or more	.58 (.20, 1.66)	
Annual Household Income		
< $75,000	Referent	.78
≥ $75,000	1.15 (.44, 2.96)	
Ethnicity		
Non-Hispanic	Referent	.02
Hispanic	4.45 (1.28, 15.44)	
Race		
White	Referent	--[1]
Asian	2.49 (.96, 6.43)	
Black	-- [1]	
Mixed/other	2.52 (.82, 7.82)	
Duration of relationship with doctor (mo.)	.98 (.96, 1.0)	.03

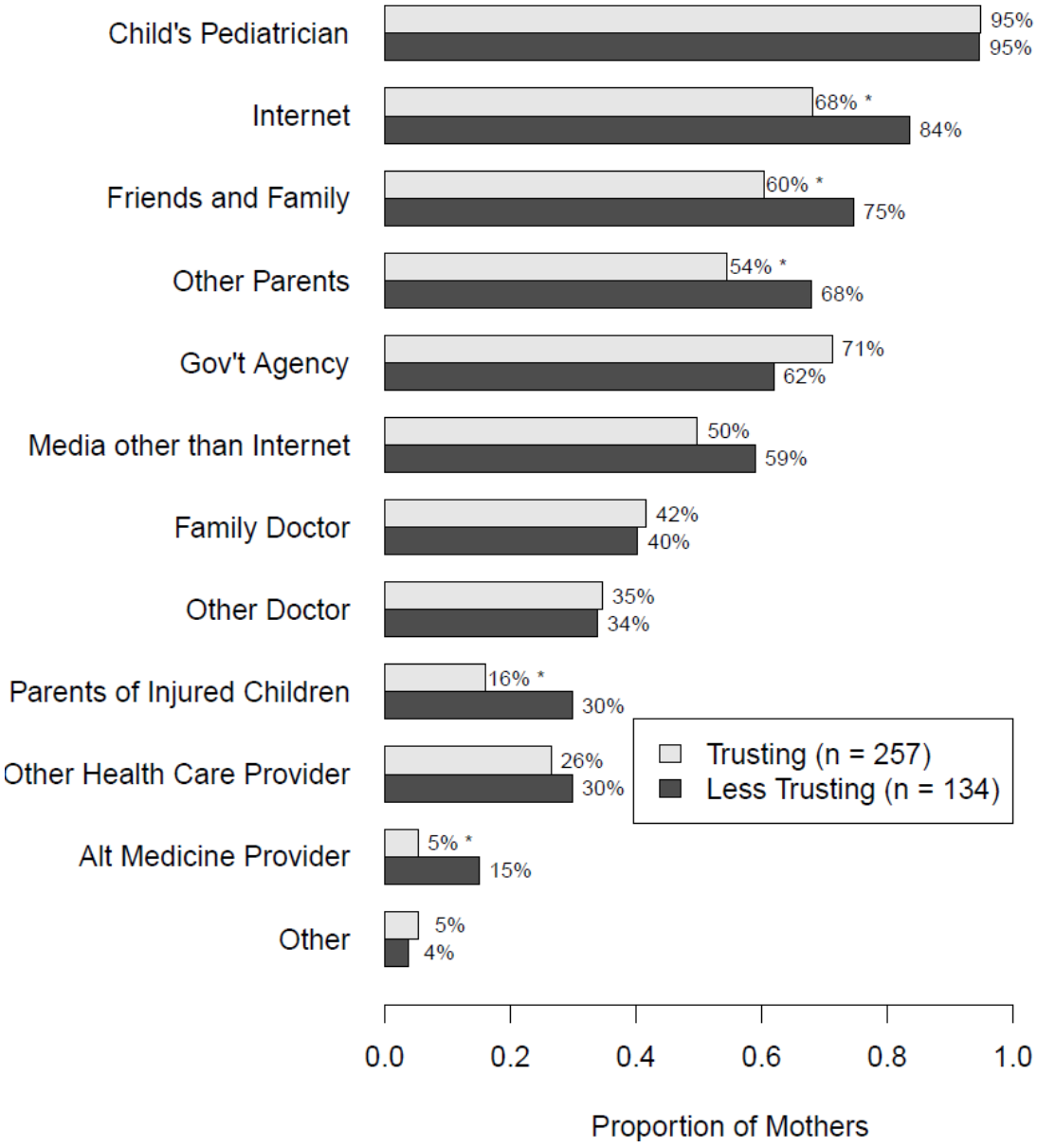
[1]No black participants reported the internet as their main information source.

Table 6: Multivariable estimates: characteristics associated with making an effort to read or watch stories about vaccines (hypothesis 3).

Characteristic	Odds Ratio (95% CI)	p-value
Trust Level		
Less Trusting	Referent	.74
Trusting	1.08 (.69, 1.69)	
Maternal age (1 year increment)	1.04 (.99, 1.09)	.13
No. of Children	1.28 (1.01, 1.61)	.04
Marital Status		
Single or divorced	Referent	.79
Married or partnered	.89 (.39, 2.04)	
Education		
Less than 4-year college degree	Referent	.64
4 years college or more	1.15 (.64, 2.09)	
Annual Household Income		
< $75,000	Referent	.25
≥ $75,000	.73 (.42, 1.24)	
Ethnicity		
Non-Hispanic	Referent	.83
Hispanic	1.11 (.44, 2.78)	
Race		
White	Referent	.32
Asian	1.20 (.63, 2.26)	
Black	1.04 (.26, 4.23)	
Mixed/other	2.0 (.95, 4.23)	
Duration of relationship with doctor (mo.)	1.0 (.99, 1.0)	.30

Figure 1: Use of source for vaccine information by level of trust in healthcare providers.

* Chi-squared analysis showed a statistically significant difference ($p<.05$) for use of this source for vaccine information between mothers with different levels of trust.



References:

[1] de St Maurice A, Edwards KM. Vaccine Hesitancy in Children-A Call for Action. Children (Basel). 2016;3.

[2] MacDonald NE. Vaccine hesitancy: Definition, scope and determinants. Vaccine. 2015;33:4161-4.

[3] MacDonald NE, Dubé E. Unpacking Vaccine Hesitancy Among Healthcare Providers. EBioMedicine. 2015;2:792-3.

[4] Hall MA, Dugan E, Zheng B, Mishra AK. Trust in physicians and medical institutions: what is it, can it be measured, and does it matter? Milbank Q. 2001;79:613-39.

[5] Mills E, Jadad AR, Ross C, Wilson K. Systematic review of qualitative studies exploring parental beliefs and attitudes toward childhood vaccination identifies common barriers to vaccination. J Clin Epidemiol. 2005;58:1081-8.

[6] Benin AL, Wisler-Scher DJ, Colson E, Shapiro ED, Holmboe ES. Qualitative analysis of mothers' decision-making about vaccines for infants: the importance of trust. Pediatrics. 2006;117:1532-41.

[7] Why People Don't Trust Government. Boston, MA: Harvard University Press; 1997.

[8] Glanz JM, Wagner NM, Narwaney KJ, Shoup JA, McClure DL, McCormick EV, et al. A mixed methods study of parental vaccine decision making and parent-provider trust. Acad Pediatr. 2013;13:481-8.

[9] Lee C, Whetten K, Omer S, Pan W, Salmon D. Hurdles to herd immunity: Distrust of government and vaccine refusal in the US, 2002-2003. Vaccine. 2016;34:3972-8.

[10] Stahl JP, Cohen R, Denis F, Gaudelus J, Martinot A, Lery T, et al. The impact of the web and social networks on vaccination. New challenges and opportunities offered to fight against vaccine hesitancy. Med Mal Infect. 2016;46:117-22.

[11] Ruiz JB, Bell RA. Understanding vaccination resistance: vaccine search term selection bias and the valence of retrieved information. Vaccine. 2014;32:5776-80.

[12] Wheeler M, Buttenheim AM. Parental vaccine concerns, information source, and choice of alternative immunization schedules. Hum Vaccin Immunother. 2013;9:1782-9.

[13] Smith PJ, Kennedy AM, Wooten K, Gust DA, Pickering LK. Association between health care providers' influence on parents who have concerns about vaccine safety and vaccination coverage. Pediatrics. 2006;118:e1287-92.

[14] Fredrickson DD, Davis TC, Arnould CL, Kennen EM, Hurniston SG, Cross JT, et al. Childhood immunization refusal: provider and parent perceptions. Fam Med. 2004;36:431-9.

[15] Henrikson NB, Opel DJ, Grothaus L, Nelson J, Scrol A, Dunn J, et al. Physician Communication Training and Parental Vaccine Hesitancy: A Randomized Trial. Pediatrics. 2015;136:70-9.

[16] Opel DJ, Mangione-Smith R, Taylor JA, Korfiatis C, Wiese C, Catz S, et al. Development of a survey to identify vaccine-hesitant parents: the parent attitudes about childhood vaccines survey. Hum Vaccin. 2011;7:419-25.

[17] Opel DJ, Taylor JA, Zhou C, Catz S, Myaing M, Mangione-Smith R. The relationship between parent attitudes about childhood vaccines survey scores and future child immunization status: a validation study. JAMA Pediatr. 2013;167:1065-71.

[18] Centers for Disease Control and Prevention. National Immunization Survey. 2011.

[19] Thom DH, Ribisl KM, Stewart AL, Luke DA. Further validation and reliability testing of the Trust in Physician Scale. The Stanford Trust Study Physicians. Med Care. 1999;37:510-7.

[20] Jones AM, Omer SB, Bednarczyk RA, Halsey NA, Moulton LH, Salmon DA. Parents' source of vaccine information and impact on vaccine attitudes, beliefs, and nonmedical exemptions. Adv Prev Med. 2012;2012:932741.

[21] Sewell AA. Disaggregating ethnoracial disparities in physician trust. Soc Sci Res. 2015;54:1-20.

[22] Voils CI, Oddone EZ, Weinfurt KP, Friedman JY, Schulman KA, Bosworth HB. Who trusts healthcare institutions? Results from a community-based sample. Ethn Dis. 2005;15:97-103.

[23] Zheng S, Hui SF, Yang Z. Hospital trust or doctor trust? A fuzzy analysis of trust in the health care setting. Journal of Business Research. 2017;in press.
[24] Kennedy A, Basket M, Sheedy K. Vaccine attitudes, concerns, and information sources reported by parents of young children: results from the 2009 HealthStyles survey. Pediatrics. 2011;127 Suppl 1:S92-9.
[25] Salmon DA, Moulton LH, Omer SB, DeHart MP, Stokley S, Halsey NA. Factors associated with refusal of childhood vaccines among parents of school-aged children: a case-control study. Arch Pediatr Adolesc Med. 2005;159:470-6.
[26] Smith PJ, Marcuse EK, Seward JF, Zhao Z, Orenstein WA. Children and Adolescents Unvaccinated Against Measles: Geographic Clustering, Parents' Beliefs, and Missed Opportunities. Public Health Rep. 2015;130:485-504.
[27] Nowak GJ, Cacciatore MA. Parents' confidence in recommended childhood vaccinations: Extending the assessment, expanding the context. Hum Vaccin Immunother. 2017;13:687-700.
[28] Reich JA. Calling the Shots: Why Parents Reject Vaccines. New York: New York University Press; 2016.
[29] Biss E. On Immunity: An Inoculation. Minneapolis: Graywolf Press; 2015.
[30] Goold SD. Trust and the ethics of health care institutions. Hastings Cent Rep. 2001;31:26-33.
[31] Cooper LZ, Larson HJ, Katz SL. Protecting public trust in immunization. Pediatrics. 2008;122:149-53.
[32] Dubé E, Gagnon D, MacDonald NE. Strategies intended to address vaccine hesitancy: Review of published reviews. Vaccine. 2015;33:4191-203.
[33] Blendon RJ, Benson JM, Hero JO. Public trust in physicians--U.S. medicine in international perspective. N Engl J Med. 2014;371:1570-2.
[34] Mergler MJ, Omer SB, Pan WK, Navar-Boggan AM, Orenstein W, Marcuse EK, et al. Association of vaccine-related attitudes and beliefs between parents and health care providers. Vaccine. 2013;31:4591-5.
[35] McKinstry B, Ashcroft RE, Car J, Freeman GK, Sheikh A. Interventions for improving patients' trust in doctors and groups of doctors. Cochrane Database Syst Rev. 2006:CD004134.

Appendix 1: Point assignments for trust scale. Points from all four questions were summed for each parent, to create a scale ranging from 0, representing high trust, to 8, representing low trust. The scale was then dichotomized such that scores of 0 were considered trusting and scores of 1 or higher were considered less trusting.

Survey Question	**Response assigned 0 points**	**Response assigned 1 point**	**Response assigned 2 points**
Overall, I trust the information I receive about shots	Agree, strongly agree	Not sure	Disagree, strongly disagree
I am able to openly discuss my concerns about shots with my child's doctor	Agree, strongly agree	Not sure	Disagree, strongly disagree
All things considered, how much do you trust your child's doctor?	8-10, ten represents "completely trust"	6, 7	0-5, zero represents "do not trust at all"
In general, medical professionals in charge of vaccinations have my child's best interests at heart	8-10, ten represents "strongly agree"	6, 7	0-5, zero represents "strongly disagree"

Appendix 2: Pair-wise correlations between vaccine information sources used within individuals.