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Alexandra Tuttle Date

Analysis of Trust in Different Sources of Health Information and Predicting Adult Vaccine Uptake in the United States, United Kingdom, and France

By

Alexandra Tuttle

Master of Public Health

Epidemiology

Robert A. Bednarczyk, PhD

Committee Chair

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By

Alexandra Tuttle

B.A., Northwestern University, 2017

Thesis Committee Chair: Robert A. Bednarczyk, PhD

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Abstract

Analysis of Trust in Different Sources of Health Information and Predicting Adult Vaccine Uptake in the United States, United Kingdom, and France
By Alexandra Tuttle

Background: Adult vaccine coverage trails high rates of childhood immunization globally, threatening protection from vaccine preventable diseases. Fewer policies and social pressures surround adult vaccines, leaving the decision to individuals. Vaccine information can vary widely depending on the source. The objective of this study was to determine which sources adults trust most for information about two routinely recommended adult vaccines, the seasonal influenza vaccine and tetanus containing booster, and determine if this trust predicts vaccine uptake.

Methods: Results of a cross-sectional survey conducted February to March of 2014 were analyzed. Participants from the US, UK, and France reported their level of trust in doctors, health departments, news media, and social media. Participants also reported receipt of the seasonal influenza vaccine in the past 6 months and tetanus containing booster in the past 10 years. Descriptive statistics were calculated and log binomial regression was used to evaluate associations between vaccine uptake and trust in information sources.

Results: A total of 2,541 responses were collected. Trust in doctors was most strongly associated with uptake of both vaccines (influenza PR: 3.48, 95% CI: 2.77, 4.37; tetanus PR: 1.38, 95% CI: 1.23, 1.55) followed by health departments (influenza PR: 3.11, 95% CI: 2.64, 3.66; tetanus PR: 1.29, 95% CI: 1.19, 1.44). Trust in news and social media were also positively associated with influenza vaccine receipt (news PR: 2.19, 95% CI: 1.97, 2.45; social media PR: 1.67, 95% CI: 1.48, 1.87). Tetanus containing booster receipt was weakly associated with trust in news media (PR: 1.08, 95% CI: 1.01, 1.15); it was not associated with trust in social media (PR: 1.02, 95% CI: 0.94, 1.11). After adjusting for trust in other sources, all observed effects were attenuated. Trust in social media was no longer significantly associated with influenza vaccine receipt, nor was trust in news media significantly associated with tetanus containing booster receipt. Effects were further attenuated after adjusting for demographic covariates.

Conclusions: Traditional sources of health information are influential in adult vaccinations. Health departments should communicate clear guidelines for adult vaccines and providers should regularly check immunization histories to recommend vaccines when gaps are identified.

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Literature Review

Background

Vaccine confidence has been declining in recent years.[1,2] In 2019, the World Health Organization (WHO) declared vaccine hesitancy as one of the top ten threats to global health.[3] A large-scale study of 149 countries found decreasing confidence in the importance, safety, and effectiveness of vaccines in 5 countries between 2015 and 2019.[4] Over the same time period, respondents who strongly disagreed that vaccines are safe increased significantly in 6 countries.[4] Furthermore, a 2018 study found rising rates of non-medical exemptions to vaccines in 12 of 18 states in the United States (US).[5] These trends threaten global vaccine coverage and increase the risk of vaccine preventable disease outbreaks.[1,6] This is of great public health concern, particularly in the context of a global pandemic in which a return to normalcy for many aspects of society is contingent upon the widespread uptake of vaccines.[7] A myriad of factors have been attributed to increasing vaccine hesitancy, including the perceived lack of necessity of vaccines, the growth of the anti-vaccine movement, diminishing trust in institutional medicine, and others.[1,8] Contributing to many of these factors are the different sources people trust for their health information.[9,10] Traditionally, healthcare providers and health departments have been viewed as the foremost authorities in this arena[1,11]; in recent years, however, new sources have emerged. Many people now rely on news media to keep up to date and informed about relevant health issues.[2,12] Social media websites allow people to share their health experiences as well as foster communities of like-minded individuals[9,13,14]; such sites have been a catalyst of the anti-vaccination movement.[15] Understanding the mediums through which people obtain their health information is essential to understanding their vaccine beliefs and subsequently improving vaccine confidence and uptake. The aim of this review is to examine the existing literature about

trust in different sources of health information in the context of vaccination. We begin by exploring trust in traditional sources of health information followed by new sources and look at how each relationship is related to vaccine uptake. We conclude by evaluating the existing evidence and identifying gaps in the literature that warrant further exploration.

Traditional sources of health information

Amid a growing landscape of health information sources, health care providers such as physicians and nurses remain the most trusted for vaccine information.[1] In a study of over 5,000 parents in the US, the majority reported that health care providers are their topmost trusted source for vaccine information.[11] Another study found that 76% of parents trusted their child's doctor "a lot" with respect to vaccine information.[9] This high level of trust is consistent for adults making decisions about their own vaccinations as well. A study of German adults found that receiving vaccination advice from a physician was associated with significantly higher uptake of the two routinely recommended adult vaccines, the seasonal influenza vaccine and the decennial tetanus containing adult booster.[16] Furthermore, in a qualitative study of 20 elderly British patients, distrust of doctors and modern medicine emerged as a theme among those who elected not to receive the annual influenza vaccine.[17] Trust in providers can be impacted by an individual's preconceived notions about vaccines. A cross-sectional study of US parents revealed that while healthcare providers were the most frequently trusted source of vaccine information overall, parents who identified as vaccine "acceptors" were more likely to be trusting of healthcare providers when compared to those who expressed a desire to delay or refuse vaccines for their child.[11] A cohort study found parents who believed vaccines were not safe were significantly less likely to be influenced by healthcare providers compared to those who believed

they are; conversely, parents who reported being influenced by providers were twice as likely to view vaccines as safe compared to those who did not (95% CI: 1.47, 2.74).[18]

Government health agencies are another traditionally reliable source of health information. In a study of US parents, they were found to be the second most trusted source of vaccine information behind only physicians.[9] A 2016 study found that the Centers for Disease Control and Prevention (CDC) website was the most common source for vaccine information among pregnant women.[19] An analysis of the 2007 Health Information National Trends Survey (HINTS) found parental trust in government health agencies to be a significant predictor of human papillomavirus (HPV) vaccine acceptance; trust in healthcare providers was also found to be a significant predictor in this analysis.[20] Furthermore, reliance on government health agencies for health information amplifies during public health crises. In such situations, establishing and maintaining trust in health officials is critical to ensure compliance with public health recommendations, including vaccinations. During the 2009 H1N1 influenza pandemic, overall trust in government was high.[21] Americans were equally likely to trust providers, the CDC and public health departments, and news reports for information regarding the H1N1 influenza vaccine; in contrast, healthcare providers were the single most trusted source for the usual seasonal influenza vaccine.[22] In a study of new mothers in the wake of the 2014-15 measles outbreak in the US, government websites and information from doctor's offices were the most trusted sources for information about the MMR vaccine; however, despite this high level of trust, they were utilized significantly less than other information mediums like online news, television news, and social media.[23] A recent Kaiser Family Foundation study found that the endorsement of federal, state, and local health agencies were important to 87% of respondents when

considering whether or not to receive a coronavirus vaccine; 88% of respondents also reported their own doctor or nurse as being important in making this decision.[24]

Though reported trust in traditional sources is consistently high, evidence as to whether this translates into vaccine uptake is conflicting. Hesitancy can vary by vaccine type; in particular, newer vaccines are often viewed with more skepticism.[1] Uptake of the seasonal influenza vaccine, which is updated annually to protect against the strains of the virus expected to dominate in a given influenza season, is low despite routine recommendation from trusted government health agencies and healthcare providers[25–27]; this suggests trusting information from these sources does not inherently promote vaccination. Conversely, Böhmer et al. demonstrated that trust in professional vaccine advice was associated with higher uptake of seasonal influenza and tetanus containing adult booster vaccines.[16] Additionally, the HINTS study found that parental trust in providers and government health agencies were each significant predictors of HPV vaccine receipt.[20] Moreover, one study found that during the 2009 H1N1 pandemic, those who were confident in the government were 2.82 times more likely to receive the H1N1 influenza vaccine than those who were not ($p < 0.01$).[28] In contrast, a separate study found only a weak association between trust in government and intent to get the vaccine.[21] Further research is needed to clarify the relationship between trust in traditional mediums of health information and vaccine uptake.

New sources of health information

While doctors and health departments have historically dominated the realm of health information, new sources have entered the field in the past several decades. News media has a history of highlighting vaccine scares. In the mid 1970's, news coverage amplified attention of a report from a United Kingdom (UK) hospital suggesting a relationship between the diphtheria,

tetanus, and pertussis (DTP) vaccine and neurological conditions in children.[29] Despite confirmation of the vaccines safety by multiple independent advisory groups, fear of brain damage drove down DTP vaccination rates, leading to several pertussis outbreaks and multiple lawsuits which subsequently increased DTP vaccine prices and ultimately created a shortage of the vaccine.[29,30] In the late 1990's, news of a purported link between the hepatitis B vaccine and multiple sclerosis made the front pages of newspapers worldwide.[31] Though the association was later debunked, hepatitis B vaccination coverage sharply decreased.[32] The media also played a significant role in propagating former physician Andrew Wakefield's false claims about the MMR vaccine causing autism; this discredited study still fuels anti-vaccination arguments today.[33,34] News media has become ubiquitous; it can be accessed all day and night on television, online, and in print. Few studies have examined how much people trust the news with regards to health information; however, general trust in media has declined in recent years.[35] As with government agencies, people turn to news media for information during public health emergencies. As previously noted, people relied on news reports as much as healthcare providers and health agencies when deciding whether to receive the 2009 H1N1 influenza vaccine.[22] Additionally, a 2015 study found those who were following media reports during the 2009 H1N1 influenza pandemic were 3.71 times as likely to receive the vaccine.[28] A separate cross-sectional study found that personal information sources such as doctors, school, work, family, and friends had a stronger impact on intention to receive the H1N1 influenza vaccine than mass media sources.[10]

Another emerging source of health information are social media websites. With the rise of the Internet, social media sites have expanded and given groups once marginalized to the fringe a platform for their views to be heard, regardless of the credibility of their claims.[2] Similar

to news media, these sites typically amplify negative experiences with vaccines rather than positive ones, which are inherently anti-climactic.[36] As such, vaccine questioning individuals seeking to educate themselves may be more likely to come across vaccine critical arguments on these sites.[31] While the dangers of social media perpetuating vaccine misinformation are well established, relatively few studies have examined how trust in these sites impacts vaccine uptake. A 2018 study of white and African American adults found that Twitter and Facebook users were significantly more likely to receive the influenza vaccine compared to non-users.[13] Exposure to negative social media content was associated with lower HPV vaccine coverage in a 2017 analysis.[14]

Despite their increasing popularity, the credibility of information from these new sources is variable to say the least. These mediums are not subjected to the same intensive review health departments are prior to releasing information, nor do they receive years of medical training like physicians and other healthcare providers. As such, understanding the level of trust people place in these sources is critical. A study conducted in the wake of the 2014-15 measles outbreak in the US found that online news and social media were the most frequently used sources for information about the outbreak; however, despite high utilization, these sources were only trusted by 18% and 1% of respondents, respectively. In contrast, traditional media such as brochures in doctor's offices and information from government websites were far less commonly used but were associated with significantly higher levels of trust. Moreover, only 13% of respondents reported trusting these types of new media over traditional.[23] These findings suggest that regardless of what sources are most frequently encountered, trust in traditional sources still prevails.

Conclusion

Overall, the sources people rely on for health information are expanding. Importantly, the validity of information from new sources such as news and social media is not as thoroughly scrutinized as some of the more established sources like government health agencies and healthcare providers. As such, it is vital to understand what sources people are trusting for their health information to understand what influences choices they make for their health.

Relatively few studies have examined the relationship between trust in information sources and vaccine uptake, particularly for the emerging sources of health information. Those that have typically focus on pregnant women and parents making decisions for their child's immunizations. Further research should be conducted to examine this relationship in the context of adult vaccines. This is a significant gap as coverage of routinely recommended adult vaccines are low compared to the high rates of childhood immunizations.[37,38] Understanding this relationship can be leveraged to bridge this gap by identifying information sources through which vaccine communication will be most effective in increasing adult vaccine uptake.

Introduction

Vaccines are widely regarded as one of the greatest achievements of public health.[39,40] The success of most vaccines is two-fold in that they provide direct protection for vaccinated individuals while also conferring indirect protection of susceptible individuals in a community; the latter effect is often referred to as "herd immunity" or "community immunity."[1,41] Achieving high levels of coverage is essential to maximize vaccine effectiveness.[1] The majority of existing vaccine promotion efforts focus on childhood immunizations[42]; strategies range from vaccine requirements for school entry in the US to monetary incentives for parents of vaccinated children in Australia to financial penalties for failing to adhere to strict vaccine mandates in Slovenia.[43] In comparison, fewer external motivators exist to encourage adult vaccine uptake aside from requirements for specific high-risk subgroups such as healthcare workers and residents of long-term care facilities.[42,44,45] In the absence of social and regulatory pressures, adult vaccination is primarily left to individual discretion. Relatedly, adult vaccine coverage rates often lag far behind the near 90% coverage of most childhood immunizations.[46] As such, understanding factors that influence the decision to receive adult vaccines is crucial to effectively promote their uptake.

There are several vaccines recommended for adults. Some, including the zoster and pneumococcal vaccines, have specific age-based recommendations.[47] For the purposes of this analysis, we focused on vaccines more widely recommended for all adults rather than specific age groups. In the US, the CDC routinely recommends two vaccines for all Americans over 18 years of age: the seasonal influenza vaccine and the decennial tetanus, diphtheria, and pertussis (Tdap)/tetanus and diphtheria (Td) booster.[47] The seasonal influenza vaccine protects against the strains of influenza virus research indicates will dominate in a given influenza season, which

typically lasts from October to April.[27,48] Influenza vaccines are multivalent, meaning they protect against more than one strain of the virus.[27] Most are trivalent or quadrivalent, protecting against 3 or 4 strains, respectively.[27] There are two widely available types of influenza vaccine: live attenuated influenza vaccines (LAIV) and inactivated or recombinant influenza vaccines.[49] Though the mechanism of action differs for each vaccine type, most advisory groups including the Advisory Committee on Immunization Practices (ACIP) do not express a preference for one vaccine type over another; that said, the LAIV is contraindicated for people who are pregnant as well as immunocompromised individuals.[49,50] Recommendations regarding seasonal influenza vaccination of adults vary globally.[51] While the US recommends all adults over age 18 receive a seasonal influenza vaccine, in the UK and France the national strategy is to target those at a higher risk of severe disease from influenza virus infection, which includes older adults over the age of 65, people who are pregnant, and those with certain health conditions.[47,51,52] In 2020 the UK expanded these recommendations to include adults age 50 and over to reduce the strain on the healthcare system during the COVID-19 pandemic as well as prevent cases of severe disease resulting from co-infection with the influenza and SARS-CoV-2 viruses.[53] In the 2019-2020 influenza season, 48% of US adults over the age of 18 received a seasonal influenza vaccine, with 70% of adults 65 and older vaccinated.[37] In the same influenza season, 72 and 45% of adults over 65 received a seasonal influenza vaccine in the UK and France, respectively.[38,54]

The second routinely recommended adult vaccine is a tetanus containing booster. Unlike influenza and most other vaccine preventable diseases, tetanus cannot be transmitted from person to person, which means the vaccine only provides direct protection to the vaccinated individual; in other words, there is no herd immunity effect from tetanus vaccines.[55,56] Tetanus is an acute disease caused by infection with a bacterium called *Clostridium tetani*.[57] The bacteria enters the

body through breaks in the skin and once inside produces toxins that impair motor neurons, leading to generalized rigidity and painful muscle spasms, particularly of the jaw and neck muscles.[58–60] Tetanus immunity is reliant on anti-toxin antibodies; if antibody titers fall below a certain threshold, immunological memory cannot confer protection.[61] As such, tetanus containing vaccines are recommended as booster doses several years after initial vaccination to bolster waning immunity levels.[62] There are multiple variations of adult tetanus containing boosters, the two most common being Td and Tdap.[25,60] The Td vaccine protects against tetanus and diphtheria while the Tdap vaccine confers additional protection against pertussis; in some countries, adults are administered these vaccines in conjunction with the inactivated polio virus (IPV) vaccine.[25,63,64] The ACIP recently expanded recommendations to allow for either the Td or Tdap vaccine to be administered as a booster dose; prior to this update, the Td vaccine was the official recommendation.[65] In the US, all adults over age 18 are recommended to receive a tetanus containing booster every 10 years.[25] In France, the recommendation is to receive a tetanus containing vaccine every 20 years until age 65, after which it is recommended every 10 years.[56,66] In the UK, tetanus containing boosters are only recommended for high-risk groups, which includes adults over the age of 65.[66] In all three countries, Tdap vaccination is recommended for people who are pregnant.[25,66] Tetanus containing booster coverage is typically around 62% in the US.[38,67] Data on coverage rates for tetanus containing boosters in Europe and the UK is sparse, though one estimate suggests 71% coverage of French adults.[56,68]

There are a variety of reasons adults may choose not to receive a recommended vaccine. These include the perceived lack of necessity of vaccines, fear of vaccine components, distrust of institutional medicine, and others.[1,8] Underscoring many of these motives is the information an individual is exposed to, which in large part is determined by the medium or mediums they

utilize for health information. Importantly, not all vaccine information is equally credible. While information from traditional sources of health information such as doctors and health departments is typically subjected to thorough review, more contemporary sources such as news media and social media are not beholden to this same level of scrutiny; as such, the validity of information from these sources is not always reliable.[1,23] Despite this uncertainty, media sources are often more widely accessible, particularly in contrast to sources such as doctors whose accessibility can be contingent on additional factors such as access to health insurance.[16] For these reasons, it is vital to understand what sources people trust for their health information so we may begin to understand how this influences decisions to get vaccinated. Understanding the motivations underlying this decision is essential to determine how to effectively promote adult vaccine uptake and thereby increase protection from vaccine preventable diseases. The primary objectives of this study were to determine what sources adults trust for information about the seasonal influenza vaccine and tetanus containing booster and whether that trust predicts uptake of these two routinely recommended adult vaccines.

Methods

Data Collection

Data used in this study were collected by the Imperial College of London and Double Helix Development with funding from Sanofi Pasteur as part of the "Attitudinal Barometers of Vaccination" survey. Participants completed the cross-sectional survey either online or via telephone over a one-month period from February to March of 2014. All participants were over the age of 18 and provided informed consent prior to data collection. This analysis of previously collected data was approved by the Emory University Institutional Review Board (IRB).

This analysis used responses from participants in the US, UK, and France. Basic demographic information was collected including country of residence, age, sex, and education; race and ethnicity data were only collected for US and UK participants. Participants were asked to self-report whether they had received an influenza vaccine in the past 6 months (yes/no) as well as whether they had received a tetanus containing booster in the last 10 years (yes/no/don't know). In addition, participants were asked to indicate how strongly they agreed with statements about trust in specific sources of health information with regard to the influenza vaccine and tetanus containing boosters on an 11-point Likert Scale (1 = strongly disagree to 10 = strongly agree, 11 = Don't know/not applicable). The four information sources queried were health departments, news media, social media, and doctors. Full language of the survey statements is documented in Box 1; specific language was determined by what was most appropriate for the participants reported country of residence.

Statistical Analysis

Descriptive statistics, including frequencies and percentages, were calculated for demographic characteristics, adult vaccine receipt, and trust in the various sources of health information for each vaccine type. The 11-point Likert scale utilized for the trust in information sources questions was dichotomized into disagree (0-5) and agree (6-10). In the interest of data completeness, "Don't know/not applicable" responses were included as part of descriptive statistics, as were "Do not know/do not remember" responses to tetanus containing booster receipt; however, these responses were later coded as missing for the purposes of the binomial regression models. Statistical significance was set at α=0.05 for all analyses.

A log-binomial regression model was fit to estimate the association between adult vaccine uptake and trust in different sources of health information. Vaccination outcomes were dichotomized as yes/no, with "Do not know/do not remember" responses to tetanus containing booster receipt coded as missing. Initial models estimating the association of each information source independently with vaccine receipt were run to obtain unadjusted prevalence ratios (PR) with 95% confidence intervals. We obtained adjusted prevalence ratios (aPR) for each information source accounting for the impact of trust in the other examined information sources. Finally, we adjusted for demographic covariates previously demonstrated to be associated with the uptake of these two vaccines. For the influenza model, this included country of residence, age, race, and education; however, the full model failed to converge. We then ran a model assessing the impact of the demographic covariates alone as well as separate models examining the impact of each covariate in conjunction with the trust variables. For tetanus containing booster receipt, a full model with all four information source variables in addition to the pertinent

demographic covariates was run to estimate an aPR for each variable. All analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC).

Results

A total of 2,541 responses were collected from participants in the US, UK, and France (Table 1). Participants were predominantly non-Hispanic white (79%) with an education level of high school or less (43%) (Table 1). About a third (36%) of participants reported receiving an influenza vaccine in the past 6 months, while over half (54%) reported receiving a tetanus containing booster in the last 10 years (Table 1). Doctors were the most trusted source of vaccine information for both vaccine types followed by health departments (Table 1). While reported trust in information sources was primarily consistent across vaccine types, there were notable differences among French participants for trust in health departments. Less than half of French participants (46%) reported trusting this source for information about the seasonal influenza vaccine while a larger proportion (58%) agreed with statements about trusting health departments for information about tetanus containing adult boosters (Table 1).

Factors associated with influenza vaccine receipt

Trust in health departments and doctors were associated with over a three-fold increase in influenza vaccine receipt (PR: 3.11; 95% CI: 2.64, 3.66 and PR: 3.48; 95% CI: 2.77, 4.37, respectively) (Table 2). Those who reported trusting news media and social media for influenza vaccine information were about twice as likely to receive the vaccine (PR: 2.19; 95% CI: 1.97, 2.45 and PR: 1.67; 95% CI: 1.48, 1.87, respectively) (Table 2). After controlling for trust in other information sources, the association between trust in social media and influenza vaccine receipt was no longer significant (aPR: 1.05; 95% CI: 0.93, 1.19) (Table 2).

When examining demographic covariates alone, country of residence and age had the strongest associations with influenza vaccine receipt. UK respondents were about 10% less likely than Americans to have received the influenza vaccine (aPR: 0.89; 95% CI: 0.80, 0.98); French

respondents were about 50% less likely (aPR: 0.53; 95% CI: 0.46, 0.61) (Table 2). Compared to individuals aged 18-44, older participants were more likely to receive the influenza vaccine; those age 45-64 were 1.33 times more likely than those age 18-44 (95% CI: 1.16, 1.52) and those over 65 were 2.45 times more likely (95% CI: 2.17, 2.76) (Table 2).

Factors associated with tetanus containing booster receipt

Participants who reported trusting health departments for tetanus containing booster information were 1.29 times more likely to have received a tetanus containing booster in the last 10 years than those who did not (95% CI: 1.19, 1.40) (Table 3). Similarly, participants who trusted doctors were 1.38 times more likely to have received a tetanus containing booster than those who did not (95% CI: 1.23, 1.55) (Table 3). Participants who trusted news media for tetanus containing booster information were slightly more likely to receive the vaccine (PR: 1.08; 95% CI: 1.01, 1.15) (Table 3). There was not a statistically significant association between trust in social media for tetanus containing booster information and booster receipt (PR: 1.02; 95% CI: 0.94, 1.11) (Table 3). After adjusting for trust in other information sources, the association between trust in news media and tetanus containing booster vaccine receipt became null (aPR: 1.01; 95% CI: 0.93, 1.09) (Table 3).

When additionally adjusting for demographic covariates, statistically significant associations between trust in traditional sources of health information and tetanus containing booster receipt persisted (health department aPR: 1.27; 95% CI: 1.15, 1.40 and doctor aPR: 1.17; 95% CI: 1.03, 1.34, respectively) (Table 3). UK residents were significantly less likely to receive the tetanus containing booster when controlling for all other variables (aPR: 0.64; 95% CI: 0.57, 0.72) (Table 3). Adults over the age of 65 were about 8% more likely than those 18-44 to report receiving a tetanus containing booster (aPR: 1.08; 95% CI: 1.00, 1.15) (Table 3).

Discussion

We found that doctors and health departments are the most trusted sources of adult vaccine information; these findings are consistent with previous studies in adult and childhood immunizations.[1,9,11] Notably, less than half of French participants agreed with statements about trusting health departments for seasonal influenza vaccine information while 58% agreed with statements about trusting the same source for information about tetanus containing adult boosters. In contrast, over 60% of US and UK participants reported trusting this source for both vaccine types. This paradox could be the result of growing distrust of public officials in France in recent years.[31,69] Furthermore, the seasonal influenza vaccine is altered on an annual basis, and previous research has demonstrated that newer vaccines are typically met with more skepticism relative to more established vaccines.[1,27] While the influenza vaccine is not inherently new each season, its variable nature in combination of with distrust of health authorities this may explain in part the lower trust in health departments we observed for influenza vaccine information compared to tetanus containing booster information among French participants.

Overall associations between trust in each information source and vaccine receipt were stronger for the seasonal influenza vaccine compared to the tetanus containing adult booster. Again, this may be linked to the changing nature of the seasonal influenza vaccine as well as the differing transmission dynamics of the diseases each vaccine prevents.[1,27,57] Trust in doctors and health departments were the strongest predictors of uptake of both vaccines. These findings underscore the importance of the patient-physician relationship in guiding adult vaccine decisions. Doctors should take care to regularly check their patient's vaccination history and make recommendations where gaps are identified. Our findings suggest that such recommendations can be influential in a patient's decision to vaccinate. Furthermore, effective

communication by health agencies in the form of clear guidelines and recommendations are another important factor in promoting adult immunization. Adult vaccine information from these sources is highly trusted and has the power to increase overall coverage.

Trust in news media was associated with increased receipt of the seasonal influenza vaccine; however, after adjusting for other information sources as well as demographic covariates, the association with tetanus containing booster receipt was no longer significant. This may be due to the nature of the diseases each of these vaccines prevent. Influenza virus outbreaks are a constant part of the news cycle throughout influenza season, and this coverage is associated with higher vaccination rates.[70] In contrast, tetanus is not a contagious disease and thus cases are far less likely to make headlines as fewer people are impacted.[57] Tetanus containing boosters have not been a major part of the news cycle since the DTP scare back in the late 1990's.[29,30] Our findings suggest that trust in news media is particularly important when vaccines or the disease they prevent is a part of the news cycle; as such, this medium could play an important role in the uptake of COVID-19 vaccines.[24]

While social media is an appealing candidate for vaccine promotion efforts due to its widespread accessibility, our findings suggest that trust in this information source is quite low and is not associated with adult vaccine uptake.[71] As such, vaccine messages communicated through this medium may have less of an impact on vaccine receipt compared to similar messages from more trusted sources. It is important to recognize, however, that information sources do not exist in a vacuum; individuals do not solicit advice from one medium at the exclusion of all others.[9,17] Indeed, our findings support this notion as the magnitude of association between vaccine receipt and trust in each information source was attenuated after adjusting for trust in other sources of information. Multiple mediums can be used in concert to

promote vaccine uptake more effectively. As an example, social media accounts from healthcare providers and government health officials can leverage the reach afforded by social media to amplify their trusted voices.[71]

Our findings aligned with country specific age guidelines for each vaccine, with uptake most strongly associated with those over 65 years of age.[47,51,52] Additionally, we observed differences in tetanus containing adult booster receipt that aligned with country recommendations; compared to the US where this booster is recommended decennially for all adults, it is only recommended for those over the age of 65 in the UK.[25,66] Indeed, we observed that UK participants were less likely than those in the US to receive tetanus containing boosters when controlling for all other factors. In France tetanus containing boosters are recommended every 20 years until age 65 after which the recommendation is every 10 years[56]; receipt did not differ significantly from US participants, possibly because of this similarity in guidance. Adult vaccine recommendations are typically established by health agencies and then communicated by doctors at the point of care.[1,6] These findings offer further support of the importance of health agencies setting clear guidelines for adult vaccines in addition to providers regularly checking patient vaccine histories and making recommendations in accordance with these guidelines.

Limitations

This study was not without limitations. Vaccine receipt was reliant on participant self-reporting; actual vaccine receipt was not verified. Additionally, recall of tetanus containing booster receipt was likely challenging due to the decade or more between vaccinations. The survey included a "do not know/do not remember" answer choice to account for this uncertainty, however this left us unable to use data from participants who selected this answer choice when evaluating factors influencing tetanus containing booster receipt. Despite these challenges,

reported receipt of both vaccines in this study aligned with country specific estimates.[37,38,54,56,67,68]

Furthermore, the omission of a race/ethnicity survey question for French participants as well as the inconsistent categorization of racial and ethnic groups across the US and UK surveys hindered our ability to accurately estimate the role of trust in health information sources in adult vaccine uptake. Certain racial minority populations have a history of distrust of physicians and institutional medicine due to systemic medical mistreatment and exploitation[72,73]; additionally, vaccine coverage of these groups is typically lower relative to their white counterparts.[74] As such, accounting for race in this association is important to understanding the true relationship.

Moreover, a full model with the four information sources and all pertinent demographic covariates failed to converge for influenza vaccine receipt due to small cell sizes. As such, we were unable to directly estimate the effect of each of these predictors when controlling for all others; instead, we examined each trust variable controlling for all demographics as well as all four information sources together in a model.

Conclusions

We found that traditional sources of health information like doctors and health departments are the most trusted sources for information about the seasonal influenza vaccine and tetanus containing adult booster. Furthermore, we established that this trust is associated with increased uptake of these two vaccines. These findings highlight the importance of health departments setting clear and comprehensive guidelines for adult vaccines as well as healthcare providers regularly reviewing vaccine histories and communicating these recommendations when appropriate. Our study demonstrates that such actions have a significant impact on increasing adult vaccine uptake.

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Tables & Figures

Table 1. Characteristics of *Attitudinal Barometers of Vaccination* survey participants in the US, UK, and France, February – March 2014

Characteristic	**Overall** (n=2541)	**United States** (n=846)	**United Kingdom** (n=847)	**France** (n=848)
Age (years)				
18-44	1131 (45%)	365 (43%)	377 (45%)	389 (46%)
45-64	893 (35%)	319 (38%)	295 (35%)	279 (33%)
65+	517 (20%)	162 (19%)	175 (21%)	180 (21%)
Sex				
Female	1340 (53%)	434 (51%)	445 (53%)	461 (54%)
Male	1201 (47%)	412 (49%)	402 (47%)	387 (46%)
Race/Ethnicity*				
White**	1327 (79%)	578 (69%)	749 (89%)	
Black***	114 (7%)	100 (12%)	14 (2%)	
Asian****	92 (5%)	37 (4%)	55 (7%)	
Other*****	147 (9%)	125 (15%)	22 (3%)	
Education				
High school diploma or less	1097 (43%)	331 (39%)	427 (50%)	331 (39%)
University diploma	636 (25%)	301 (36%)	231 (27%)	104 (12%)
Higher degree	395 (16%)	159 (19%)	92 (11%)	144 (17%)
Other	413 (16%)	55 (7%)	97 (11%)	261 (31%)
Received influenza vaccine in past 6 months				
Yes	921 (36%)	407 (48%)	316 (37%)	198 (23%)
No	1620 (64%)	439 (52%)	531 (63%)	650 (77%)
Received tetanus booster in last 10 years				
Yes	1366 (54%)	487 (58%)	295 (35%)	584 (69%)
No	812 (32%)	239 (28%)	396 (47%)	177 (21%)
Do not know/do not remember	363 (14%)	120 (14%)	156 (18%)	87 (10%)
Trust health department about influenza vaccine				
Agree	1554 (61%)	532 (63%)	635 (75%)	387 (46%)
Disagree	869 (34%)	285 (34%)	164 (19%)	420 (50%)
N/A	118 (5%)	29 (3%)	48 (6%)	41 (5%)
Trust news media about influenza vaccine				
Agree	970 (38%)	395 (47%)	373 (44%)	202 (24%)
Disagree	1418 (56%)	412 (49%)	394 (47%)	612 (72%)
N/A	153 (6%)	39 (5%)	80 (9%)	34 (4%)
Trust social media about influenza vaccine				
Agree	435 (17%)	189 (22%)	141 (17%)	105 (12%)
Disagree	1769 (70%)	560 (66%)	526 (62%)	683 (81%)
N/A	337 (13%)	97 (11%)	180 (21%)	60 (7%)
Trust doctor about influenza vaccine				
Agree	1887 (74%)	628 (74%)	675 (80%)	584 (69%)
Disagree	539 (21%)	181 (21%)	123 (15%)	235 (28%)
N/A	115 (5%)	37 (4%)	49 (6%)	29 (3%)
Trust health department about tetanus vaccine				
Agree	1602 (63%)	534 (63%)	578 (68%)	490 (58%)
Disagree	706 (28%)	240 (28%)	154 (18%)	312 (37%)
N/A	233 (9%)	72 (9%)	115 (14%)	46 (5%)
Trust news media about tetanus vaccine				
Agree	911 (36%)	354 (42%)	293 (35%)	264 (31%)
Disagree	1304 (51%)	399 (47%)	381 (45%)	524 (62%)
N/A	326 (13%)	93 (11%)	173 (20%)	60 (7%)
Trust social media about tetanus vaccine				
Agree	428 (17%)	180 (21%)	132 (16%)	116 (14%)
Disagree	1677 (66%)	532 (63%)	504 (60%)	641 (76%)
N/A	436 (17%)	134 (16%)	211 (25%)	91 (11%)

Trust doctor about tetanus vaccine				
Agree	1934 (76%)	632 (75%)	632 (75%)	670 (79%)
Disagree	384 (15%)	137 (16%)	103 (12%)	144 (17%)
N/A	223 (9%)	77 (9%)	112 (13%)	34 (4%)

*Race/ethnicity data not available for France

**Includes participants who reported “White or European American” or “White British or Irish”

***Includes participants who reported “Black or African American,” “Black African,” or “Black Caribbean”

****Includes participants who reported “Asian American,” “Asian or Asian British: Indian,” “Asian or Asian British: Pakistani,” “Asian or Asian British: Bangladeshi,” “Asian or Asian British: Chinese,” or “Asian or Asian British: Other Asian”

*****Includes participants who selected “Other,” “Hispanic or Latino,” “Native American/American Indian or Alaska,” or “Mixed Race”

Table 2. Associations between influenza vaccine receipt and trust in different health information sources adjusting for other information sources and demographic covariates among *Attitudinal Barometers of Vaccination* survey participants in the US, UK, and France, February – March 2014

	Model						
Variable	**Information source alone** PR (95% CI)	**Adjusting for other information sources** aPR (95% CI)	**Adjusting for demographic covariates** aPR (95% CI)	**Adjusting for other information sources and country of residence** aPR (95% CI)	**Adjusting for other information sources and age** aPR (95% CI)	**Adjusting for other information sources and race** aPR (95% CI)	**Adjusting for other information sources and education** aPR (95% CI)
Trust health department about vaccine							
Agree	3.11 (2.64, 3.66)	1.91 (1.54, 2.35)	N/A	1.87 (1.51, 2.31)	1.89 (1.53, 2.33)	1.90 (1.54, 2.35)	1.89 (1.53, 2.34)
Disagree	Referent	Referent	N/A	Referent	Referent	Referent	Referent
Trust news media about vaccine							
Agree	2.19 (1.97, 2.45)	1.38 (1.20, 1.59)	N/A	1.27 (1.11, 1.46)	1.30 (1.15, 1.48)	1.37 (1.19, 1.57)	1.38 (1.20, 1.58)
Disagree	Referent	Referent	N/A	Referent	Referent	Referent	Referent
Trust social media about vaccine							
Agree	1.67 (1.48, 1.87)	1.05 (0.93, 1.19)	N/A	1.04 (0.92, 1.17)	1.09 (0.98, 1.20)	1.03 (0.91, 1.17)	1.06 (0.93, 1.20)
Disagree	Referent	Referent	N/A	Referent	Referent	Referent	Referent
Trust doctor about vaccine							
Agree	3.48 (2.77, 4.37)	1.78 (1.37, 2.32)	N/A	1.83 (1.41, 2.38)	1.74 (1.35, 2.26)	1.78 (1.37, 2.32)	1.77 (1.36, 2.31)
Disagree	Referent	Referent	N/A	Referent	Referent	Referent	Referent
Country							
United States	N/A	N/A	Referent	Referent	N/A	N/A	N/A
United Kingdom	N/A	N/A	0.89 (0.80, 0.98)	0.72 (0.63, 0.81)	N/A	N/A	N/A
France	N/A	N/A	0.53 (0.46, 0.61)	0.60 (0.51, 0.69)	N/A	N/A	N/A
Age (years)							
18-44	N/A	N/A	Referent	N/A	Referent	N/A	N/A
45-64	N/A	N/A	1.33 (1.16, 1.52)	N/A	1.33 (1.16, 1.52)	N/A	N/A
65+	N/A	N/A	2.45 (2.17, 2.76)	N/A	2.13 (1.88, 2.40)	N/A	N/A
Race/Ethnicity							
White	N/A	N/A	Referent	N/A	N/A	Referent	N/A
Black	N/A	N/A	1.05 (0.88, 1.24)	N/A	N/A	1.28 (1.05, 1.56)	N/A
Asian	N/A	N/A	1.17 (1.02, 1.34)	N/A	N/A	1.21 (0.98, 1.49)	N/A
Other	N/A	N/A	0.96 (0.79, 1.17)	N/A	N/A	1.12 (0.91, 1.37)	N/A
Education							
HS diploma or less	N/A	N/A	Referent	N/A	N/A	N/A	Referent
University	N/A	N/A	1.08 (0.97, 1.21)	N/A	N/A	N/A	1.34 (0.99, 1.30)
Higher degree	N/A	N/A	1.13 (1.00, 1.28)	N/A	N/A	N/A	1.28 (1.11, 1.48)
Other	N/A	N/A	1.24 (1.09, 1.41)	N/A	N/A	N/A	1.11 (0.92, 1.32)

Table 3. Associations between tetanus containing booster receipt and trust in different health information sources adjusting for other information sources and demographic covariates among *Attitudinal Barometers of Vaccination* survey participants in the US, UK, and France, February – March 2014

Characteristic	**Information source alone** PR (95% CI)	**Adjusting for other information sources** aPR (95% CI)	**Adjusting for other information sources and demographic covariates** aPR (95% CI)
Trust health department about vaccine			
Agree	1.29 (1.19, 1.40)	1.17 (1.06, 1.29)	1.27 (1.15, 1.40)
Disagree	Referent	Referent	Referent
Trust news media about vaccine			
Agree	1.08 (1.01, 1.15)	1.01 (0.93, 1.09)	1.00 (0.93, 1.07)
Disagree	Referent	Referent	Referent
Trust social media about vaccine			
Agree	1.02 (0.94, 1.11)	0.93 (0.85, 1.02)	0.95 (0.87, 1.04)
Disagree	Referent	Referent	Referent
Trust doctor about vaccine			
Agree	1.38 (1.23, 1.55)	1.24 (1.09, 1.42)	1.17 (1.03, 1.34)
Disagree	Referent	Referent	Referent
Country			
United States	N/A	N/A	Referent
United Kingdom	N/A	N/A	0.64 (0.57, 0.72)
France	N/A	N/A	1.07 (0.99, 1.15)
Age (years)			
18-44	N/A	N/A	Referent
45-64	N/A	N/A	1.02 (0.95, 1.09)
65+	N/A	N/A	1.08 (1.00, 1.15)
Race/Ethnicity			
White	N/A	N/A	Referent
Black	N/A	N/A	0.86 (0.71, 1.05)
Asian	N/A	N/A	0.92 (0.75, 1.14)
Other	N/A	N/A	0.89 (0.76, 1.05)
Education			
HS diploma or less	N/A	N/A	Referent
University	N/A	N/A	0.99 (0.91, 1.07)
Higher degree	N/A	N/A	1.04 (0.97, 1.12)
Other	N/A	N/A	1.06 (0.98, 1.15)

Box 1. *Attitudinal Barometers of Vaccination* survey questions about level of trust in specific sources of health information regarding the influenza and vaccine tetanus containing booster administered to survey participants in the US, UK, and France, February – March 2014

"I trust the information provided by ***the NHS/Department of Health/National Health Authority*** *about the* ***flu shot/jab****"*

"I trust the information provided by ***news reports on TV & radio or newspapers*** *about the* ***flu shot/jab****"*

"I trust the information provided by ***blogs, Facebook or Twitter*** *about the* ***flu shot/jab****"*

"I trust the information provided by ***my GP/doctor*** *about the* ***flu shot/jab****"*

"I trust the information provided by ***the NHS/Department of Health/National Health Authority*** *about the* ***tetanus containing booster****"*

"I trust the information provided by ***news reports on TV & radio or newspapers*** *about the* ***tetanus containing booster****"*

"I trust the information provided by ***blogs, Facebook or Twitter*** *about the* ***tetanus containing booster****"*

"I trust the information provided by ***my GP/doctor*** *about the* ***tetanus containing booster****"*

Public Health Implications

Increasing vaccine coverage is essential to controlling vaccine preventable disease outbreaks in populations. With fewer policies and regulations surrounding adult vaccines, it is important to understand what influences the decision to get vaccinated. While previous studies have identified doctors and health departments as highly trusted sources of vaccine information, our study reveals that this trust is associated with increased uptake of two routinely recommended adult vaccines. This highlights the importance of these information sources in promoting adult vaccine coverage.

Healthcare providers can promote adult vaccine uptake by regularly checking the immunization history of their patients. When gaps in coverage are identified, doctors can recommend the vaccine or vaccines to their patients. Based on our findings, such a recommendation has a strong impact on the ultimate decision to get vaccinated. To further improve adult vaccine coverage, health agencies should set clear and comprehensive guidelines around adult vaccinations and communicate these recommendations widely. While our research demonstrates health departments are highly trusted for vaccine information, previous studies have revealed this source is not often sought out.[23] As such, improved communication is critical to exerting the influence of health departments on increasing adult vaccine uptake.

Improving adult vaccine coverage is imperative to protecting populations from vaccine preventable disease and death; however, it is especially pertinent amid a global pandemic. As we begin to approach the point of supply of COVID-19 vaccines, which are currently only recommended for those over 16 years of age, overtaking demand in the US and other countries, understanding how to maximize vaccine coverage will be crucial to finally gain control of the

pandemic.[75,76] Our findings suggest that bolstering trust in doctors and health departments will be the most influential in amplifying uptake of COVID-19 vaccines.