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Information source's influence on vaccine perceptions: an exploration into perceptions of knowledge, risk and safety

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ABSTRACT

Background: College-age students are a particularly important population regarding establishing beliefs about vaccines that carry on into later adulthood. One of the primary ways these beliefs can be influenced is via the source of information that students turn to concerning vaccine information.

Method: We administered a survey to 180 college-age students based on the WHO Report of the SAGE Working Group on Vaccine Hesitancy (2014). Questions focused on vaccine beliefs, perceived knowledge, perceived safety and perceived risk. Participants were also measured on sources they would use to obtain information on vaccines (e.g. healthcare providers, news media, government official, social media, friends, and parents).

Results: Based on regression analyses, vaccine beliefs were significantly impacted by safety ($\beta = .44$) and risk perceptions ($\beta = .29$) at the expense of knowledge perceptions. Furthermore, various information sources influenced perceptions of safety (healthcare provider ($\beta = .24$)), risk (social media ($\beta = -.19$)), and knowledge (social media ($\beta = -.20$) and healthcare providers ($\beta = .16$)). Specifically, increases in social media source usage resulted in more negative vaccine beliefs. Conversely, utilization of healthcare providers resulted in more positive vaccine beliefs.

Conclusion: Results suggest, in cases of college-age students, vaccine information should focus on issues dealing with students' perceptions of risk and safety, not their level of knowledge. Additionally, while parents and friends may act as a primary information sources, more attention needs to be paid to the negative impact of social media and the positive impact of healthcare providers.

KEYWORDS

Vaccination; communication; risk; health education

Vaccines have had, and continue to have, a large impact on health worldwide, resulting in the eradication of diseases such as smallpox, wide elimination of poliomyelitis, and preventing approximately 2.5 million deaths globally each year [1]. Communicating about vaccines has presented challenges and requires thoughtful insights about audiences to develop appropriate messaging and helping to improve lives. Such concerns are necessary due in part that despite the documented positive influence of vaccines, the U.S. has observed a rise in vaccine hesitancy [2]. Vaccine hesitancy refers to a delay in acceptance or refusal of vaccines, despite availability of vaccination services [3]. The rise of vaccine hesitancy can be partly attributed to the anti-vaccination sentiments among the public; many of these thoughts were spurred on by the Wakefield et al. [4] research, which described safety concerns of the measles, mumps and rubella (MMR) vaccine [4]. Following the retraction of the article and mounting communication efforts by the Centers for Disease Control and Prevention (CDC) [5] and the World Health Organization (WHO), the U.S. has done remarkably well in re-establishing a high coverage rate (approximately

90%) for most childhood diseases including measles, mumps, rubella, polio and hepatitis B [6]. Despite the high overall coverage rate, a recent study shows that one in three parents are choosing to delay the CDC-recommended vaccine schedule which may contribute to the emergence of childhood vaccine – preventable diseases (VPDs). This delay in vaccines may be heightened and a future cause for concern as the COVID pandemic forges on and parents fear taking children in for regular pediatric visits [7].

While overall vaccination rates remain high here in the U.S., our vulnerability to VPDs has been brought to the forefront with the recent outbreaks in measles, mumps and pertussis – including the 20-state outbreak of measles in 2015 linked to the Disneyland park in California [8], the 2019 measles outbreak in Washington state (which was part of a much larger outbreak [9]), and outbreaks of measles and mumps in university settings and the resurgence of pertussis [10]. Most recently, the COVID-19 pandemic highlighted concerns about diseases when a vaccine is not available [11]. These outbreaks are a reminder that we are still quite vulnerable and face several challenges in managing

outbreaks of VPDs and new emerging diseases. The need for communication efforts remains important, and necessary, to continue preventing these diseases and what new vaccines are available to the public. Communication scholars and practitioners can be at the forefront of helping future vaccine interventions reach people and improve the rates of VPDs.

In reviewing the literature and climate of why VPDs are on the rise, several factors appear. The anti-vaccination movement embedded a degree of uncertainty into the population about the safety of vaccines [12]. In some cases, individuals are questioning the need of a vaccine for a disease that has been considered eradicated or has not been prevalent in the population for a considerable amount of time [12]. Additionally, access to inaccurate and conflicting information on vaccines can be considered as a driving factor for some parents deciding to delay or refuse vaccines for their child [13]. Furthermore, many of the anti-vaccination websites may contain misinformation, leading parents to make anti-vaccination decisions without a full understanding of vaccines [14]. Recent polling has shown a decrease in Americans that feel it is extremely or very important to vaccinate children dropping from 95% in 2001 to 84% in 2020 [15].

Amidst the current COVID-19 pandemic, there is again great concern that recent surges in anti-vaccine activity could undermine efforts to control the spread of coronavirus, once a vaccine is available [16]. The viral spread of anti-vaccination information through social media and YouTube platforms is concerning. Most recently, polls show that 1 in 5 Americans say they will not get vaccinated for coronavirus [17]. Given the clear lack of natural immunity to this virus and the deadly consequences it can have on health and the global economy, communication of sound data regarding vaccines has again become crucial.

It is critical that we, as communication scholars and practitioners, continue to understand perceptions of vaccines in individuals to better understand how to slow the rise of vaccine hesitancy. Specifically, in our study, we focused on college-age students (18–24 years of age) as they are considered ‘emerging adults.’ We are conducting an exploratory line of research into the relationships between information sources and perceptions of risk, safety and knowledge about vaccines. This age-group is often perceived as a key time when individuals are developing their identities as adults [18]. Furthermore, individuals in this stage also display an acceptance of personal responsibility regarding health decisions [19]. Finally, as they are the next potential parental generation, they will have a direct impact on whether their children will follow the recommended childhood vaccination schedule. A Pew Internet & American Life study found that many young adults feel vaccines should be a parental decision, and not mandatory [20]. It suggests that

young adults may be forming opinions about vaccines and deciding to not vaccinate their future children. In this study, we thus sought to understand more about young adults’ risk and safety perceptions of vaccines and perceived knowledge about vaccines, and how sources of information may be influencing these perceptions. We hope this exploration will assist future vaccine communication efforts.

Contributors to vaccine perceptions

While there are many concepts that can be associated with vaccine health behaviors, we chose to focus on aspects that relate to individual vaccine perceptions among college-age students. In particular, we selected the variables of perceived beliefs, perceived knowledge, perceived risk, and perceived safety. These concepts draw from the WHO Report of the SAGE Working Group on Vaccine Hesitancy [3] as key contributors related to vaccine hesitancy. Specifically, we argue that college-age students’ vaccine beliefs, their perceived level of knowledge, their perceptions of risk, and the perceived safety of vaccines can be impacted by the sources of information that college-age students use to learn about and inform their perceptions of vaccines. Communication scholars and practitioners can use this information to assist in messaging and future vaccination interventions.

Vaccine health beliefs

The relationship between health beliefs and health behaviors has been studied for years across a variety of health issues in health communication [21]. In each of these contexts, research suggests that understanding how health beliefs are formed, and subsequently can predict health behaviors, is a key first step for communicating a health issue [21]. The importance of vaccine health beliefs in relation to vaccine hesitancy is no exception. One study found the relationship between flu vaccine beliefs among the college-age population is augmented by social networks that support vaccination [22]. Furthermore, intrapersonal variables (e.g. attitudes and beliefs) accounted for the most variance (53%) of intentions to get a H1N1 influenza vaccine among college-age students [23]. Additionally, another study found negative health beliefs about vaccines persisted among their college-age sample, especially among those who had vaccination waivers [24]. Therefore, the relationship between vaccine health beliefs and determinants of vaccine hesitancy are important to assess.

Perceived knowledge

Understanding the knowledge young adults have about vaccines can be a key contributor to better

communication about vaccine effectiveness and VPDs. Research suggests knowledge can be a precursor to forming attitudes and behavioral intentions [25], as well as preventive health behaviors [26]. However, in the context of vaccines and the possibility of conflicting information available from multiple sources, it may be more likely that young adults have *perceived knowledge* of vaccines. Various research on health issues have suggested that studies asking about knowledge are assessing individual's perception of their knowledge and not actual knowledge. Heiss et al. [10] found knowledge about pertussis among participants was that it was a 'childhood disease' and thus booster vaccinations are not needed. Additionally, knowledge about when and how many vaccines are needed is inaccurate among many audiences. This lack of knowledge could be attributed to the 'lay theory of immunity' which states that too many vaccines can overload an immune system, especially a child [13,27]. Furthermore, regarding the human papillomavirus (HPV) vaccine, one study found a mis-understanding that the vaccine provided complete protection against cervical cancer led to decisions of vaccine acceptance [28]. Thus, it is quite possible that college-age students may perceive they understand vaccines and the vaccine process, but in fact they do not. It is therefore important to learn what sources of information may be contributing to these perceived knowledge thoughts.

Perceived risk

Perceptions of risk are particularly central for precautionary actions [29], such as vaccines and VPDs. In studying vaccine hesitancy, risk perceptions are in relation to estimations about vaccines helping to prevent diseases and the general effectiveness of vaccination for VPDs and the severity of VPDs [3,13]. Raising risk concerns about vaccines has remained a forefront of many anti-vaccination movements, whereas many public awareness campaigns have sought to decrease them [12]. Communication about risks associated with vaccines could be argued as one of the key predictors of vaccine related behaviors [13]. One meta-analysis of 34 studies assessing risk perceptions and vaccines found risk perceptions, defined as risk likelihood (pooled $r = .26$), susceptibility (pooled $r = .24$) and severity (pooled $r = .16$), were significant predictors of vaccination behavior [30]. Among college-age students, there is research about risk perceptions and its significant relationship to the HPV vaccine uptake or refusal (e.g. [31–33]). Thus, assessing risk perceptions and its relationship to sources of information remains vital towards improving vaccine related communication.

Perceived safety

Similar to perceived knowledge and perceived risk, perceptions of safety have been shown to impact vaccination beliefs [13]. In most cases, safety concerns surround potential side-effects or adverse reactions to particular vaccines [3,34,35]. In a study involving predictors of vaccine acceptance amongst adults, safety perceptions were found to act as barriers or promoters based on whether they were positive or negative among participants [35]. Safety perceptions were also shown to impact vaccine intent [23], as well as delays in getting vaccinated [3]. A recent study of college-age students found the safety of giving and receiving a vaccine to be a significant influence in getting a vaccination [24]. For young adults, these perceptions on safety, risks, and knowledge can be influenced by the multiple sources they interact with about vaccines, and if these resources provide consistent or conflicting information.

Sources of vaccine information

The central relationship between sources of health information and health outcomes cannot be denied [21]. The influence of various information sources – from health communication experts, doctor-patient relationships, and family to public health campaigns – can all have an impact on individuals forming their attitudes, beliefs and health behaviors [10,21]. Vaccine related information is no exception and various sources have contributed to the perceptions and knowledge about vaccines and VPDs. Impressions about vaccines for young adults are similarly impacted, most likely being formed by many experiences and communication with a variety of sources including social networks, health professionals, family members, and others.

Government and news media

Many public health awareness campaigns are designed to help individuals understand the importance of getting vaccinated, with the hopes that this will persuade them to get vaccinated. Government agencies such as the CDC dedicate several resources to vaccine information related information and communication messages [5]. Additionally, state and local public health agencies can provide information about vaccines such as the season flu vaccine [36]. Thus, many government sources (both Federal and state) can be providing information and helping young adults learn about vaccines and VPDs. Their efforts often are seen as credible and reliable resources of vaccine information to best inform audiences. Previous research suggests that trust in the government can influence uptake of government-recommended behaviors [37].

However, it is possible for college-age students to be exposed to messages that are not designed by government public health awareness efforts and may provide conflicting information. In fact, college-age students can receive media messages about vaccines framed in multiple ways [38]. In particular, the news media may represent an often-unreliable source of information. The negative effects of news media coverage on health issues is often reported across health issues [39]. In particular, 'the media raise concerns by reporting ostensible risks that are later shown to be false (e.g. the Millennium bug, safety concerns regarding H1N1 influenza vaccines),' ([40], p. 146). Or, the news media neglect to include full details about the vaccines. For example, a content analysis of news coverage (e.g. print and broadcast) on HPV vaccines found 'the majority of news stories lacking vital pieces of information about the vaccine or HPV prevention,' ([41], p. 7). Thus, understanding how reliance or use of government and news media sources of information could be important contributors to vaccine related beliefs, knowledge and perceptions.

Internet and social media

In addition, the Internet and social media provides a range of messages regarding vaccines and VPDs, which often times can be laden with misinterpreted or false information [48]. In fact, some of the vaccine information online can be misleading or potentially dangerous (e.g. [42–44]). For example, websites can falsely claim how vaccines can cause an illness (e.g. autism), and are not effective or safe (e.g. contaminated) [45]. Furthermore, user-generated vaccine related content can be conflicting [46]. Often, the negative information available may outweigh the positive information [32,47]. Recent research also suggests that social media may provide even more damaging effects related to vaccine perceptions. 'The interactive and interpersonal nature of many social media sites could make posted anti-vaccine content particularly potent,' ([48], p. 152). Furthermore, research suggests that an individual's ability to distinguish credibility differences in sources is dependent on their motivation to do so [49]. Thus, in cases where lack of motivation exists, perceptions of credibility may take a secondary role (if any) to comfort level with the communication medium. Thus, college-age students, already comfortable with social media and the Internet turn to these mediums instead of others and fail to see a disparity between them.

Healthcare providers, family and friends

Other sources may also influence vaccination perceptions [50]. Despite the wealth of information available online or through social media, vaccination

conversations often occur in interpersonal settings. For instance, Heiss et al. [10] found healthcare providers to be a significant source for vaccine related decisions about pertussis. Many times, family members, healthcare providers, and friends are used to provide direction and advice about vaccines [51]. As children, young adults were accompanied by parents to visit their pediatrician's office to receive vaccines, and upon entering post-secondary school, required to fill out a card of vaccines received. Therefore, parents provide a key source of information to these students at a young age. Furthermore, learning others' experiences with vaccines from social networks (e.g. friends, co-workers, etc.) can also influence vaccine related decisions [10,52]. Similarly, the presence of social networks willing to discuss vaccine related information, has been shown to significantly impact perceptions and intentions concerning vaccines in college-age students [22].

The question remains as to which sources these college-age students go to and in turn, what effect does the source have on the risk and safety perceptions and knowledge these young adults have of vaccines. Taken together, the aforementioned literature suggests the following inquiries:

HYP 1: Positive beliefs about vaccines by college-age students will be impacted by the level of knowledge, risk and safety perceptions that students possess.

RQ1: How are college-age students' levels of perceived knowledge surrounding vaccinations impacted by various informational sources (government officials, news media, Internet/social media, family/friends or healthcare professionals)?

RQ2: How are college-age students' levels of perceived risk surrounding vaccinations impacted by various informational sources (government officials, news media, Internet/social media, family/friends or healthcare professionals)?

RQ3: How are college-age students' perceptions regarding the safety of vaccinations impacted by various informational sources (government officials, news media, Internet/social media, family/friends or healthcare professionals)?

Method

The purpose of this study is to explore the associations and impact of sources of information on vaccine related perceptions of risk, safety and perceived knowledge on vaccines.

Participants

A total of 255 participants completed an online survey. The criteria for participation was at least 18 years of age. Full sample ages ranged from 18 to 74 years of age, which included parents and grandparents. Given

that the focus of this study was college-age students, this analysis focuses on a subset of 180 respondents, 18–24 years of age, of the larger sample. Of these 180 young adults, the majority are female ($n = 114$; 63.3%), have some college experience ($n = 131$; 72.8%), and self-reported being White/Caucasian ($n = 123$; 68.3%).

Procedure

Participants were recruited from a convenience sample and snowballing technique at two private Northeastern universities to participate in an online survey. Recruitment consisted of emails announcing the study with the survey URL to staff and faculty and encouraging faculty to forward the study information to their classes in Social Science, Natural Science, Humanities, Math, and Business at both schools. Additionally, flyers were posted throughout one campus providing the URL to the survey. Institutional Review Board (IRB) approval was granted.

Upon entering the study URL, all participants were provided an informed consent form outlining their rights as a participant in the study. Respondents then answered a series of questions assessing their knowledge, perceptions and thoughts of vaccinations, and demographics (e.g. age, race/ethnicity). At the end of the survey, participants were asked to click on a separate URL to submit their email address to be entered into a drawing to win a \$25 gift card. It was at the discretion of individual faculty forwarding the study to their students to offer an additional incentive of extra credit for their classes. All participants answered the survey once, and the study took approximately 20 minutes to complete.

Variables

Variables were derived from the WHO Report of the SAGE Working Group on Vaccine Hesitancy [3] and previous cited literature on vaccine perceptions. All questions were asked along a 5-point Likert scale of '1 = Strongly Disagree' to '5 = Strongly Agree.'

Vaccine beliefs

Participants indicated their beliefs surrounding vaccinations via three items ($M = 3.23$; $SD = .76$; Cronbach $\alpha = .70$). Statements were 'I believe there are better ways to prevent vaccine preventable disease than with a vaccine' [reverse coded], 'I think vaccines strengthen the immune system,' and 'I think it is possible to have too many vaccines' [reverse coded].

Perceived knowledge

Young adults indicated if they agreed or disagreed with 10 statements about their knowledge of vaccines in general, and specific vaccines such as HPV, polio,

measles and flu, and booster vaccines ($M = 3.44$; $SD = .53$; Cronbach $\alpha = .73$). Questions related to general and specific vaccines were asked to reflect individuals may have a general understanding of vaccines and the vaccine process, but may not have specific knowledge about vaccines for VPDs. Example items include 'I know which vaccines I should get for myself,' 'I have heard about the HPV vaccine,' 'I think the measles vaccine is still needed,' 'I understand how vaccines work,' and 'I understand the basic primary mechanism for how vaccines work to boost the immune system.'

Risk perceptions

Participants responded to five items about their agreement or disagreement about the risks associated with vaccines ($M = 3.55$; $SD = .58$; Cronbach $\alpha = .71$). Statements included 'I consider other activities more important than getting a vaccine' [reverse-coded], 'I believe vaccine preventable diseases can be serious,' and 'I think vaccines are effective.'

Safety perceptions

Participants responded with their opinions about the safety of vaccines, the side effects and information shared about safety information. A total of seven statements were included about safety concerns ($M = 3.57$; $SD = .69$; Cronbach $\alpha = .84$). Safety perceptions were selected as they qualitatively represent a difference among individuals than risk perceptions [3]. Items included 'I think there is adequate safety information given about vaccines,' 'I trust that adverse vaccine reactions will be reported to the general public,' 'I believe vaccines are safe for me,' and 'I believe vaccines are safe for my community.'

Sources of Information

Participants were asked to indicate how likely they would use the following sources to obtain information on vaccines: (a) healthcare providers ($M = 3.91$; $SD = .97$); (b) news media ($M = 3.25$; $SD = 1.05$); (c) government official ($M = 2.73$; $SD = 1.03$); (d) social media (e.g. Twitter, Facebook, etc.) ($M = 2.71$; $SD = 1.19$); (e) friends ($M = 3.16$; $SD = 1.01$); and (f) parents ($M = 3.93$; $SD = .93$).

Data analysis

Data were analyzed using SPSS Statistics 25. The analyses involved descriptive statistics, Pearson correlations and standard multiple regression. For all analyses, significance was set at $p = .05$.

Results

Multicollinearity issues

Prior to engaging in analysis, all variables of interest were examined for issues in involving multicollinearity. Results indicate that in all cases, variables failed to exceed a correlation coefficient of .75 (see Table 1). These results suggest that the variables did not suffer from issues of multicollinearity, which is argued to be present when coefficients approach or exceed a value of .90 [53].

In addition, prior to analysis, key demographics were tested to determine potential significant differences. Results indicated that there were no significant differences between gender, ethnicity or education level regarding the dependent variables. Given this, they were not controlled for within the following regression analyses.

Vaccine beliefs and perceptions

The hypothesis suggested that college-age students' positive beliefs about vaccinations would be influenced by their perceptions of risk, knowledge and safety regarding vaccines. A standard multiple regression was performed with perception of risk, perception of knowledge and perception of safety entered in one block as the independent variable and vaccine beliefs used as the dependent variable. Results indicated that 52% of the variance in vaccine beliefs can be accounted for by knowledge, safety and risk perceptions ($F(6, 173) = 64.33, p < .001$). An examination of perception variables indicates that only risk perceptions ($beta = .29, p < .001$) and safety perceptions ($beta = .44, p < .001$) were significant predictors. Hypothesis 1 was partially supported.

Information sources and perceptions

The first research question investigated the impact of information source on college-age students' perceptions of knowledge about vaccines. A standard multiple regression was performed with information source (healthcare provider, news media, government official, Internet/social media, friends, or parents) entered in one block as the independent variable and

Table 1. Summary of Intercorrelations for vaccine beliefs, perceived knowledge, perceived safety and perceived risk ($N = 180$).

	Vaccine beliefs	Perceived knowledge	Perceived safety	Perceived risk
Vaccine Beliefs	–	.47***	.69***	.65***
Perceived Knowledge	–	–	.54***	.57***
Perceived Safety	–	–	–	.73***
Perceived Risk	–	–	–	–

*** $p < .001$.

perceived knowledge used as the dependent variable. Results indicated that 14% of the variance in perceived knowledge can be accounted for by information source ($F(6, 173) = 5.06, p < .001$). An examination of the information source variables indicates that only healthcare providers ($beta = .16, p < .05$) and social media ($beta = -.20, p < .05$) were significant predictors.

Research question two examined the potential impact that information source had on perceptions of risk regarding vaccines. Results from a regression analysis indicated that information source accounted for 14% of the variance in risk perceptions ($F(6, 173) = 4.72, p < .001$). Results further indicated that social media ($beta = -.19, p < .05$) was the only significant predictor.

The final research question asked if the source of information that college-age students turn to regarding vaccines, impacts their safety perceptions of vaccines. Using a regression analysis, results indicated that in cases of safety perceptions, information source accounted for 17% of the variance ($F(6, 173) = 6.02, p < .001$). In this case, healthcare providers ($beta = .24, p < .01$) were the only significant predictors.

Discussion

The purpose of this research was an initial exploration into understanding the relationship between sources of vaccine information and their contributions to vaccine perceptions among college-age students. The recent increase in vaccine hesitancy, anti-vaccine movements and VPD outbreaks suggest further research is needed to understand why these persist. We focused on the college-age sample as this is a unique audience, one often studied in relation to specific vaccines (e.g. flu, HPV, pertussis, etc.). Additionally, health decisions formed during this developmental period could be life-long, as well as inform future parental decisions. Furthermore, we sought to apply concepts from the WHO Sage Report on the Working Group on Vaccine Hesitancy [3] and ask questions relating to key determinants this group found towards vaccine hesitancy.

Vaccine beliefs, and knowledge, risk and safety perceptions

The relationships between vaccine beliefs, perceived knowledge, perceived risk and perceived safety have been argued to be important towards improving VPD communication. As the initial results indicated (see Table 1), these variables had significant positive relationships with each other. Furthermore, these variables did not exhibit issues of multicollinearity within this sample, thus suggesting they represent independent concepts. In addition, the perception variables were shown to have been impacted in a variety of ways by the source of information that college-age students utilize.

Unfortunately, in the case of predicting positive vaccine beliefs held by college-age students, this study suggests that perceptions of safety and risk are significant, while perceptions of knowledge are not. At first glance this is surprising given the existent literature suggesting the importance of perceived knowledge to vaccine beliefs, as well as the significant associations between vaccine beliefs and perceived knowledge found in this study. However, one might consider that while perceived knowledge is important in determining vaccine beliefs among college-age students, it is superseded by perceived risk and safety, or encapsulated by them. To answer this question, we performed a post-hoc hierarchical linear regression, with vaccine beliefs as the dependent variable, and perceptions of knowledge was entered in the first block and perceptions of risk and safety are entered as the second block. The results appear to confirm this assumption (see Table 2). Perceived knowledge by itself is a significant predictor of vaccine beliefs, however, once it is combined with perceptions of risk and safety, it becomes insignificant. This suggests that in the context of dealing with college-age students, perceptions of risk and safety are a priority and may override concerns about knowledge level in determining vaccine beliefs.

Sources of vaccine information

The relationship between information sources and health perceptions has often been studied, especially in regard to inaccurate information or misleading portrayals of diseases [39]. Vaccine related perceptions represent a health issue that is often laden with false information, myths and questions about its safety and efficacy [12]. Often, there are concerns about information available on the Internet or through social media, and in the case of vaccines, especially about the credibility of the information being shared [32]. Additionally, research in health communication recognizes that there is a strong relationship between interpersonal channels and vaccine-related health decisions ([10]). We thus sought to understand which of these sources, along with sources identified by the WHO Sage Report on the Working Group on Vaccine Hesitancy [3], as key contributors to influencing college-age students' perceptions about vaccines.

Table 2. Regression Model for Post-hoc Analysis Regarding Predictors of Vaccine Beliefs ($N = 180$).

Variable	Model 1			Model 2		
	<i>B</i>	SE <i>B</i>	β	<i>B</i>	SE <i>B</i>	β
Perceived Knowledge	.67	.09	.47***	.10	.09	.07
Risk Perceptions				.38	.10	.29***
Safety Perceptions				.48	.09	.44***
<i>R</i>	.22			.52		
<i>F</i> for change in R^2	50.40			55.79***		

*** $p < .001$.

Taken together, the results suggest that as college-age students' reliance on social media as their source of information about vaccines increases, they tend to view vaccines as riskier, and perceive themselves as having less knowledge about vaccines. In contrast, as college-age students utilize healthcare providers as their source of information, their level of perceived knowledge, as well as the perception that vaccines are safe, increases. Thus, there is a reliance among this population for communicating with others about vaccines, either through social media or interpersonal means, to increase their knowledge and form their perceptions.

It is not surprising that college-age students found that social media was a likely source of vaccine information. A recent Pew Internet & American Life study found that 76% of young adults that are online use Facebook, about 67% use Instagram, and about 62% use Snapchat [54]. Yet, it is unclear if college-age students are aware that this medium may be contributing to their lack of knowledge and (perhaps inaccurate) risk perceptions about vaccines. College-age students may consider themselves 'savvy' in regard to social media, but perhaps not in the context of vaccine information. Also, the results are curious for the lack of significance for the Internet as a significant source of information. The Internet remains a consistent frequent source of health information for Americans (Pew Internet & American Life Project, 2018). Yet, it may not be an important source for college-age students about vaccines. Further research is needed to investigate this relationship.

Interestingly, the 'traditional' use of a health source, such as a healthcare provider, could be the belief that healthcare providers are a more trusted source of information than social media. Results echo previous research stating a healthcare provider is a close second as a source of health information, after the Internet [55]. Health campaigns often urge individuals to 'talk to your doctor,' so the reliance on this source of vaccine information may not be surprising. In the case of vaccines and VPDs, the results suggest that the healthcare provider role is more important than other interpersonal means for college-age students. While this confirms previous research [56], there is some literature suggesting healthcare providers also exhibit vaccine hesitancy with patients [57]. Thus, further research on this population as a source of information is needed.

The results also suggest the role of family and friends may represent a minimized role for college-age students about vaccines. The lack of significant relationships between family and friends towards perceived knowledge, perceived risk and perceived safety suggests an interesting insight. It suggests that these interpersonal channels may not be perceived to be valid sources of vaccine information among

college-age students. In the case of friendships, it could be surmised that college-age students feel their peers may not have the knowledge about vaccines to provide information to them. Thus, they would not go to them for vaccine related health information.

The lack of significance of parents as a contributor to perceived knowledge, perceived risk and perceived safety of vaccines suggest further investigation. In particular, it begs the question that if college-age students feel their parents may not know the answers to vaccine related questions, do they value the healthcare provider more than their parents when it comes to vaccine information, or do they not want to engage in conversations with their parents about vaccines? Parents are a unique audience in regards to vaccine hesitancy and VPDs as they could be a source of information to their children about vaccines, but they are also an audience that is a focus of much vaccine hesitancy research. In fact, parents' vaccine confidence remains a key element in the success of vaccination programs [58]. For college-age students, they may know their parents may be pro-or-anti-vaccination and thus adjust their preferences for health information accordingly. Additionally, it is possible that parents no longer are a strong option for health information. Research on emerging adulthood suggests that during this time college-age students are starting to engage in healthcare by themselves for the first time [59]; thus, they may become independent of parental influences on health decisions. More research is needed to understand how parents may or may not be a valid source of information for college-age students about vaccines.

The insignificance of government officials and news media may reflect the current trends of college-age students using other sources of information for their information needs. A 2015 poll from the Harvard University Institute of Politics found 74% of millennials do not trust the Federal government and 88% do not trust the media [60]. Such high percentages of distrust mimic previous research finding the general public has a distrust of the government concerning health issues [61]. While distrust of the media may be due to the conflicting information provided [39], the lack of government sources used does present challenges. Such low levels of trust are alarming, given that much of the communication about vaccines may stem from government agencies trying to communicate the latest science and information about vaccines and VPDs. Additional research is warranted to see how the government sites may be better able to communicate their aims towards improving vaccine rates.

Potential practical implications

While this study was an initial exploration into the relationship between information sources and vaccine beliefs in college-age students, there were

several findings that could have important practical implications for those dealing with vaccine campaigns or promoting vaccine related messages. First, while knowledge risk and safety perceptions all have important associations with positive vaccine beliefs, they may not have equal value regarding their impact on college-age students. As results suggested, issues surrounding perception of knowledge become secondary, when in the presence of issues involving perception of risk and safety, at least in college-age students. This might suggest that in general, attention might be better served dealing with messages attempting to improve risk and safety perceptions, rather than level of knowledge.

Second, the existence of social media as a source of information concerning vaccines, particularly surrounding issues of safety and risk perceptions, is a potential concern. As results suggest, increases in social media usage as a 'go to' source resulted in more negative vaccine beliefs. Further research is needed to examine exactly how this relationship is created. Regardless, health practitioners and designers of health messages must be aware that social media usage may present an adversarial relationship to the goal of creating positive vaccine beliefs in college-age students.

Finally, while not conclusive, these results suggest that the assumption of parents as a primary influence concerning vaccine beliefs may not be true in the case of college-age students. The lack of close interpersonal relationships (parents and friends) as sources of information with a significant impact on knowledge, safety and risk perceptions was surprising. While further study is needed to fully understand these results, it might be that getting adults to discuss vaccines with their children, or work on addressing parents concerns about vaccinations in the hope that it filters down to their children, might not be the best strategy when dealing with college-age students.

Limitations

There are several limitations with this study to consider as avenues for future research. We conducted this study prior to the COVID-19 pandemic starting, and acknowledge our findings occurred prior to worldwide interest in a particular vaccine. Furthermore, this cross-sectional survey was limited in generalizability to the Northeast universities and their populations. The study has little variation in race or ethnicity among the sample. Additionally, while working with the WHO Sage Working Group on Vaccine Hesitancy [3] concepts provided a wonderful opportunity, it did create some restrictions in terms of survey items. Specifically, we did not include questions involving fear of needles, previous vaccinations, or intentions to vaccinate which may have provided additional

insight. Finally, the researchers focused on vaccines in general, without specific reference to a particular vaccine. Given the exploratory nature of the study, it was felt that gaining a base understanding of vaccine issues was needed, before moving into the nuances associated with specific vaccines and VPDs.

Conclusion

There are several factors contributing to vaccine hesitancy to consider when developing a vaccine awareness program. The college-age student represents a unique population whose vaccine-related beliefs and perceptions may be influenced by different sources of information.

It is possible that future vaccination programs may need to be more targeted in their approaches to provide vaccine information based upon the preferences of this population. Such understanding may add additional clarity to contributors of vaccine hesitancy.

Ethical approval

No funds supported the development of this article. Ethical approval was granted by the Institutional Review Board of Bryant University.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Data available on request from the authors

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to containing information that could compromise the privacy of research participants.

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