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Alternative Diet Practices as Predictors for Vaccine Confidence

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This is to certify that the doctoral study by

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Walden University
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Abstract

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MPH, Liberty University, 2017

BA, Ashford University, 2015

Doctoral Study Submitted in Partial Fulfillment

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Abstract

Perceived risks and side effects have left some with a lack of confidence in the safety and efficacy of vaccines. This may lead to not adhering to the recommended vaccination schedule and result in outbreaks that have the potential to harm those who are unable to get vaccinated due to age or infirmity. It is vital to seek and address the characteristics that may predict one's confidence in vaccines. The aim of this study was to identify whether an individual's alternative diet behavior may be able to predict their confidence in the measles, mumps, and rubella (MMR) vaccine. The theoretical concepts of the health belief model and the social ecological theory, with their insight into influences of health behavior, were used to assist in assessing how following an alternative diet (vegan/vegetarian, non-GMO, and organic) may affect an individual's confidence in MMR vaccines. The research questions addressed whether there is a significant relationship between an alternative diet and the factors that may contribute to vaccine confidence: an individual's perceived risk of side effects and benefits, the trust an individual has in pharmaceutical leaders to give accurate information on risks and side effects, and whether an individual believes the risks outweigh the benefits or the benefits outweigh the risks. This quantitative study was conducted using chi-square analysis, with *p* value determining whether there is a significant relationship between diet and vaccine confidence. The results of this study can be used to inform public health practitioners of the predictors of vaccine confidence so targeted interventions addressing those predictors may be developed resulting in increased vaccine adherence and the reduction of disease outbreaks, which can be both a public health danger and a financial burden to society.

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Dedication

I would like to dedicate this dissertation to my husband, Benjamin Dolin, who supported me throughout the entire process of writing it- when I was frustrated, demoralized, and ready to quit, you encouraged me to stick it out, for which I am eternally grateful. I would also like to dedicate this to my children, Gabrielle, CJ, Griffon, Ashlyn, and Nash for enduring the long weekends while I conducted my study, many of which were during the summer when they would have loved to take a weekend trip somewhere but understood my determination to accomplish my goals. I would also like to dedicate this dissertation to my mom, who passed away suddenly and unexpectedly during the development of this study. I know that she is looking down at me so very pleased and proud.

Acknowledgments

The completion of this dissertation would not have been possible without the guidance and direction of my lord and savior, who saw me though the beginning of my research and kept me focused throughout the entire process, even when I was ready to give up. I would also like to acknowledge my professor, Dr. Clarence “Shuey” Schumaker who answered my questions and gave me the guidance I needed to synthesize all of the components of this study and encouraged me to continue “onward and upward”. I would also like to acknowledge Dr. Julia Leischner and Dr. Manoj Sharma, both of which made this dissertation possible by reviewing, offering guidance, and, ultimately, helping me to achieve one of my greatest life’s goals.

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Section 1: Foundation of the Study and Literature Review

Foundation of the Study

Antivaccination sentiment focusing on risks and side effects has been an ongoing obstacle to adhering to the recommended routine vaccine schedule, particularly for the measles, mumps, and rubella (MMR) vaccine (DeStefano & Shimabukuro, 2019). Even though purported claims that the MMR may cause autism have been disproven, there still exists a large portion of the population that refuses to vaccinate with the MMR vaccine out of lack of confidence in its safety (DeStefano & Shimabukuro, 2019). Given the importance of adhering to MMR vaccination recommendations to population health and safety, targeted interventions to educate those who lack confidence in the MMR vaccine are needed (De Stefano & Shimabukuro, 2019). It is, therefore, worthwhile to examine potential predictors and characteristics of those who lack confidence in the MMR vaccine within the U.S. population so interventions can be tailored to them specifically. In this study, I attempted to assess the predictability of one health behavior based on another by assessing MMR vaccine confidence for those who practice alternative dietary practices.

A growing body of research suggests that there are health benefits such as decreased body mass index (BMI), decreased risk of cardiovascular disease and diabetes associated with certain alternative diet practices such as veganism and vegetarianism (Radnitz et al., 2015). There is also scientific evidence that certain dietary factors like eating a vegetarian diet modifies inflammatory as well as other brain pathways that are known to affect one's mood, resulting in feelings of happiness (Beezhold et al., 2014). Given these health benefits, it is no surprise that alternative diet practices like veganism

and vegetarianism are on the rise, especially in economically advantaged countries like the United States (Radnitz et al., 2015). Along with refraining from eating meat and other animal products, vegans and vegetarians are known to also engage in other healthful behaviors such as limiting frequency of alcohol consumption and engaging in more moderate daily exercise (Beezhold, et al., 2015). Given these facts, it is worth assessing whether those who engage in these alternative dietary practices are also more likely to support or oppose other health behaviors such as routine childhood vaccination, particularly the MMR vaccine, given the nonvegan ingredients such as eggs and porcine gelatin ("Are Vaccines Vegan?," 2020).

Background

Although there exists research on relationships between personal health behaviors and vaccine hesitancy (Wiley et al., 2020), to date, there has been little research between a person's health habits and her/her confidence in vaccines (Frew et al., 2019). Because a lack in confidence in vaccines and vaccination can lead to decreases in routine child immunizations such as the MMR vaccine, which would then endanger herd immunity, and, therefore, increase cases and can potentially lead to measles outbreaks, assessing possible relationships between lifestyle habits like diet and vaccine confidence is important (Frew et al., 2019). Because the extent to which people will "protect" their bodies and their children's bodies is not limited only to vaccines, it is important to understand what other characteristics may contribute to those who lack vaccine confidence.

Problem Statement

Even though the advent of vaccines has virtually eliminated the threat of several diseases that were once thought to be potentially fatal (Wutzler et al., 2017) and rates of diseases like measles, mumps, chicken pox, and whooping cough have been significantly reduced (Omer et al., 2013), there still exist people who fear that their children will suffer life-long consequences from the MMR vaccine (Jama et al., 2018). With the rise of the antivaccination movement and its supporters' objectives, the United States has seen an increase in the number of people opting out of routine vaccinations for their children and, consequently, an increase in outbreaks of vaccine-preventable illnesses (Yang et al., 2015). Responding to a measles outbreaks cost the United States between $2.7 and $5.3 million in 2011 (Sundaram et al., 2019). The World Health Organization (WHO, 2015) has named vaccination hesitancy as one of the top 10 leading threats to global health. Vaccination hesitancy is defined as a delay in acceptance or refusal of vaccines despite their availability (Kumar et al., 2016). It is widely known within the public health community that vaccine hesitancy is heavily influenced by a person's lack of confidence in a vaccine's safety (Kumar et al., 2016, Larson et al., 2015). This lack of trust is extended to trust in health authorities as well (Shapiro et al., 2018). Given these facts, it is vital for public health professionals to determine what characteristics are associated with confidence in vaccines so that they can develop interventions that address these characteristics in order to reduce the number of vaccine exemptions and reinforce the herd immunity required to prevent outbreaks of vaccine-preventable illnesses. Various dietary practices such as veganism, vegetarianism, abstaining from foods that contain

genetically modified organisms (GMOs), and eating an organic diet are common among those who strive for a healthy life for themselves as well as for their children (Dizon et al., 2016). It is, therefore, worthwhile for public health professionals to investigate the possible relationship between these dietary practices and the likelihood of lacking confidence in routine vaccinations. The relationship is even more significant with certain vaccines such as MMR because these vaccines contain both egg products and porcine gelatin (Armstrong, 2018). There are several studies that examine relationships between personal health behaviors and vaccine hesitancy but, to date, there has been no research that examines the connection between a person's health habits and their confidence in vaccines (Frew et al., 2019). Because a lack of confidence in vaccines and vaccination can lead to decreases in routine child immunizations such as MMR, which would then endanger herd immunity and therefore increase cases, and can potentially lead to measles outbreaks, assessing relationships between lifestyle habits like diet and vaccine confidence is vital (Frew et al., 2019).

Purpose of the Study

The purpose of this study was to assess whether there is a statistically significant relationship between alternative dietary practices and MMR vaccine confidence. The data used for this study came from the Pew Research Center's American Trends 17th Wave Panel survey (https://www.pewresearch.org/internet/dataset/american-trends-panel-wave-17/). The independent variables were alternative dietary practices. The dependent variables were factors associated with an individual's vaccine confidence (see Table 1).

Examining the potential relationship between these types of variables may contribute to what researchers know about healthy living habits and confidence in vaccines.

Table 1

Variables Within the Dataset

Name Presentation	Variables		
	Type	Category	Dataset
Alternative diet	Independent variable	Vegan/Vegetarian	FUD29: Do you consider yourself a vegan or vegetarian?
		Organic diet	FUD22: How much of the food you eat is organic?
		Non-GMO Diet	FUD15: Thinking about the last 30 days, how often did you or someone in your household buy non-GMO food?
Vaccine confidence	Dependent variable	Belief of risk of MMR side effects	BIO33a: Thinking about childhood vaccines for measles, mumps, and rubella (MMR), how would you rate the risk of side effects?
		Belief of preventive MMR benefits	BIO33b: Thinking about childhood vaccines for measles, mumps and rubella, how would you rate the preventive health benefits?
		Amount of trust in pharmaceutical industry	BIO39c: How much, if at all, do you trust pharmaceutical industry leaders to give full and accurate information about the health risks and preventive health benefits of childhood vaccines for measles, mumps, and rubella?
		Whether respondent believes the benefits outweigh risks, or risks outweigh benefits	BIO34: Overall, do you think the benefits of childhood vaccines for measles, mumps, and rubella outweigh the risks, or that the risks outweigh the benefits?

Note. The study variables and how they are presented within the dataset.

Research Questions and Hypotheses

In this study, I examined relationships between MMR vaccination confidence and alternative dietary practices among female caregivers ages 18 to 29 years. The dependent variables associated with vaccine confidence were (a) perceived risk of MMR side effects, (b) the perceived preventive health benefits of the MMR vaccine, (c) the amount

of trust in the pharmaceutical industry to give full and accurate information about the health risks of the MMR vaccine, and (d) believing that the health benefits of the MMR vaccine outweigh the risks and vice versa. These variables were measured on ordinal scales ranging from 1 to 5 with 1 representing the least amount of intensity for the outcome opinion and 5 representing the most intensity for the outcome opinion. The independent variables were those that represent the alternative dietary practices: (a) vegan/vegetarian, (b) non-GMO, and (c) organic diets, and they were measured on an ordinal scale from 1 to 4 with 1 representing a very strict adherence to the alternative diet and 4 representing no dietary restrictions at all. Independent control variables in this analysis were gender and age The dependent and independent variables are described in more detail below:

RQ1: What is the relationship between having an alternative diet and the perceived risk of MMR side effects among female respondents aged 18 to 29 years?

$H_0$1: There is no significant relationship between being vegan/vegetarian and one's perceived risk of MMR side effects among female respondents aged 18 to 29 years.

H_a1: There is a significant relationship between being vegan/vegetarian and one's perceived risk of MMR side effects among female respondents aged 18 to 29 years.

$H_0$2: There is no significant relationship between having a non-GMO diet and one's perceived risk of MMR side effects among female respondents aged 18 to 29 years.

H_a2: There is a significant relationship between having a non-GMO diet and one's perceived risk of MMR side effects among female respondents aged 18 to 29 years.

H_03: There is no significant relationship between having an organic diet and one's perceived risk of MMR side effects among female respondents aged 18 to 29 years.

H_a3: There is a significant relationship between having an organic diet and one's perceived risk of MMR side effects among female respondents aged 18 to 29 years.

RQ2: What is the relationship, if any, between having an alternative diet and the perceived preventive health benefits of the MMR vaccine among female respondents aged 18 to 29 years?

H_04: There is no significant relationship between being vegan/vegetarian and one's perceived preventive health benefits of the MMR vaccine among female respondents aged 18 to 29 years.

H_a4: There is a significant relationship between being vegan/vegetarian and one's perceived preventive health benefits of the MMR vaccine among female respondents aged 18 to 29 years.

H_05: There is no significant relationship between having a non-GMO diet and one's perceived preventive health benefits of the MMR vaccine among female respondents aged 18 to 29 years.

H_a5: There is a significant relationship between having a non-GMO diet and one's perceived preventive health benefits of the MMR vaccine among female respondents aged 18 to 29 years.

H_06: There is no significant relationship between having an organic diet and one's perceived preventive health benefits of the MMR vaccine among female respondents aged 18 to 29 years.

H_a6: There is a significant relationship between having an organic diet and one's perceived preventive health benefits of the MMR vaccine among female respondents aged 18 to 29 years.

RQ3: What is the relationship between having an alternative diet and the amount of trust one has in pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of the MMR vaccine among female respondents aged 18 to 29 years.

H_07: There is no significant relationship between being vegan/vegetarian and the amount of trust one has in pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of the MMR vaccine among female respondents aged 18 to 29 years.

H_a7: There is a significant relationship between being vegan/vegetarian and the amount of trust one has in pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of the MMR vaccine among female respondents aged 18 to 29 years.

$H_0$8: There is no significant relationship between having a non-GMO diet and the amount of trust one has in pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of the MMR vaccine among female respondents aged 18 to 29 years.

H_a8: There is a significant relationship between having a non-GMO diet and the amount of trust one has in pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of the MMR vaccine among female respondents aged 18 to 29 years.

$H_0$9: There is no significant relationship between having an organic diet and the amount of trust one has in pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of the MMR vaccine among female respondents aged 18 to 29 years.

H_a9: There is a significant relationship between having an organic diet and the amount of trust one has in pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of the MMR vaccine among female respondents aged 18 to 29 years.

RQ4: What is the relationship between having an alternative diet and believing that the benefits of the MMR vaccine outweigh the risks or that the risks outweigh the benefits among female respondents aged 18 to 29 years?

$H_0$10: There is no significant relationship between being vegan/vegetarian and believing that either the preventive health benefits outweigh the risks of the MMR

vaccine, or the risks outweigh the preventive health benefits among female respondents aged 18 to 29 years.

H_a10: There is a significant relationship between being vegan and believing either the preventive health benefits of the MMR vaccine outweigh the risks, or the risks outweigh the preventive health benefits among female respondents aged 18 to 29 years.

H_011: There is no significant relationship between having a non-GMO diet and believing either the preventive health benefits of the MMR vaccine outweigh the risks, or the risks outweigh the preventive health benefits among female respondents aged 18 to 29 years.

H_a11: There is a significant relationship between having a non-GMO diet and believing either the preventive health benefits of the MMR vaccine outweigh the risks, or the risks outweigh the preventive health benefits among female respondents aged 18 to 29 years.

H_012: There is no significant relationship between having an organic diet and believing that either the preventive health benefits of the MMR vaccine outweigh the risks, or the risks outweigh the preventive health benefits among female respondents aged 18 to 29 years.

H_a12: There is a significant relationship between having an organic diet and believing that either the preventive health benefits of the MMR vaccine outweigh the risks, or the risks outweigh the preventive health benefits among female respondents aged 18 to 29 years.

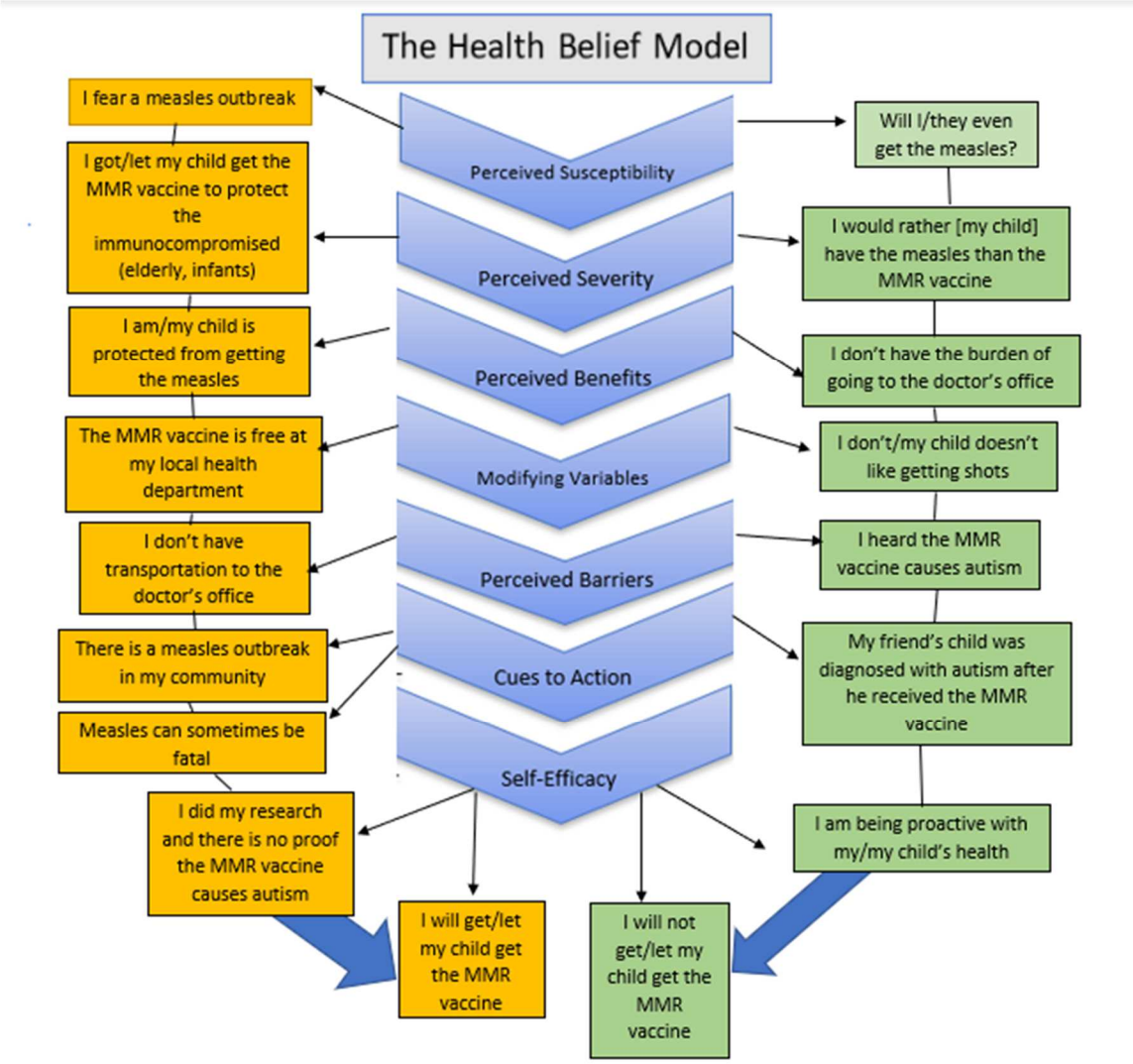
Conceptual Framework

In his book, *Historical Origins of the Health Belief Model,* Rosenstock (1974) described the health belief model and how it examines the factors that influence a person's health behaviors such as perceived fear of getting sick/hurt, perceived risk, and self-efficacy (see Figure 1). For this reason, this model was selected as a theoretical framework for the study along with the social ecological model, which has been identified as a useful analytical tool to address health behaviors based on multiple levels of social influence (Kolff, 2018). The decision to utilize these two models was based on their individual contribution to the subject matter.

The health belief model, developed in the 1950s by the U.S. Public Health Service, posits that health behaviors depend on several factors including perceived risk, perceived severity, perceived barriers, perceived benefits, modifying variables, cues to action, and self-efficacy (Rosenstock, 1974). What sets this model apart from others is that it attempts to examine and predict health-related behaviors and is often used in studies that seek to predict vaccination behaviors (Wagner et al., 2017).

Figure 1

Constructs of the Health Belief Model



Note. Individual constructs that make up the health belief model including examples.

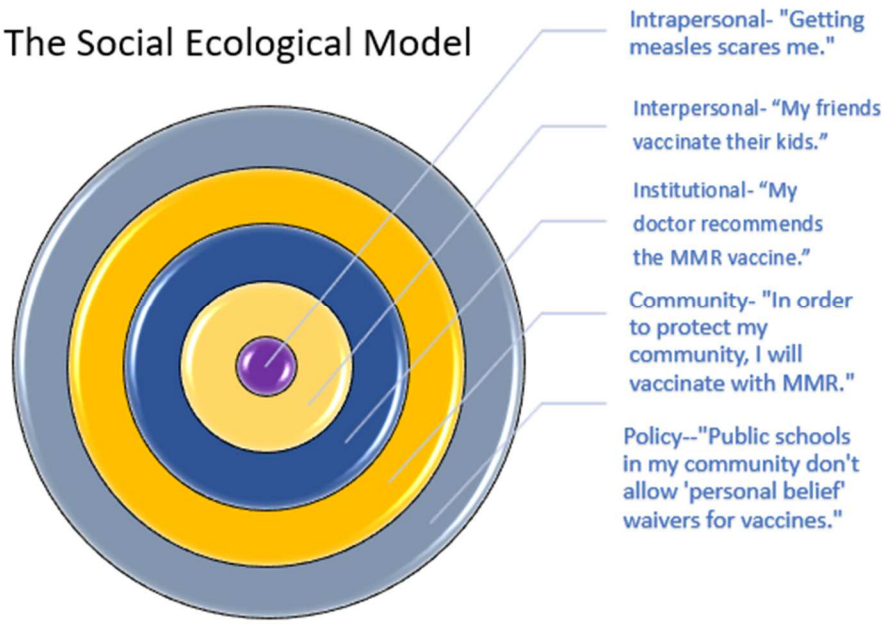
Own work.

The other model that was used congruently with the health belief model was the social ecological model. This model is similar to the health belief model in that it also considers various factors that have the potential to influence a person's health behaviors (see Figure 2). What is unique about this model is that it considers the complex interactions between influencing factors at different levels (Glanz et al., 2008). Kumar et al. (2012) noted that factors on all levels of the social ecological model (individual, relationship, community, societal, and policy) had a significant influence on a person's decision to receive the H1N1 vaccine in 2009:

- **Intrapersonal**: Such as perceived risk of acquiring measles, mumps, or rubella
- **Interpersonal**: Such as the number of family or friends that have been vaccinated or those who oppose vaccination.
- **Institutional**: Such as the presence of health care provider and his/her attitude about vaccination
- **Community**: Such as the presence of measles within the community.
- **Policy**: Such as having health insurance or being in a priority group for vaccination (i.e., the elderly or immune-compromised individuals) or vaccines being mandated for public school entry.

Figure 2

Constructs of the Social Ecological Model



Note. Individual constructs that make up the social ecological model. Own work.

These frameworks were chosen in a combined application due to the insight that each model provides. The social ecological model examines social/ecological determinants of vaccination behavior. The HBM's construct of perceived barriers is applied to vaccination adherence. The combined application of these two models has seen success in similar studies in identifying behavioral processes related to HPV vaccination hesitancy (Walker et al., 2020).

Section 2: Research Design and Data Collection

Nature of the Study

Methodological Approach

The nature of the study was quantitative research using a comparative design which helped in understanding the possible associations between independent and dependent variables. The chi-square test will be conducted in IBM SPSS Statistics (Version 25). My independent variables were alternative diets (vegan/vegetarian, non-GMO, and organic) and the dependent variables were four individual characteristics associated with vaccine confidence:

- perceived risk of MMR side effects
- perceived health benefits of MMR
- the amount of trust in pharmaceutical industry leaders to give full and accurate information about the health risks and benefits associated with the MMR vaccine
- whether the respondent believes that the benefits of the MMR vaccine outweigh the risks or if they believe the risks of MMR outweigh the benefits

Sampling and Data Collection

The Pew Research Center is a nonpartisan organization comprised of experts who conduct public opinion polling, social science and demographic research. The Pew Research American Trends 17th Wave Panel is a national publicly available survey conducted on over 4,000 random adults between May and June of 2018 (Pew Research Center, 2020). The survey consisted of questions regarding parental beliefs about

vaccines and vaccination, as well as attitudes about the health care system and vaccine researchers. Questions were multiple choice and were administered in both English and Spanish. The scales of the answers were ordinal with answers ranging from 1 to 5 with 1 being *very high* and 5 being *very low* based on the survey questions or binary variables, wherein the answers to the questions indicated whether the respondent believes that the benefits of the MMR outweigh the risks or vice versa.

Data Analysis

The data for this study were analyzed utilizing the chi-square test for independence. This statistical test was chosen for its ability to compare categorical variables (Pallant, 2011). For the purposes of this study, the independent variables were gender, age, and type of diet (vegan/vegetarian, organic, non-GMO) and the related dependent variables were answers to questions related to perceived MMR safety which will included: trust in the pharmaceutical industry and medical scientists to give full and accurate information about the health risks of MMR, whether or not the respondent believes the benefits of MMR outweigh the risks, the level of perceived risk of side effects of MMR, and the level of perceived health benefits of MMR.

Definition of Terms

Herd immunity: When a large portion of a population becomes immune to an infectious illness (usually by being vaccinated), and those who do not become immune (in many cases because they are not vaccinated) are protected from the illness because the incidence of it has decreased due to vaccination (Desai & Majumder, 2020).

Non-GMO diet: Located in the dataset in question FUD14, a diet in which the food does not contain any genetically modified ingredients (Pew Research Center, 2020).

Organic diet: Located in the dataset in question FUD22, a diet that consists of no genetically modified ingredients and no pesticides (Bialik & Walker, 2019).

Vaccination: Being treated with a vaccine in order to induce the body's immune system to fight a disease or diseases (OxfordLanguages, n.d.).

Vaccine: A product used to stimulate the body's natural immune system against one or multiple diseases but prepared to not induce the disease(s), only to act as an antigen against the disease (OxfordLanguages, n.d.).

Vaccine confidence: A feeling of trust that a person has in vaccines, the people who administer vaccines, and of the developments, regulations, and manufacture of vaccines (U.S. Department of Health and Human Services, n.d.). For this study, vaccine confidence was determined by the answers to questions listed in the American Trends survey (see Appendix A) that assess beliefs and opinions of the respondents in areas such as one's perception of risk of the MMR vaccine trust in the pharmaceutical industry.

Vaccine hesitancy: A delay in accepting or outright refusal to be vaccinated (or allow a loved one to be) despite the vaccine being available (MacDonald, 2015).

Vegan: Located in the dataset in question FUD29, someone who omits any food that originates from animals including eggs and dairy (Funk and Kennedy, 2016).

Vegetarian: Located in the dataset in question FUD29, someone who omits meat and fish from their diet (Funk & Kennedy, 2016).

Assumptions

This study was based on several basic assumptions. The first was that people who adhere to alternative dietary practices such as veganism or vegetarianism also adhere to other health-sustaining practices. These practices may include getting or allowing their child to get routine vaccinations, such as MMR. Second, I assumed that the reason people with alternative dietary practices such as veganism or vaccination abstain from routine childhood vaccines is that the vaccine contains ingredients that are derived from animals. Lastly, I assumed that those who abstained from other routine childhood vaccinations would also abstain from MMR.

Scope and Delimitations

For this study, the objective was to determine whether alternative diet practices such as veganism and vegetarianism are predictors of confidence in the MMR vaccine. The target population included people who adhere to certain dietary practices. These practices included vegan, vegetarian, organic, and non-GMO diets. These variables were based on answers from questions FUD14, FUD22, FUD29, BIO33, BIO34, BIO35, and BIO39 (https://www.pewresearch.org/science/dataset/american-trends-panel-wave-17/). This study provided necessary research regarding the behaviors people engage in that may predict compliance with recommended routine vaccinations, particularly the MMR. From a public health perspective, the research derived from this study can provide necessary information for the development of community-based health interventions aimed at encouraging vaccine confidence in those who may be hesitant in getting or allowing their child to get routine vaccinations such as MMR.

Limitations

Using data from surveys and questionnaires has limitations in that there is always the chance that someone may not remember an event correctly. Recall accuracy on behalf of the interviewee is considered a significant limitation of survey/questionnaire data (Ley et al., 2019). Another limitation of this study is that it only addressed a select number of reasons why a person may lack confidence in the MMR vaccine when there can be other factors that were not addressed within the dataset. In addition, the dataset used for this study did not contain information about whether or not the respondents had their child(ren) vaccinated with the MMR vaccine, which would have given a more thorough understanding about the impact of having a lack of confidence in the MMR vaccine.

Significance

According to Smith et al. (2017), there are significant patterns in the reduction of confidence not only in MMR vaccines, but also in their administration and in the scientists who develop them. In addition, while this study used factors that have commonly been examined such as vaccine effectiveness and safety, it included other characteristics regarding attitudes and opinions about the institutions that are involved in MMR vaccination such as medical scientists and pharmaceutical industries (Frew et al., 2019). Therefore, by examining the trust and confidence in MMR vaccination as dependent variables and alternative dietary habits of the respondents as independent variables, this study sought to address relationships that have not been assessed, as a thorough review of the literature yielded no such relationships having been addressed in previous research. Researchers have suggested that relationships between patients and

other institutions involved in vaccination (beyond the dyadic relationship between patient and health care provider) should be examined in order to evaluate the chain of trust necessary to establish vaccine confidence (Paterson, 2016). The results of this study may not only satisfy that recommendation but may also assist in understanding patient trends over time that can help in the development of interventions designed to limit the reduction in vaccine confidence (de Figueiredo et al., 2020).

Literature Search Strategy

In searching for literature pertaining to this study, I used two databases, PubMed and ProQuest, the Centers for Disease Control (CDC) website, the Walden Library, and Google Scholar. Topics that were searched included *vaccine confidence, vegans and vaccines, diet and vaccines, vegans and vegetarians and MMR vaccine, organic diet and vaccination, vaccines and non-GMO diet, predictive behaviors for not getting vaccinated, vaccination and the health belief model,* and *vaccination and the social ecological model.* An effort was made to retrieve scholarly sources from the past 5 years; however, with no pieces of literature focused specifically on the combination of alternative diets and MMR vaccine confidence and very few sources that examine alternative diets and vaccination, some of the sources were older, yet still contained relevant information. With few studies concerning the correlation of alternative dietary practices and vaccination, and no studies about alternative diets as a possible predictor for vaccine confidence, a gap in the literature about this topic was evident.

Literature Review

For this study, I conducted a review of the literature about alternative diets and vaccine confidence for the following topics: (a) health benefits of alternative diets and how they connect with vaccine behavior, (b) vaccine confidence in general, (c) MMR vaccine confidence, (d) safety, ethics, and mistrust and vaccine confidence, (e) MMR vaccine confidence and theory, and (e) identified gaps in the literature.

Health Benefits of Alternative Diets and Vaccine Behavior

A correlation between those who practice complementary and alternative medicine (CAM) and the incidence of vaccine hesitance was conducted by Hornsey et al. in 2020. Results from a survey of over 5,200 Spanish residents revealed that vaccine hesitancy is strongly linked to distrust in conventional medicine (Hornsey et al., 2020). This supports the hypothesis that those who choose not to vaccinate fear for the safety of vaccines and/or the people who make them and administer them. As some believe that the combined practices of CAM and alternative diets both focus on an overall desire to be healthy, it could, therefore, be determined that knowing the behaviors in connection with one's dietary habits may offer insight into that person's other health behaviors, including vaccination. While there were multiple articles within the literature about the health benefits associated with practicing a vegan or vegetarian diet (Cramer et al., 2020; Radnitz et al., 2015), there also exist studies that refute the notion that a vegan or vegetarian diet is healthier than an omnivorous diet (Burkert et al., 2014). In fact, Burkert et al. (2014) found in their study, "Nutrition and health- The association between eating behavior and various health parameters: A matched sample study", that vegetarians on

average suffer many more health problems than omnivores such as allergies, cancer, anxiety, and depression. Furthermore, Burkert et al. argued that lifestyle factors such as engaging in physical activity was a far greater contributor to decreasing disease rates than alternative dietary habits such as veganism and vegetarianism and that vegetarians had an overall lower quality of life when it came to the domain of physical health.

Similar to vegan or vegetarian diets that are thought to offer some benefits (e.g., decreased BMI and cardiovascular disease; Bakaloudi et al., 2020; Heiss et al., 2017), organic diets are said to offer health benefits including adding vital nutrients to one's diet like proteins and carotenes, which increase antibodies and fight infection (Anwar et al., 2020). While practicing a vegan/vegetarian diet and eating an organic diet both share the common ideology of overall better health, there remains another significant factor that both diets share in common—the fact that vaccines can contain inorganic components (Poon & Patel, 2020) and some animal products (Veganfriendly.org, 2020). While there are several perceived benefits of the vegan/vegetarian and organic diets to one's health (Cramer et al., 2017), the determination of whether or not those who eat an organic or vegetarian diet may refuse vaccines based on their ingredients is less clear. In fact, Burkert et al. (2014), found that, within their analysis of the Austrian Health Interview Survey, vegetarians were vaccinated less often than all alternative dietary practices.

The article "Are Vaccines Vegan?" (2020) offered some insight into the mindset of some vegans when it comes to vaccination. Within this article, the point was made that many who practice a vegan diet do so for ethical purposes (e.g., the cruelty toward animals that has been associated with a meat-consuming diet) but minimizing the

suffering of one animal used for food while promoting suffering (from infectious diseases) among humans is a significant contradiction in ethics. It is, therefore, worth speculating that the perceived health benefits of these diets over the perceived risk of infection have been overexaggerated within antivaccination websites as pointed out by Moran et al. (2016). Moreover, it has been speculated that some people jaded by what they are taught about a highly criticized modern health system tend to protest traditional medical practices like vaccination as they switch to a more natural preventive health approach along including practicing an organic diet (Wiley et al., 2020).

Vaccine Confidence in General

In examining vaccine confidence, an assessment of determinants of vaccine hesitancy was practical (Cadeddu et al., 2021). Vaccine hesitance is defined as a delay in accepting or outright refusal to be vaccinated (or allow a loved one to be) despite the vaccine being available (MacDonald, 2015). Several factors can lead a person to be hesitant about vaccines and vaccination. While health care providers are one of the strongest influences in vaccine decisions (Paterson et al., 2016), there is also the strong influence of media, especially the internet (Moran et al., 2016). A significant presence on the internet is the antivaccination community, in which the authors go to great extents to claim that vaccines are dangerous. These websites often, both on purpose and inadvertently, will combine the acceptance of routine childhood vaccination with a traditional or conventional mindset of medical intervention (Wiley et al., 2020).

MMR Vaccine Confidence

By portraying vaccines as part of an "old fashioned" ideology, some of the authors of antivaccination sites paint vaccine refusal as an alternative or natural approach to one's lifestyle that can also include alternative dietary practices and such as eating all organic foods and using CAM (Wiley et al., 2020). The MMR vaccine, in particular, has been analyzed and scrutinized by the antivaccination community for years, most certainly due to a now retracted article published in 1998 that linked the MMR vaccine with autism (Wakefield et al., 1998). In their article, "Perceptions of measles, pneumonia, and meningitis vaccines among caregivers in Shanghai, China and the health belief model: A cross-sectional study", Wagner et al. (2017) explained how vaccine behavior can also be influenced by demographic factors, such as where a person lives or how urban their environment. With multiple factors coming into play, it is not surprising that vaccine hesitancy has become a global concern (WHO, 2015). And, given that the MMR has been singled out among some "anti-vaxxer" websites as a source of dangerous side effects like coma, seizures, and death (Serebour & Fuseini, 2021), reinforcing the safety of vaccines and the trustworthiness of our health care provers has become mandatory in encouraging vaccine confidence, especially in the MMR vaccine (Mendel-Van Alstyne et al., 2018). Despite the overwhelming proof of the safety and effectiveness of the MMR vaccine (and other vaccines), the number of vaccine-hesitant parents has increased as the number of those who have confidence in vaccines, including the MMR, has decreased (Badur et al., 2020). But in spite of this fact, there exists little about vaccine confidence within the literature. In recognizing the evident lack of research on vaccine confidence, Van Alstyne

et al. (2018) explored the significant role that vaccine knowledge had on shaping one's vaccine confidence and posits that there may be multiple characteristics that shape it as well. Knowing what it is that shapes a person's vaccine confidence is vital in the design of interventions aimed at promoting vaccination and vaccines and by gaining a better understanding of the characteristics of those who are confident in the MMR vaccine, we are able to design and implement MMR vaccine awareness programs to the people who need them most while reinforcing current successful vaccine awareness efforts.

Safety, Ethics, and Mistrust and Vaccine Confidence

While learning the predictors of vaccine confidence for all routine childhood vaccines can be pivotal in the design of public health campaign strategies (de Figueiredo et al., 2020), I researched vaccine confidence in the MMR vaccine because it is this vaccine that has received so much attention among social media because of its inaccurate association with autism (de Stefano & Shimabukuro, 2020). the perceived ethics and mistrust in both the pharmaceutical industry as well as health care providers, are significant factors associated with vaccine hesitancy and refusal (Chakraborty & Bouder, 2013). According to Reuben et al. (2020), these factors will require a comprehensive effort as well as an improved insight of both key demographics as well as attitudinal actions on behalf of parents and caregivers to have an effective approach to addressing a lack of vaccine confidence.

MMR Vaccine Confidence and Theory

When examining whether or not a specific characteristic may be a predictor for a specific outcome, having a theoretical framework on which to base one's study is vital.

Theoretical frameworks are necessary in order to understand what key variables may have an effect on a particular outcome; and how the variables may be different for different circumstances (Labaree, 2013). For this study, the variables chosen to be examined (type of diet and level of MMR vaccine confidence), were done so based on two individual theoretical models- the health belief model and the social economical model. The attributes of the health belief model in relation to vaccine behaviors have been well documented (Zampetakis & Melas, 2021). Recently, the HBM was used to assess intentions to vaccinate against covid-19, as explained by authors Zampetakis and Melas (2021) in their article, "The health belief model predicts vaccination intentions against COVID-19: A survey experiment approach." In this article, researchers found that the key constructs of the HBM (perceived risk, perceived severity, perceived barriers, perceived benefits, modifying variables, cues to action, and self-efficacy) were useful in gaining a better understanding of why or why not people chose to be vaccinated against COVID-19 (Zampetakis & Melas, 2021). Moreover, researchers found that the constructs of the HBM listed above have a direct impact with one's perception of health risks and benefits associated with a vaccine (Zampetakis & Melas, 2021). In addition, Wagner et al. (2017) explained how the HBM is useful in illustrating vaccine behaviors as a product of a person's perceptions of both susceptibility and vulnerability to acquiring a communicable illness such as measles.

The social ecological model was the second theoretical model selected because of its applicability to vaccination behaviors. The SEM is based upon several other social/ecological theories, however, many of the theories are based upon a theoretical

ecological perspective established by developmental psychologist Urie Bronfenbrenner. In his article, “Toward an experimental ecology of human development” (1977), Bronfenbrenner examined a method for human development research that focuses on the changing environment in a person’s life and how the different characteristics in individual segments of one’s social environment can influence their behaviors. Bronfenbrenner’s theory was applied to public health behaviors in the article, “An ecological perspective on public health programs” (McLeroy et al., 1988). In their article, McLeroy et al., proposed that the aspects associated with a person’s health are influenced not solely on one’s individual behavior but also from outside influences within the domains of organization, community, and policy, and how these separate influences work together to result in one’s health-related behavior (1988).

Kolff et al. described the use of the SEM in their article, “The use of technology to promote vaccination: A social ecological model-based framework” as an important instrument in analyzing health behaviors as it factors in the multiple levels of influence when determining vaccine behaviors (2018). Kolff et al., goes on to emphasize the SEM’s ability to address vaccine coverage among all populations, addressing the influences at each level from individual (an application on one’s phone) to societal (the exchange of electronic vaccination data) and how these levels can help researchers by allowing for them to evaluate and overcome barriers to vaccination (2018). To do that, Kolff et al. showed how outdated technology (such as phone call reminders to get vaccinated from health care providers) can be replaced with new electronic forms of communications (text reminders and secure email messaging) using state-of-the-art

technology (2018). Wendel et al. described several applications of the SEM to public health issues including chronic disease and tobacco control and they echoed the sentiments of McLeroy by pointing out that the SEM's social levels are broad categories that can reflect the various groups within a person's life that affect his/her behaviors (2015).

Gaps within the Current Literature

While the topic of vaccine hesitance has thousands of resources available online, the topic of vaccine confidence has much fewer resources from which researchers can extract information; and resources that address one's dietary practices as predictors for vaccine confidence are nonexistent. This lack of data indicates that there is an evident gap in the literature in on the topic. Because of this gap, I addressed the main topics of this study and how the literature alludes to several areas that warrant new data. The topics for which future research was suggested included areas ranging from vaccine refusal to the application of our selected theoretical models to vaccine behaviors. The need for future research in the area of vaccine refusal was proposed in the article, "Mistrust of the medical profession and higher disgust sensitivity predict parental vaccine hesitancy", in which Reuben et al. stated: "Counteracting vaccine hesitancy and refusal will require a multifaceted effort, and a better understanding of key demographics and attitudinal predictors will be required for an effective approach" (2020). Wiley et al. explained that crucial questions remain about the transferability of knowledge about non-vaccinating families in certain well-defined sub-populations and the processes by which a parent arrives at vaccine refusal or delay, to other populations in the understanding of vaccine

refusal (2020). Larsen et al. echoed these sentiments as well by explaining the importance of understanding who is vaccine hesitant and what their concerns are given that the concept of vaccine hesitancy is rarely population-wide, but that it is unique to specific sub-groups within a population (2015).

Regarding diet and health behaviors, Heiss et al. alluded to future research by asserting, "In addition to possible differences in levels of eating pathology, relatively little is known about potential discrepancies in other health behaviors between vegans and omnivores" (2017). In addition, Cramer et al., states in their article, "Characteristics of Americans Choosing Vegetarian and Vegan Diets for Health Reasons", that the integration of diet into health care delivery warrants further attention given the amount of dietary and health advice available on the internet that is not based on actual scientific evidence (2017). Cramer et al. also mentions that a better grasp of vegetarian and vegan diet use for health purposes is needed due to the potential connotations of these diets on one's well-being (2017). Moreover, Radnitz et al., suggests that we may be able to start developing profiles of vegans and other subpopulations as research in the vegan diet's impact on food choices and other health behaviors accrue within the literature (2015).

Regarding the application of the health belief model, Bandura (1977) suggested in his early work, "Self-Efficacy: Toward a Unifying Theory of Behavioral Change" that further research was needed on the processes suggested within the HBM as it would increase our understanding of both cognitive and behavior change as well as the relationship between them. Indeed, authors Zampetakis and Melas (2020), praised the applicability of the HBM and predicted that utilization of it will have a definite impact on

peoples' vaccination choices. Wagner et al. (2017), suggested in their work, "Perceptions of Measles, Pneumonia, and Meningitis vaccines among caregivers in Shanghai, China, and the Health Belief Model: A Cross-Sectional Study", that future studies should take a longitudinal look at the attitudes associated with a disease and its vaccine, as a caregiver's perceived need of vaccination was higher for the MMR vaccine than other routine childhood vaccines in their study.

The application of the SEM in analyzing the confidence one has in the MMR vaccine was supported by Nyambe et al. in their article, "Screening and Vaccination as Determined by the Social Ecological Model and the Theory of Triadic Influence: A Systematic Review" (2016). In their article, Nyambe et al. found that the SEM was effective in vaccination studies yet the empirical evidence for such studies was believed to be inadequate, implying the need for more studies to use SEM to verify its validity in vaccine behavior research (2016). Moreover, the ecological perspective was supported in vaccination-related studies in the article, "Upending the Social Ecological Model to Guide Health Promotion Efforts Toward Policy and Environmental Change", where Goldman et al. found there has been inadequate articulation in how structures including systems, policies, and environments work to result in both the feasibility and positive results of health promotion programs (2015).

Summary

In this section, I conducted a review of current literature on research regarding vaccine confidence, I determined gaps within this literature. And I determined the general scope of the problem. The health belief model and the social ecological model provided

an effective theoretical framework for the conduction of this study by presenting thought processes of those who lack vaccine confidence, especially in the MMR vaccine. Finally, potential social change was determined and described through the research conducted within this study. As the world continues to change and people continue to adapt to these changes, within the concept of vaccination, there seems to be a polarization in the attitudes and beliefs regarding the safety and morality of vaccines such as MMR.

Section 3: Presentation of the Results and Findings

Introduction

The purpose of this study was to assess the potential predictability of alternative diet practices on MMR vaccine confidence. The independent variables in this study that represent alternative diet practices were based upon questions within the dataset that represented our three alternative diet practices: vegan/vegetarian, organic, and non-GMO. These survey questions were as follows:

- FUD29: Do you consider yourself a vegan or vegetarian?

  1 I am a strict vegan/vegetarian

  2 I am mostly a vegan/vegetarian

  3 I am neither vegan nor vegetarian

- FUD22: How much of the food you eat is organic?

  1 Most of it

  2 Some of it

  3 Not too much

  4 None at all

- FUD15: Thinking about the past 30 days, how often did you or someone in your family do each of the following?

  Buy GMO-free food, which is food labeled as having no genetically modified ingredients?

  1 Several times

  2 About once

3 Never

4 Not sure

The dependent variables within the dataset that represented vaccine confidence were (a) perceived risk of MMR side effects, (b) perceived health benefits of the MMR vaccine, (c) whether the respondent believed the risk of side effects of the MMR vaccine are greater than the benefits, or that the benefits of the MMR vaccine outweigh the risks, and (d) the level of trust the respondent has in pharmaceutical industry leaders to give fair and accurate information about the health risks and benefits of the MMR vaccine:

BIO33: Thinking about childhood vaccines for measles, mumps, and rubella (MMR), How would you rate:

The risk of side effects:

1 Very high

2 High

3 Medium

4 Low

5 Very low

The preventive health benefits:

1 Very High

2 High

3 Medium

4 Low

5 Very low

BIO34: Overall, do you think…

1 The benefits of childhood vaccines for measles, mumps, and rubella outweigh the risks?

2 The risks of childhood vaccines for measles, mumps, and rubella outweigh the benefits?

BIO39 How much, if at all, do you trust pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of childhood vaccines for measles, mumps, and rubella?

1 A lot

2 Some

3 Not too much

4 Not at all

Once I selected my variables from the dataset, I developed my research questions:

- RQ1: What is the relationship between practicing an alternative diet and perceived risk of side effects for the MMR vaccine among females aged 18 to 29?
- RQ2: What is the relationship between having an alternative diet and perceived health benefits of the MMR vaccine among females aged 18 to 29?
- RQ3: What is the relationship between having an alternative diet and the level of trust one has in pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of the MMR vaccine among females aged 18 to 29?

- RQ4: What is the relationship between having an alternative diet and believing that the benefits of the MMR vaccine outweigh the risks, or that the risks of the MMR vaccine outweigh the benefits?

Data Collection

As explained in Section 1, I used Pew the Research Center's American Trends 17th Wave Panel survey (https://www.pewresearch.org/internet/dataset/american-trends-panel-wave-17/). This is a national and publicly available survey conducted on over 4,000 random adults between May and June of 2018 (Pew Research Center, 2020). The survey consisted of questions regarding parental beliefs about vaccines and vaccination, as well as attitudes about the health care system and vaccine researchers. Questions were multiple choice and were administered in both English and Spanish. The scales of the answers were ordinal with answers ranging from 1(*very high*) to 5 (*very low*) based on the survey questions or binary variables, wherein the answers to the questions indicated whether the respondent believes that the benefits of the MMR outweigh the risks or vice versa. I chose to use data from female respondents specifically because studies show that mothers, in particular, are influenced by others' advice when making decisions about vaccination (Forster et al., 2016). Next, I wanted to ensure that my sample size would be large enough to yield the most accurate results, so I went in and assessed the frequencies for both gender and age of the respondent (see Tables 2 and 3).

Table 2

Age Category

	Age range	Frequency	Percent	Valid	Cumulative %
Valid	18-29	558	12.2	12.2	12.2
	30-49	1,273	27.9	27.9	40.2
	50-64	1,428	31.3	31.3	71.5
	65+	1,300	28.5	28.5	100.0
	Total	4,559	99.9	100.0	
Missing	System	4	.1		
Total		4,563	100.0		

Note. Frequencies of the age category within the dataset.

Table 3

Sex Category

	Sex	Frequency	Percent	Valid	Cumulative %
Valid	Male	2,213	48.5	48.5	48.5
	Female	2,350	51.5	51.5	51.5
	Total	4,563	100.0	100.0	100.0

Note. Frequencies of the sex category within the dataset.

Upon examining the frequencies of gender types and ages, I determined that the sample size was adequate given a 95% confidence interval and a 5% margin of error, as the ideal sample size for an analysis of 4,563 respondents was around 350 (Kadam & Bhalerao, 2010). I proceeded with my investigation by assessing the characteristics of my variables. It was at this point when I discovered that the group of respondents had several missing data (see Table 3). This was the case with the other variables for FUD and BIO question groups as well. Moreover, the group of respondents who answered all FUD questions in the survey was completely different from the group that answered the BIO questions. As I already determined that I was going to use the chi-square analysis, which

cross tabulates two categorical variables, the next step was to refine the dataset to reflect the missing data required for my analysis, as missing data can alter the dataset such that inferences can be skewed and potential bias can result, compromising the validity of my data analysis outcomes (Jakobsen et al., 2017).

The next step was imputing my data so I could account for the missing values. This process began with me analyzing patterns of missing data, then imputing this missing data using logistic regression (see Appendix B). For my missing data I chose to have 10 possible versions (or imputations) of my data generated by the logistic regression model of multiple imputation. Once I had completed the multiple imputation process, I filtered the data to consist solely of females 18 to 29 years old. Next, I had to determine which imputation to use. For my analysis, I selected the fifth imputation because this imputation had the lowest number of missing data. I then removed all values that could not contribute to my outcome, which were the values under "refused" and those in which the respondent selected "not sure".

The chi-square test was now able to be performed. I chose chi-square analysis because of its nonparametric nature, which is ideal for categorical data as it will allow analysis of data that do not meet the strict assumptions of parametric techniques (Pallant, 2003). In order to run the chi-square test for independence, there were some assumptions that had to be met. The first was that all values were independent. As this could not be determined from the data, I had to assume that this assumption was met. The next assumption for the chi-square test to be valid was that at least 80% of the cells had to

have an expected frequency of 5 or more (McHugh, 2013). The final assumption was that the sample size was large enough to yield accurate results.

Results

Research Question #1

First, I want to reiterate the purpose of my analysis by beginning at my research questions and their respective null and alternative hypotheses. My first research question was

> RQ1: What is the relationship between having an alternative diet and the perceived risk of MMR side effects among female respondents aged 18 to 29 years?

For my analysis, I had to assess the relationship, if any, between practicing a mostly vegan/vegetarian diet and one's perceived risk of side effects of the MMR vaccine. The hypotheses for this variable are as follows:

> $H_0$1: There is no significant relationship between being vegan/vegetarian and one's perceived risk of MMR side effects among female respondents aged 18 to 29 years.
>
> H_a1 There is a significant relationship between being vegan/vegetarian and one's perceived risk of MMR side effects among female respondents aged 18 to 29 years.

Survey questions for this analysis were the following:

- FUD29: Do you consider yourself a vegan or vegetarian?

- BIO33a: Thinking about childhood vaccines for measles, mumps, and rubella, how would you rate the risk of side effects?

Upon viewing the table for crosstabulation between my variables, I saw that none of the values for expected frequencies was less than 5 so I concluded that the assumptions that the sample size (see Table 5). Next, I needed to determine whether or not there was a statistically significant relationship between my variables. The next thing I investigated was the *p* value for my crosstabulation. This value was .017384 (see Table 4), which was smaller than the alpha value .05, so I was able to conclude that the result was significant. Therefore, I concluded that there was a statistically significant relationship between being vegan or vegetarian and one's perceived risk of MMR side effects among female respondents aged 18 to 29 years while holding all other values constant and with 8 degrees of freedom:

$$\chi^2(8, N = 3029) = 18.5623, p < .05$$

Table 4

Chi-Square, P *Value, Degrees of Freedom and Cramer's V Values for BIO33a*

Diet	Chi-Square Value	*p* value	*df*	Cramer's V
FUD29 /BIO33a	18.5623	.017384	8	.0583
FUD15c/BIO33a	4.1894	.839647	8	.0289
FUD22/BIO33a	20.0086	.066924	12	.0496

Note. Values for alternative diet and perceived risk of MMR side effects.

Table 5

Crosstabulation for Vegan/Vegetarian and Perceived Risk of MMR Side Effects

Variable	Very high	High	Medium	Low	Very low
Strict vegan/vegetarian	2 (7.69)	9 (8.05)	40 (36.43)	59 (58.52)	83(82.31)
Mostly vegan/vegetarian	14 (7.18)	6 (7.51)	35 (33.97)	66 (54.50)	59 (76.77)
Neither vegan nor vegetarian	93 (94.13)	99 (98.45)	441(445.60)	704 (715.90)	1024(1006.92)

Note. Expected values are in parentheses.

Since the relationship between the variables was statistically significant, the next step was look at the effect size, which is what determined the strength of the relationship between FUD15c and BIO33a. To do this, I had to assess the effect size. Because I did a chi-square analysis, I had to look at the Cramer's V value, as this is the value that determines the strength of the association between categorical variables (Khalilzadeh & Tasci, 2017). The Cramer's V for FUD29 and BIO33a was .0583 (see Table 4). Once I had the Cramer's V value, I looked at the strength between the variables. Any value that falls between .2 and .6 is considered a moderate effect size. As the value was under .2, I concluded that while the relationship between the two variables was statistically significant, the strength of the association was very weak (see Table 10).

Next thing I wanted to see whether there was a significant relationship between practicing a non-GMO diet and one's perceived risk of MMR side effects. The hypotheses for these variables were as follows:

$H_0$2: There is no significant relationship between having a non-GMO diet and one's perceived risk of MMR side effects among female respondents aged 18 to 29 years.

H_a2: There is a significant relationship between having a non-GMO diet and one's perceived risk of MMR side effects among female respondents aged 18 to 29 years.

The survey questions for these variables were as follows:

- FUD15c: Thinking about the past 30 days, how often did you or someone in your household buy GMO-free food, which is food labeled as having no genetically modified ingredients?
- BIO33a: Thinking about childhood vaccines for measles, mumps, and rubella (MMR), how would you rate the risk of side effects?

The first step was to ensure that the sample size was large enough. To do that, I had to make sure that no less than 80% of the cells had a value of 5 or more. As none of the expected values for the crosstabulation of these variables were under 5, I was able to conclude that the sample size was large enough for my analysis, and I could, therefore, ensure that the assumption that at least 80% of the cells had an expected frequency of 5 or more was met. Then, I had to look at the *p* value to see if this value was higher than the alpha value of .05 which determines the significance of the relationship between FUD15c and BIO33a. As the *p* value for the crosstabulation between these variables was .839647 (see Table 4), I concluded that, because this value is higher than the alpha value of .05, there was not a significant relationship between these variables and my analysis for them was complete. Therefore, I failed to reject the null hypothesis that there is no statistically significant relationship between an individual's consumption of non-GMO

foods and their perceived risk of side effects from the MMR vaccine, holding all other values constant, with 8 degrees of freedom, in females aged 18 to 29 years:

$$\chi^2 (8, N = 3029) = 4.1894, p > .05$$

Table 6

Crosstabulation for Non-GMO Diet and Perceived Risk of MMR Side Effects

	Very high	High	Medium	Low	Very low
Several times	44 (41.64)	54 (54.71)	185 (187.40)	330 (324.17)	413 (418.08)
About once	22 (18.55)	30 (24.37)	80 (83.47)	138 (144.39)	187 (186.22)
Never	36 (41.81)	50 (54.92)	194 (188.13)	326 (325.44)	424 (419.71)

Note. Expected values are in the parentheses.

I then moved on to determine whether there was significant relationship between practicing an organic diet and the one's perceived risk of side effects of the MMR vaccine. The hypotheses for these variables were as follows:

$H_0 3$: There is no significant relationship between having an organic diet and one's perceived risk of MMR side effects among female respondents aged 18 to 29 years.

$H_a 3$: There is a significant relationship between having an organic diet and one's perceived risk of MMR side effects among female respondents aged 18 to 29 years.

The survey questions for these variables were the following:

- FUD22: How much of the food you eat is organic?
- BIO33a: Thinking about childhood vaccines for measles, mumps, and rubella (MMR), how would you rate the risk of side effects?

The first task I had to do with these variables was determine if the effect size was large enough to show a large enough sample population. In looking at Table 7, I observed no expected frequency values under 5 so I was able to conclude that the assumption that at least 80% of the cells in the crosstabulation between the variables was 5 or more was met, and that the sample size was large enough. I then moved onto assessing if the relationship between FUD22 and BIO33a was significant. To do this, I examined the *p*-value for the crosstabulation. At 0.066924, this value exceeded the alpha value of .05, therefore I concluded that, because there my analysis was complete. I failed to reject the null hypothesis that there is no statistically significant relationship between practicing an organic diet and one's perceived risk of side effects of the MMR vaccine, holding all other values constant, with 12 degrees of freedom:

$$\chi^2 (12, N = 3029) = 20.0086, p > .05$$

Table 7

Crosstabulation for Organic Diet and Perceived Risk of MMR Side Effects

	Very high	High	Medium	Low	Very Low
Most of It	14 (14.92)	23 (17.35)	85 (77.94)	140 (126.05)	151 (176.74)
Some of It	30 (35.15)	31 (40.89)	176 (183.63)	311 (296.96)	425 (416.39)
Not Too Much	46 (37.24)	49 (43.32)	201 (194.57)	289 (314.66)	446 (441.21)
Not at All	8 (10.69)	11 (12.44)	50 (55.86)	88 (90.34)	139 (126.67)

Note. Expected values are in the parentheses.

Research Question #2

Table 8

Chi-Square, P Value, Degrees of Freedom and Cramer's V *Values for BIO33b*

Diet	Chi-Square Value	*P*- value	df	Cramer's V
FUD29/BIO33b	15.5553	.049206	8	.0491
FUD15c/BIO33b	23.2055	.000311	8	.0734
FUD22/ BIO33b	22.3036	.034254	12	.05

Note. Values for alternative diets and perceived health benefits of MMR vaccine.

RQ2- What is the relationship, if any between having an alternative diet and the perceived preventive health benefits of the MMR vaccine among female respondents aged 18 to 29 years?

I first wanted to see if there is a relationship between being vegan/vegetarian and one's perceived preventive health benefits among females aged 18 to 29.

H_{02}- There is no significant relationship between practicing a vegan/vegetarian diet and one's perceived preventive health benefits of the MMR vaccine among female respondents aged 18 to 29 years.

Ha_2- There is a significant relationship between practicing a vegan/vegetarian diet and one's perceived preventive health benefits of the MMR vaccine among female respondents aged 18 to 29 years.

The survey questions for this analysis were:

- FUD29: Do you consider yourself a vegan or vegetarian?
- BIO33b. Thinking about childhood vaccines for measles, mumps, and rubella (MMR) how would you rate the preventive health benefits?

For this analysis, I had to determine whether the percentage of lowest expected frequency in any cells had a count of 5 or more was 80% or more. Because there were 2 cells with an expected frequency less than 5, I ensured that at least 80% had an expected frequency of 5 or more (Table 9). I determined this by adding all expected frequencies together and dividing them by 15 cells, which gave me an average expected frequency of 198. As only 13.3% of the cells had a value of 5 or less, I determined that the sample size was large enough and that the assumption that at least 80% of the cells had a value of 5 or more was met. Next, I had to determine whether or not the relationship between my variables was statistically significant. Looking at Table 8, I saw that the *p*- value for FUD29 and BIO33b was .049206. As this was below .05, I concluded that there was a statistically significant relationship between having a vegan/vegetarian diet and one's perceived preventive health benefits of the MMR vaccine among females aged 18 to 29 years while holding all other values constant and with 8 degrees of freedom:

$$\chi^2(8, N= 3029) = 15.553, p < .05$$

The next thing I had to do was determine the strength of the relationship via effect size between the variables. Again, I looked at the Cramer's V value for the chi-square test. This value was .0491, and I concluded that, while there was a statistically significant relationship between practicing a vegan/vegetarian diet and one's perceived preventive health benefits of the MMR vaccine among females aged 18 to 29 years, this relationship was very weak.

Table 9

Crosstabulation for Vegan/Vegetarian Diet and Perceived Preventive Health Benefits of MMR

	Very High	High	Medium	Low	Very Low
Strict Vegan/Vegetarian	108 (103.30)	52 (58.88)	33 (25.37)	5 (7.81)	2 (4.64)
Mostly Vegan/Vegetarian	104 (97.62)	46 (55.64)	28 (23.97)	3 (7.38)	8 (4.39)
Neither Vegan nor Vegetarian	1323 (1334.09)	777 (760.47)	316 (327.66)	108 (100.82)	59 (59.97)

Note. Expected values are in the parentheses.

I then moved on to the next set of variables, which were consuming a non-GMO diet and one's perceived preventive health benefits of the MMR vaccine. The hypotheses for these variables were as follows:

H_{011}- There is no significant relationship between having a non-GMO diet and believing either the preventive health benefits of the MMR vaccine outweigh the risks, or the risks outweigh the preventive health benefits among female respondents aged 18 to 29 years.

Ha_{11}- There is a significant relationship between having a non-GMO diet and believing either the preventive health benefits of the MMR vaccine outweigh the risks, or the risks outweigh the preventive health benefits among female respondents aged 18 to 29 years.

Table 10

Interpretation for Cramer's V

Effect Size	Interpretation
ES ≤ 0.2	Although statistically significant, it the relationship is weak at best.
0.2 < ES ≤ 0.6	The relationship is moderate.
ES > 0.6	The relationship is strong.

Note. From "Cognos Analytics," by IBM Analytics, 2016 (http://hdl.handle.net/10057/13560)

The survey questions for this variable were the following:

- FUD15c: Thinking about the past 30 days, how often did you or someone in your household buy GMO-free food, which is food labeled as having no genetically modified ingredients?
- BIO33b: Thinking about childhood vaccines for measles, mumps, and rubella, how would you rate the preventive health benefits?

In ensuring that the sample size was large enough, effect size was determined by looking through the expected values of the crosstabulation between my variables and making sure that at least 80% of the cells had a value of 5 or more. As there were no expected values under 5, I was assured that the effect size was such that the sample population was large enough and that the assumption that at least 80% of the cells had an expected frequency of 5 or more was met (Table 11). I then examined the *p*- value in order to determine whether the relationship between my variables was significant or not. As the *p*- value for these variables was 0.00311, which was less than the alpha value of .05, I was able to presume that the relationship between FUD15c and BIO33b was statistically significant (Table 8). I then moved on to see what the strength of this relationship was, so I looked to Cramer's V value for the crosstabulation. This value was 0.0734 which falls below the range of values of .2 to .6 which represent a moderate strength (Table 10), therefore, I concluded that while the relationship between consuming a non-GMO diet and one's perceived risk of side effects of the MMR vaccine, holding all other values constant, with 8 degrees of freedom, among females aged 18 to 29 years was statistically significant, the strength of this relationship was weak at best:

$\square^2$ (8, N= 2039) = 23.2055, $p < .05$

Table 11

Crosstabulation for Non-GMO Diet and Perceived Preventive Health Benefits of MMR

	Very high	High	Medium	Low	Very Low
Several Times	44 (41.64)	54 (54.7)	185 (187.40)	330 (324.17)	413 (418.08)
About Once	22 (18.55)	30 (24.37)	80 (83.47)	138 (144.39)	187 (186.22)
Never	36 (41.81)	50 (54.92)	194 (188.13)	326 (325.44)	424 (419.71)

Note. Expected values are in parentheses.

I then moved on to the next set of variables, which were those for organic diet and perceived health benefits of the MMR vaccine. The hypotheses for these variables are as follows:

H_{06}- There is no significant relationship between having an organic diet and one's perceived preventive health benefits of the MMR vaccine among female respondents aged 18 to 29 years.

Ha_{6}- There is a significant relationship between having an organic diet and one's perceived preventive health benefits of the MMR vaccine among female respondents aged 18 to 29 years.

The survey questions for these variables were:

- FUD22: How much of the food you eat is organic?
- BIO33b: Thinking about childhood vaccines for measles, mumps, and rubella, how would you rate the preventive health benefits?

The first thing I needed to do was check and ensure that my sample size was large enough. To do this, I looked at the crosstabulation table for these variables. As none of

the cells had a value less than 5, I was able to determine that the assumption that at least 80% of the cells have a value of 5 or more (Table 12). I then moved on to assess whether the relationship between my variables was statistically significant. To determine this, I had to be sure that the *p* value for the crosstabulation was larger or smaller than the alpha, which was .05. Because this value was .034254, which was lower than the alpha value, I concluded that I could reject the null hypothesis that there was no statistically significant relationship between practicing an organic diet and one's perceived health benefits of the MMR vaccine among females aged 18 to 29 years (see Table 8). Because the relationship was significant, I then assessed the strength of this relationship by noting the Cramer's V value of the crosstabulation of the variables. This value was 0.05, which falls within the "weak" range (Table 10). Therefore, I concluded that, while the relationship between practicing an organic diet and one's perceived health benefits of the MMR vaccine, while holding all other values constant, and with 12 degrees of freedom, among females aged 18 to 29 years was significant, the strength of the association between the two variables is very weak.

$$\square^2 (12, N = 3029) = 22.3036, p < .05$$

Table 12

Crosstabulation for Organic Diet and Perceived Preventive Health Benefits of MMR

	Very high	High	Medium	Low	Very low
Most of It	207 (216.51)	126 (123.40)	60 (53.92)	12 (16.42)	15 (9.76)
Some of It	606 (560.35)	286 (319.36)	134 (139.54)	37 (42.48)	24 (25.27)
Not Too Much	565 (593.85)	370 (338.46)	146 (147.88)	49 (45.02)	22 (26.78)
Not at All	152 (159.29)	90 (90.78)	41 (39.67)	18 (12.08)	8 (7.18)

Note. Expected values are in the parentheses.

Research Question #3

Table 13

Chi-Square, P- value*, Degrees of Freedom and Cramer's V* Value*s for BIO39c*

Diet	Chi-Square Value	*P-* value	df	Cramer's V
FUD29/BIO39c	12.3547	.054509	6	.0546
FUD15c/BIO39c	15.6675	.015655	2	.0156
FUD22/BIO39c	24.8296	.003166	9	.0528

Note. Values for alternative diets and trust in pharmaceutical industry leaders.

RQ3- What is the relationship between having an alternative diet and the amount of trust one has in pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of the MMR vaccine among female respondents aged 18 to 29 years.

I started the analysis for Research Question #3 crosstabulation for the FUD29 group, which was if there was a statistically significant relationship between practicing a vegan or vegetarian diet and one's belief that they can trust pharmaceutical industry leaders to give full and accurate information about the preventive health benefits and risks associated with the MMR vaccine among females aged 18 to 29. The hypotheses for these variables were as follows:

H_{07}- There is no significant relationship between being vegan/vegetarian and the amount of trust one has in pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of the MMR vaccine among female respondents aged 18 to 29 years.

Ha_7- There is a significant relationship between being vegan/vegetarian and the amount of trust one has in pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of the MMR vaccine among female respondents aged 18 to 29 years.

The survey questions for these variables were:

- FUD29: Do you consider yourself a vegan or vegetarian?
- BIO39c How much, if at all, do you trust pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of childhood vaccines for measles, mumps, and rubella?

The first thing I did for these variables was determine if the sample size was large enough. I did this by investigating if any of the expected frequency values were under 5, of which there were none, so I concluded that the sample size was large enough to perform my analysis and that the assumption that at least 80% of the cells had an expected frequency of 5 or more was met.

The next thing I had to do was see if there was a statistically significant relationship between practicing a vegan or vegetarian diet and the level of trust one has in pharmaceutical industry leaders to give full and accurate information about health benefits and risks of the MMR vaccine for my sample population. To do this, I looked at the *p*- value, which was 0.054509 (Table 13). Since this value was over the alpha of .05, I concluded that there was not statistically significant relationship between the variables for FUD29 and BIO39c, therefore the analysis of this set of variables was complete. I failed to reject the null hypothesis that there is no statistically significant relationship

between practicing a vegan or vegetarian diet and the level of trust one has in the pharmaceutical industry to give full and accurate information about the health benefits and risks of the MMR vaccine, while holding all other variables constant and with a degree of freedom of 6, among females aged 18 to 29 years:

$$\chi^2(6, N = 3029) = 12.3547, p > .05$$

Table 14

Crosstabulation for Vegan/Vegetarian and Trust in Pharmaceutical Industry

	A lot	Some	Not too much	None at all
Strict Vegan/Vegetarian	24 (24.10)	70 (73.35)	65 (62.29)	38 (37.27)
Mostly Vegan/Vegetarian	29 (22.99)	51 (69.99)	60 (59.44)	48 (35.57)
Neither Vegan nor Vegetarian	311 (316.91)	987 (964.66)	816 (819.26)	477 (490.17)

Note. Expected values are in parentheses.

The next variables addressed the relationship between consuming a non-GMO diet and the level of trust one has in pharmaceutical leaders to give full and accurate information about the health benefits and risks of the MMR vaccine. The hypotheses for these variables were as follows:

H_{08}- There is no significant relationship between having a non-GMO diet and the amount of trust one has in pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of the MMR vaccine among female respondents aged 18 to 29 years.

Ha_8- There is a significant relationship between having a non-GMO diet and the amount of trust one has in pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of the MMR vaccine among female respondents aged 18 to 29 years.

The survey questions for these variables were:

- FUD15c: Thinking about the last 30 days, how often did you or someone in your household buy GMO-free food, which is food labeled as having no genetically modified ingredients?
- BIO39 How much, if at all, do you trust pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of childhood vaccines for measles, mumps, and rubella?

The first thing to do with these variables was to ensure that at least 80% of the cells in the table had an expected value of 5 or more, which determines the effect size, or whether the sample population was big enough. As all of the values in the cells of the crosstabulation table were higher than 5, I was able to conclude that the assumption that at least 80% cells had an expected value of 5 was met, and, therefore, the sample population was large enough for my analysis. I then moved on to examine the *p*-value so determine whether there was a statistically significant relationship between consuming a non-GMO diet and the level of trust one has in pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of the of the MMR vaccine (Table 13). As the *p*- value for crosstabulation of the variables was .015655, I concluded that I failed to reject the null hypothesis that there was no significant relationship between consuming a non-GMO diet and the level of trust one has in pharmaceutical leaders to give full and accurate information about the health risks and benefits of the MMR vaccine, holding all other values constant, and with a degree of freedom of 6, among females aged 18 to 29 years.

Because I knew that there was a statistically significant relationship between my variables, I next wanted to assess the strength of the relationship by observing the Cramer's V value. Because this value was .0156, which falls below the range that would be considered a moderate strength between variables (Table 10). Therefore, I concluded that, while there was a statistically significant relationship between consuming a non-GMO diet and the level of trust one has in pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of the MMR vaccine, this relationship was very weak.

$$\chi^2 (6, N = 3029) = 15.6675, p < .05$$

Table 15

Crosstabulation for Non-GMO Diet and Trust in Pharmaceutical Industry

	A lot	Some	Not too much	None at all
Several times	125 (133.34)	379 (393.85)	310 (308.91)	210 (187.91)
About once	67 (52.48)	150 (155.00)	110 (121.57)	76 (73.95)
Never	89 (95.19)	301 (281.15)	231 (220.52)	110 (134.14)

Note. Expected values are in parentheses.

The next set of variables I analyzed were practicing an organic diet and the level of trust one has in pharmaceutical industry leaders to give accurate information about the health risks and benefits of the MMR vaccine. The hypotheses for these variables were as follows:

H_{09}- There is no significant relationship between having an organic diet and the amount of trust one has in pharmaceutical industry leaders to give full and

accurate information about the health risks and benefits of the MMR vaccine among female respondents aged 18 to 29 years.

Ha_9 – There is a significant relationship between having an organic diet and the amount of trust one has in pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of the MMR vaccine among female respondents aged 18 to 29 years. The survey questions for these variables were:

- FUD22: How much of the food you eat is organic?
- BIO39c: How much, if at all, do you trust pharmaceutical industry leaders to give full and accurate information about the health risks and preventive health benefits of childhood vaccines for measles, mumps, and rubella?

As with previous sets of variables, I first needed to ensure that the sample size was large enough to yield the most accurate results. To do this, I observed the table for the crosstabulation of the two variables (Table 16). None of the expected values were below 5 so the sample size was large enough and the assumption that at least 80% of the cells had a value of 5 or greater was met. The next thing I did was see if the there was a significant relationship between practicing an organic diet and the level of trust one has in pharmaceutical leaders to give accurate information about risks and benefits of the MMR vaccine, so I looked to the *p*- value for the crosstabulation. The *p*- value was 0.003166, which is less than the alpha .05 so I could conclude that the relationship between the two variables was significant (Table 13). Because the relationship was significant, I then wanted to assess the strength of the relationship, for which I observed the Cramer's V

value of the crosstabulation. This value was 0.0546 so I determined that, while the relationship between practicing an organic diet and the level of trust one has in pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of the MMR vaccine among females ages 18 to 29 years, holding all other values constant and with 9 degrees of freedom, was statistically significant, the relationship was very weak:

$$\square^2 (9, N = 3029) = 24.8296, p < .05$$

Table 16

Crosstabulation for Organic Diet and Trust in Pharmaceutical Industry

	A lot	Some	Not too much	None at all
Most of it	45 (52.16)	146 (155.64)	135 (131.82)	93 (79.37)
Some of it	138 (134.83)	369 (402.30)	362 (340.72)	214 (205.16)
Not too much	132 (143.67)	460 (428.67)	357 (363.05)	205 (218.61)
None at all	55 (39.34)	129 (117.38)	81 (99.41)	51 (59.86)

Note. Expected values are in parentheses.

Research Question #4

Table 17

Chi-Square, P- value*, Degrees of Freedom and Cramer's V* Value*s for BIO34*

Diet	Chi-square value	*p*- value	df	Cramer's V
FUD29/BIO34	3.7995	.149608	2	.0359
FUD15c/BIO34	5.2348	.072994	2	.0732
FUD22/BIO34	8.8911	.030774	3	.0551

Note. Values for alternative diets and the belief that benefits outweigh the risks or the risks outweigh the benefits.

RQ4- What is the relationship between having an alternative diet and believing that the benefits of the MMR vaccine outweigh the risks or that the risks outweigh the benefits among female respondents aged 18 to 29 years?

I began the analysis for Research Question #4 by observing the set of hypotheses for whether there is a statistically significant relationship between practicing a vegan/vegetarian diet and whether one believes that the risks of the MMR vaccine outweigh the preventive health benefits or if the preventive health benefits outweigh the risks. The hypotheses for these variables are as follows:

H_{010}- There is no significant relationship between being vegan/vegetarian and believing that either the preventive health benefits of the MMR vaccine outweigh the risks or thee or the risks outweigh the benefits among female respondents aged 18 to 29 years.

Ha_{10}- There is a significant relationship between being vegan and believing either the preventive health benefits of the MMR vaccine outweigh the risks or that the risks outweigh the benefits among female respondents aged 18 to 29 years.

The survey questions for these variables were:

- FUD29: Do you consider yourself a vegan or vegetarian?
- BIO34: Overall, do you think the benefits of childhood vaccines for measles, mumps, and rubella outweigh the risks, or that the risks of childhood vaccines for measles, mumps, and rubella outweigh the benefits?

The first thing I did for these variables was determine if the sample size was large enough by verifying that at least 80% of the cells had an expected frequency of 5 or

more. Looking over the expected counts for these two variables, I saw that there were no cells with an expected frequency less than 5 (Table 18), therefore I determined the sample size was large enough and that the assumption that at least 80% of the cells had an expected frequency of 5 or more was met. The next thing I had to do was determine whether the relationship between the FUD29 and BIO34 variables was statistically significant. To do this, I looked at the *p*- value to see if it fell below the alpha value of .05. The *p*- value for this crosstabulation was 0.149608, which is higher, therefore, I concluded that the relationship between practicing a vegan/vegetarian diet and one's belief that the preventive health benefits of the MMR vaccine or the risks, holding all other values constant with a degree of freedom of 2, among females aged 18 to 29 years was not significant (Table 17). Because of this, I failed to reject the null hypothesis that there is no statistically significant relationship between practicing a vegan or vegetarian diet and believing that either the preventive health benefits of the MMR outweigh the risks, or the risks outweigh the benefits, holding all other values constant, with a degree of freedom of 2, among females aged 18 to 29:

$$\square^2(2, N = 301) = 3.7995, p < .05$$

Table 18

Crosstabulation for Vegan/Vegetarian and Believing Benefits Outweigh Risks or Risks Outweigh Benefits

	Benefits over risks	Risks over benefits
Strict vegan/vegetarian	189 (183.20)	8 (13.80)
Mostly vegan/vegetarian	175 (172.04)	10 (12.96)
Neither vegan nor vegetarian	2385 (2393.75)	189 (180.25)

Note. Expected values are in parentheses

The next variables to analyze were those that represent one's consumption of non-GMO foods and either believing that the preventive health benefits of the MMR vaccine outweigh the risks, or that the risks outweigh the benefits. The hypotheses for these variables were as follows:

H_{012}- There is no significant relationship between having a non-GMO diet and believing either that the benefits of the MMR vaccine outweigh the risks among female respondents aged 18 to 30 years, or that the risks outweigh the benefits.

Ha_{12}- There is a significant relationship between having a non-GMO diet and believing that either the benefits of the MMR vaccine outweigh the risks among female respondents aged 18 to 30 years, or that the risks outweigh the benefits.

The survey questions for this variable were:

- FUD15c: Thinking about the last 30 days, how often did you or someone in your household buy GMO-free food, which is food labeled as having no genetically modified ingredients?
- BIO34: Overall, do you think the benefits of childhood vaccines for measles, mumps, and rubella outweigh the risks or the risks of childhood vaccines for measles, mumps, and rubella outweigh the benefits?

The first thing I had to do for these variables was to observe the frequency values for the crosstabulation. As none of the cells in this table had a value below 5, I was able to conclude that the effect size (or sample size) was large enough and that the assumption that at least 80% of the cells had an expected frequency of 5 or more (Table 12). The next thing to do was determine if the relationship between my variable was significant,

therefore, I examined the *p*- value for the crosstabulation (Table 19). As this value was 0.072994, and was higher than the alpha of .05, the relationship was not statistically significant and my analysis for these variables was complete. For this set of variables, I rejected the null hypothesis that there was not a statistically significant relationship between consuming a non-GMO diet and believing that either the preventive health benefits of the MMR vaccine outweighed the risks, or the risks outweighed the benefits, holding all values constant, with 2 degrees of freedom, among females aged 18 to 29:

$$\chi^2 (2, N = 3029) = 5.2348, p > .05$$

Table 19

Crosstabulation for Non-GMO Diet and Believing Benefits Outweigh Risks or Risks Outweigh Benefits

	Benefits over risks	Risks over benefits
Several times	189 (183.20)	8 (13.80)
About once	175 (172.04)	10 (12.96)
Never	2385 (2393.75)	189 (180.25)

Note. Expected values are in parentheses

The next set of variables included practicing an organic diet and the belief that either the preventive health benefits of the MMR vaccine outweigh the risks, or the risks outweigh the benefits. The hypotheses for these variables were as follows:

> H_{012}- There is no significant relationship between having an organic diet and believing that either the preventive health benefits of the MMR vaccine outweigh the risks, or the risks outweigh the preventive health benefits among female respondents aged 18 to 29 years.

Ha_{12}- There is a significant relationship between having an organic diet and believing that either the preventive health benefits of the MMR vaccine outweigh the risks, or the risks outweigh the preventive health benefits among female respondents aged 18 to 29 years.

The survey questions for these variables were:

- FUD22: How much of the food you eat is organic?
- BIO34: Overall, do you think the benefits of childhood vaccines for measles, mumps, and rubella outweigh the risks? /The risks of childhood vaccines for measles, mumps, and rubella outweigh the benefits?

The first thing I needed to do with these variables was determine if the sample size was large enough for the most accurate results. To do this, I looked at the crosstabulation for the FUD22 and BIO34 variables. Upon examining the expected frequencies for the crosstabulation, I did not find any that fell below a value of 5, which I then concluded that the sample size was large enough and the assumption that at least 80% of the cells in the crosstabulation had a value of 5 or more was met (Table 20). I then wanted to see if the relationship between these two variables was significant, so I observed the *p*- value for the crosstabulation, which was 0.034254. Because this value was less than the alpha of .05, I could assume that the relationship between FUD22 and BIO34 was statistically significant (Table 17). The next thing I did was determine the strength of the relationship and I did this by observing the Cramer's V value of the crosstabulation, which was 0.0551, which fell within the "weak" category. Even though the relationship between the variables was significant, it was very weak at best. I

concluded that, while the relationship between practicing an organic diet and one's belief that either the preventive health benefits of the MMR vaccine outweigh the risks, or the risks outweigh the benefits, was statistically significant, this relationship was very weak. This was holding all other values constant and with 3 degrees of freedom for females 18 to 29 years old.

$$\chi^2 (3, N = 3029) = 8.8911, p < .05$$

Table 20

Crosstabulation for Organic Diet and Believing Benefits Outweigh Risks or Risks Outweigh Benefits

	Benefits over risks	Risks over benefits
Most of it	386 (387.10)	29 (27.90)
Some of it	996 (980.34)	55 (70.66)
Not too much	1066 (1070.81)	82 (77.19)
None at all	285 (294.75)	31 (21.25)

Note. Expected values are in parentheses

Summary

In this section, I used the chi-square test to analyze relationships between my dependent variables (BIO questions) and independent variables (FUD questions). I first addressed Research Question #1 by analyzing the relationship between one's perceived risk of side effects of the MMR vaccine and practicing three different alternative diets: vegan/vegetarian, non-GMO, and organic diets. I addressed whether the null hypotheses, that there were no significant relationships between the variables, would be rejected or if I failed to reject them. I also ensured that the chi-square assumption that at least 80% of the cells in the crosstabulation tables for our analysis had a value of 5 or greater.

The results of my analysis indicated that there were no statistically significant relationships between practicing a non-GMO or an organic diet and perceived health risks of the MMR vaccine, but there was a statistically significant relationship between practicing a vegan/vegetarian diet and perceived risks, however, this relationship was weak. I then examined the relationship between one's perceived health benefits of the MMR vaccine and the alternative diet practices. The results of my analysis indicated that there was no statistically significant relationship between perceived benefits and practicing a vegan/vegetarian diet, a non-GMO diet, or an organic diet. I then examined the relationships between either believing the risks of the MMR outweigh the benefits, or if the benefits outweighed the risks of the MMR vaccine and practicing an alternative diet. The results of my analysis showed that there was no statistically significant relationship between believing benefits outweigh risks or risks outweigh benefits and practicing a vegan/vegetarian diet or a non-GMO diet. While there was a statistically significant between believing the benefits outweigh the risks or the risks outweigh benefits and practicing an organic diet, this relationship was very weak. I then moved on to examine the relationship between trust in pharmaceutical industry leaders and practicing an alternative diet. The results of my analysis showed that there was no statistically significant relationship for practicing a vegan/vegetarian diet and trust in pharmaceutical industry leaders, but there was a statistically significant relationship between trust in pharmaceutical industry leaders and practicing a non-GOM diet and organic diet. This relationship, however, was very weak.

Section 4: Application to Professional Practice and Implications for Social Change

Introduction

The purpose of this study was to see whether practicing an alternative diet may be predictive of an individual's confidence in the MMR vaccine. In conducting this study, I ultimately sought to delve into the possible predictors associated with lifestyle behaviors, including making the decision to vaccinate and a person's consumption of an alternative diet, both of which have connotations to living a "healthier" lifestyle. Dietary habits are constantly in flux with the trends of modern living, and new diets are emerging constantly that attempt to mitigate modern prominent health issues like obesity, heart disease, diabetes, and cancer to name a few. Because of this, I wanted to investigate some of the common alternative dietary behaviors, and what kind of relationship they can have with one's decision to vaccinate. I elected to focus on the MMR vaccine because it has been one of the most controversial due to the misguided belief by many that it has a direct correlation to life-long health issues such as autism (Jama et al., 2018). I used the basic constructs of two behavioral frameworks, the health belief model and social ecological model, that offer possible sources of influence on one's health behavior: one's perception of fear, and risk of illness as well as the various levels of society that may guide one's health-related behavior.

Interpretation of the Findings

A search of the existing literature yielded no previous assessments of the relationship between alternative diet practices and characteristics of those who have confidence in vaccines, particularly in the areas of safety and efficacy. The analysis of

this study yielded some interesting results in that some types of dietary practices did have a statistically significant association with some of the concepts that were aligned with one's confidence in the MMR vaccine, and some did not. The relationships that were deemed significant, however, were weak. When considering the effects of dietary behaviors on vaccination decisions, the use of the health belief model helped in shedding light on the thought processes involved in both practicing an alternative diet as well as in an individual's opinion of the vaccine. Because the health belief model employed factors associated with health behaviors such as perceived risk of illness, perceived risk of side effects and self-efficacy, these constructs can be useful in comparing and contrasting between an individual's perception of the diet they practice and of their choice to adhere to the recommended immunization schedule. Similarly, the social ecological model has the potential to help in the understanding of how and why people not only choose to practice an alternative diet over a traditional diet, but also why they support or oppose the practice of vaccination as recommended by their own personal beliefs, the beliefs of friends and family, those of medical experts, and stakeholders involved with vaccination like drug manufacturers and health insurance organizations.

Limitations

There were some significant obstacles in conducting this study. One of the most substantial obstacles that occurred was in my analysis, in which large segments of data was missing within the secondary dataset. This obstacle was amplified when it was discovered that the population group that responded to questions related to confidence in the MMR vaccine were entirely different than the respondents who answered survey

questions about alternative diets, thus making crosstabulation for the chi-square test impossible with the data as they were. Because the variables that I had selected were categorical, I needed to commit to using the nonparametric chi-square test for independence as parametric analyses required continuous variables in order to yield valid results. Because of my commitment to using chi-square analysis, I had to find a way to account for the significant amount of missed data, but I first needed to determine whether the data were missing at random or missing not at random in order to select a method of data replacement that would produce the best results. After concluding that the data were missing not at random, I resolved to the process of multiple imputation, which used the linear regression model to replace missing data with probable values. I then had to decide how to use these replaced values. I determined that I would use the iteration that had the least missing data. Once I had a sufficient amount of data, I turned to the assumptions of the chi-square analysis: that the observed values were whole numbers, that the groups were completely independent from one another (meaning that paired samples could not be used), and that at least 80% of the expected values for all cells within the crosstabulation had a value of 5 or higher (McHugh, 2013). As it was assumed that there were no paired samples, and the tables of each crosstabulation had at least 80% of the cells with a value of 5 or more, all of the assumptions were deemed as met, and I could then report the results of my chi-square analysis.

Recommendations

The results of this analysis pointed to some recommendations for future research. Given that the associations between my variables were weak, if they were significant

relationships at all, there remains a lingering need to explore other health behaviors that may coincide or work congruently with factors associated with the amount of confidence one has in not only the MMR vaccine but others as well. Some other considerations for future research on vaccination could include or expand on spending behaviors, or other health-related behaviors such as physical activity, web search behaviors, or other diet behaviors such as the paleo diet or the pescatarian diet. I also recommend that future research will include a thorough assessment of the missing data in a chosen dataset as real observed data offers a higher level of accuracy in one's analysis. Regarding the implications of these results on positive social change, this study showed that, in order to explore the reasons people may lack confidence in vaccination, we must first assess the thought process as well as the influences that lead to a person's beliefs. Trust in pharmaceutical industry leaders to give full and accurate information on the risks and side effects, as well as an individual's own perception of the risks and benefits of vaccination was proven to have a significant relationship with one's dietary behaviors, and even though these relationships were found to be weak, they exist, nonetheless. Therefore, to improve people's confidence in vaccination and increase the number vaccinated people, further exploration would prove beneficial to population health as well as confidence in the preventive health strategies that exist now and in the future.

Conclusion

While my analysis did not offer any groundbreaking discoveries, that is not to say it is irrelevant. The results of this data show a clear need for exploration of other factors that may influence vaccine uptake. As we settle into the new normal of life with COVID-

19 hanging in the forefront, it would behoove researchers to investigate other behaviors or beliefs that may influence one to accept recommended vaccination or refrain from it. Either the health belief model or the social ecological model (or both) should be considered in conducting future vaccination behavior research as any insight to possible influences on personal health decisions could be invaluable in the design and implementation of vaccine awareness campaigns whether they advocate for routine childhood vaccination or other vaccines that exist presently and those that are on the horizon of public health research.

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Appendix A: American Trends Survey Questions

BIO33: Thinking about childhood vaccines for measles, mumps, and rubella (MMR) how would you rate:

A. The risk of side effects:

(1) Very high

(2) High

(3) Medium

(4) Low

(5) Very low

B. The preventive health benefits:

(1) Very high

(2) High

(3) Medium

(4) Low

(5) Very Low

BIO34: Overall, do you think...

(1) The benefits of childhood vaccines for measles, mumps, and rubella outweigh the risks.

(2) The risks of childhood vaccines for measles, mumps, and rubella outweigh the benefits.

BIO35: Which comes closer to your views about childhood vaccines for measles, mumps, and rubella, even if neither is exactly right?

(1) Parents should be able to decide NOT to vaccinate their children, even if that may create health risks for other children and adults.

(2) Healthy children should be required to be vaccinated in order to attend schools because of the potential risks for others when children are not vaccinated.

BIO38: Thinking about what you have read and heard, how well do you understand the health risks and benefits of childhood vaccines for measles, mumps, and rubella?

(1) Very well

(2) Fairly well

(3) Not too well

(4) Not at all well

BIO39 How much, if at all, do you trust pharmaceutical industry leaders to give full and accurate information about the health risks and benefits of childhood vaccines for measles, mumps, and rubella?

(1) A lot

(2) Some

(3) Not too much

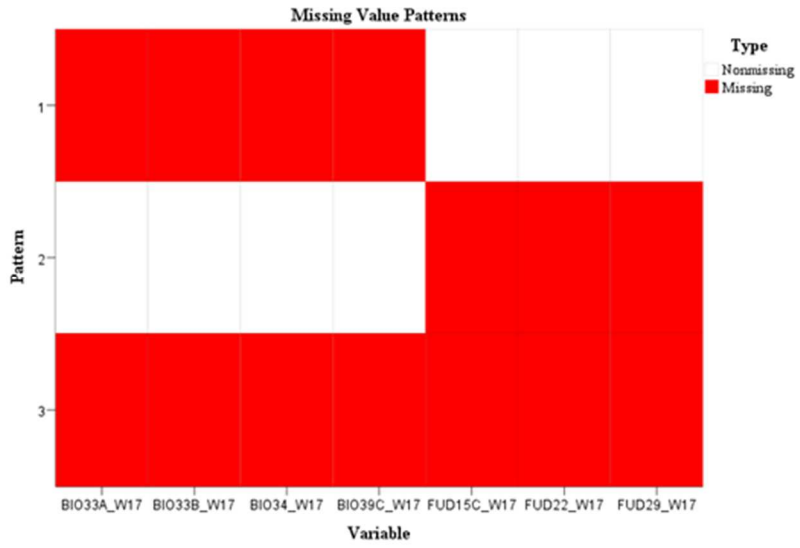
(4) Not at all

Appendix B: Imputation of Missing Variables

To account for missing data, I first had to determine whether they were missing at random (MAR) or missing not at random (NMAR), as this told me what type of analysis I should use. If the data is missing at random, a Missing Value Analysis should be used and for data that is not missing at random, multiple imputation is the most appropriate analysis, as it analyzes multiple possible versions of datasets generating imputed values for those that are missing (George & Mallery, 2012). In analyzing the output each group of questions (FUD and BIO) had large blocks of missing data where the other missed it, confirming that the missing data in my dataset were, indeed, missing not at random, as random missing data would have a pattern consisting of individual cases scattered throughout the graph referred to as "islands" (George & Mallery, 2012) within the output (Figure B1).

Figure B1

Missing Value Patterns in Dataset



Note. Representation of the missing values from the Pew Research Survey.

The analysis also showed me that all variables assessed for this study had missing data, in fact 66.7% of the data was missing and only 33.3% of the total data for all of our variables were complete. This observation indicated to me that there was most likely bias in the data, as a large number of missing cases in data indicates bias within a dataset (Johnson et al., 2021). In addition, the bar graph from my analysis indicated that the three identified patterns among my missing data were all very similar, which supports the clear need for randomization and replacing my missing data with new values. Once I assessed the data to determine how I would account for that which was missing, I proceeded to perform multiple imputation. The model that was selected was done so by selecting the automatic method which automatically selects a model type based on a scan of the data. Now that I had accounted for the missing data, I was able to proceed with my analysis (Figure 2).

Table B1

Imputation Specifications

Imputation Method	Automatic
Number of Imputations	10
Model for Scale Variables	Linear Regression
Interactions Included in Models	(none)
Maximum Percentage of Missing Values	100.0%
Maximum Number of Parameters in Imputation Model	100

Note. The specifics of values in regard to multiple imputation.