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The Privilege to Choose: How Class Status Influences the Spread of Vaccine Refusal

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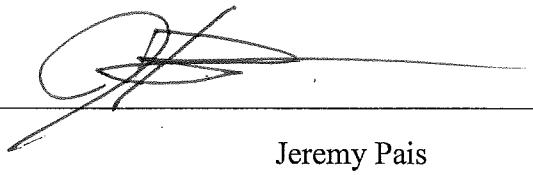
Major Advisor 

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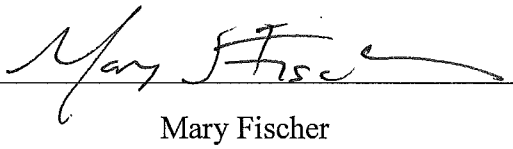
Associate Advisor 

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ABSTRACT
Most of the research that exists on vaccine refusal focuses on how exemptions impact disease outbreaks or point-in-time examinations of who is refusing. The present study addresses who is refusing over the course of the last two decades. I examine how social class influences the propensity to refuse vaccines over time. Using pooled cross-sectional National Immunization Survey data from 1995 to 2012, I estimate binary logistic regressions on the probability of being unvaccinated. The results indicate that social class does impact the propensity to refuse vaccines, but in dynamic ways. The two components of social class, education and household income, operate in opposite directions. Initially, higher levels of income decrease the odds of being unvaccinated, while higher levels of education increase the odds of being unvaccinated. However, over time income replaces education as a predictor of vaccine refusal. The changing relevance of education and income are made clearer in the key finding of this study, which is that families with status offsets—high income/low education and low income/high education—have had the greatest growth in vaccine refusal since 1995. These results suggest that class status, as it relates to vaccine refusal, influences people in dynamic ways.

The Privilege to Choose: How Class Status Influences the Spread of Vaccine Refusal

In April of 2014, the Centers for Disease Control and Prevention (CDC) reported the largest outbreak of measles since 1996 (Bernstein 2014). The recent rise of vaccine-preventable diseases has spawned considerable scholarly and media attention (Centers for Disease Control 2013a; Culp-Ressler 2013; Culp-Ressler 2014; Douclef 2014; Lowry 2014). Historically, non-vaccination occurs in populations that lack comprehensive access to healthcare, but in recent years vaccine refusal has gained notice. The medical community is now seriously concerned about non-vaccination as a potential cause of mass outbreaks (Centers for Disease Control 2013a; Culp-Ressler 2013; Culp-Ressler 2014; Douclef 2014; Lowry 2014). For social and cultural reasons, an increasing number of families are choosing not to vaccinate their children (Muskat 2011). However, the practice of vaccine refusal is not occurring randomly. Compared to families whose children are undervaccinated, families who refuse vaccines tend to be white, well-educated, and have annual incomes over $75,000 (Smith, Chu & Barker 2004).

To many who choose not to vaccinate, the practice represents the personal responsibility to protect one's children from disease without relying on the allegedly harmful chemicals found in vaccines (Reich 2014). The expression of parental responsibility through vaccine refusal is not common to all—it is a shared worldview that develops among those who occupy a similar social location. The worldview promotes self-efficacy in parental decision-making, and this self-efficacy is supported by parents' access to resources. Parents who reject vaccines have access to information on vaccine refusal, the time and education to interpret the information, or are socially engaged with parents that do appear to have the time and knowledge. These resources provide the foundation of confidence and self-efficacy it takes to confront the mainstream medical establishment. The confidence to confront social institutions and demand an

individualized plan of care is more often associated with families belonging to the middle and upper classes (Lareau 2003). Their access to important forms of capital encourages a worldview that celebrates the challenging of mainstream institutions. With their abundance of economic and cultural resources, middle class families can expect their opinions to be valued and their demands to be accommodated (Lareau 2003).

The objective of this research is to provide insight into the evolution of contrarian ideas by examining the sociodemographic composition of vaccine refusers over time. The importance of sociodemographics is two-fold. First, such characteristics identify the current and recent sources of vaccine refusal. If sociodemographics are clear predictors of refusal (Smith et al. 2004), we can use them to identify the source of the public health crisis and plan accordingly. Second, they may help us discover how contrarian ideas become imbedded in society. By examining sociodemographics over time, we can understand the pattern through which practices like vaccine refusal gain popularity. The first reason has practical implications as it identifies the populations most at risk for vaccine refusal. The second implication requires a deeper, more theoretical understanding of how ideas develop and spread despite the potential dangers to individuals and groups. This study will allow us to focus prevention efforts more accurately and attempt to reduce the further resurgence of disease.

HOW THINGS SPREAD: SOCIAL CLASS AND THE DIFFUSION OF INNOVATIONS

History and literature suggests class as an important mechanism in the choice to refuse vaccination (Allen 2007; Reich 2014; Smith et al. 2004). By examining how the sociodemographic composition has changed we can begin to understand more about how and why the practice has spread in recent history. One reason why class is such an important

consideration is that social diffusion is dependent upon compatibility. A rapid rate of adoption depends heavily on the compatibility between the innovation and the pre-existing values of the pool of adopters (Rogers 2003). According to Rogers (2003), the perceived compatibility of an innovation is positively related to the rate of adoption. Innovations can be compatible—or incompatible— with sociocultural values and beliefs, previously introduced ideas, or individual/group needs (Rogers 2003). Whether or not vaccine refusal spreads within or from one class to another may rest in how consistent it is with class-linked beliefs and precedent.

Bourdieu suggests that all cultural practices are shaped by social class and serve as a means of distinction between classes (Bourdieu 1987; Swartz 1997). His concept of social class involves the usual indicators such as income and education, but also extends to lifestyle indicators, tastes, gender and age (Swartz 1997). Bourdieu (1987) posits that differences in cultural practices reflect the differences in economic and cultural capital members of each class possess. Cultural capital refers to the cultural goods and services available to an individual or group (Bourdieu 1987). These cultural goods and services encompass a myriad of resources including cultural skills, social connections, and educational experiences, which can be transformed into various forms of value (Lareau 2003).

From this perspective, working class culture is formed by economic necessity and the constraints of earning a livelihood (Swartz 1997). The working class develops a worldview shaped by their social and economic constraints. The middle and upper classes experience degrees of relative freedom from the material scarcity experienced by the lower classes (Swartz 1997). The preferences and worldview they develop reflect this freedom. The middle and upper classes value practices that require cultural and economic capital, setting them apart from the economically constrained working class. Vaccine refusal represents a form of distinction because

it requires valuable cultural capital including, time, education, and access to alternative health knowledge and resources.

Lareau's (2003) study of social class and parenting demonstrates Bourdieu's (1987) concept of distinction and further clarifies the compatibility between vaccine refusal and the middle class worldview. Lareau (2003) finds that middle and upper class parents take an intensive, interventionist approach to parenting, while working class families prefer a more laid-back style. The middle class approach, called "concerted cultivation," involves carefully selected educational and extracurricular activities. Middle class parents are involved in most every area of their children's lives, exacting vigilant scrutiny and control, and institutions are expected to meet the individualized needs of their children.

The overseeing of institutions—educational, medical, or otherwise— is a crucial component of the concerted cultivation logic (Lareau 2003). Parents do not hesitate to intervene in situations that do not meet their children's needs. Middle and upper class parents are empowered by their education and social position to effectively advocate and intervene on behalf of their children (Lareau 2003). It is clear that the middle and upper class values of distinction and concerted cultivation are part of a worldview that is compatible with vaccine refusal. The mainstream medical establishment is just one of many institutions in which parents may intervene on behalf of their children.

Working class families take a more relaxed approach, called "the accomplishment of natural growth" (Lareau 2003). These parents view less intensive, less structured activity as the key to success for their children. Extra-curricular activity is often unstructured and consists of leaving children to dictate their own free time. Working class parents often leave the structure of children's education up to the schools, trusting the "experts" to make good decisions (Lareau

2003). As Bourdieu posits, working class families develop preferences that reflect their circumstances. They likely lack the time and economic resources to craft intensive educational and extracurricular activities, and Lareau (2003) finds that working class parents lack the confidence and efficacy to intervene in social institutions. This lack of efficacy explains why working class families prefer leaving educational decisions to the "experts." From this perspective we can understand why vaccine refusal could be rooted in the middle class, where parents are more comfortable intervening in a variety of institutions on behalf of their children.

Despite the theoretical and empirical suggestion that vaccine refusal is a middle class phenomenon, the possibility of working class refusal should not be ignored. Cultural practices do not develop in a vacuum, and literature suggests that elite practices spread to lower status groups (Patterson and Kaufman 2005; Schensul et al. 2005). Additionally, while vaccine refusal appears to be *most* compatible with the middle and upper classes, some evidence suggests lower and working class compatibility. The era of compulsory vaccination in the 1800s saw resistance from working class and poor families who were refusing vaccines and could not pay the associated fines (Allen 2007). Certain immigrant groups in the Midwest rejected vaccines because they preferred alternative methods and were suspicious of government mandates, though immigrants are not the primary source of vaccine refusal (Allen 2007). Religious groups who viewed the practice as unnatural and as interference in God's plan resisted early variolation attempts (Allen 2007). Fundamental and orthodox religious adherents remain sources of vaccine refusal and are associated with lower socioeconomic status (Kennedy and Gust 2008; Muskat 2011).

The forgoing theoretical arguments suggest social class is an important element of understanding health care practices. The literature already indicates class is an important factor in vaccine refusal (Allen 2007; Reich 2014; Smith et al. 2004), but the work of Bourdieu (1987)

and Lareau (2003) clarify *why* class is important. Relative economic constraint or freedom shapes the cultural preferences and practices of social groups. The forthcoming discussion specifies how cultural practices spread within and between social groups. The literature on how new practices spread generally agree on two types of diffusion processes: endogenous and exogenous (Rossman 2012; Henrich 2001).

Diffusion Through Social Networks

Endogenous diffusion, the most commonly occurring diffusion pattern, refers to the spread of a practice from one actor to another, perhaps by word of mouth (Henrich 2001; Rossman 2012). Three types of bias explain the pattern endogenous diffusion typically takes, giving it the alternative name Biased Cultural Transmission: 1) Direct bias, meaning the specific traits about an innovation that make it more or less "adoptable," 2) Prestige bias, which suggests people adopt ideas/behaviors of prestigious or successful people, and 3) Conformist bias, the idea that people tend to adopt the practices of the majority rather than the minority (Henrich 2001). The cultural orientation work of Bourdieu (1987) and Lareau (2003) suggest direct bias is at play for the upper and middle classes because their worldview is most compatible with vaccine refusal. Rogers (2003) finds socioeconomic status to be highly related to potential contact with early adopters who encourage diffusion, further implicating the middle class as the source of new cultural ideas concerning health care practices. Moreover, according to Dynamic Social Impact Theory (DSIT), those of higher socioeconomic status are the usual "kick starters" of an innovation because they have the social influence to incite new cultural norms (Schensul et al. 2005).

Endogenous diffusion is characterized by an s-curve that reflects the slow beginning of early adopters followed by rapid increase as the practice spreads through social networks,

culminating in a tapering-off when the population has reached saturation (Henrich 2001). One seminal diffusion study provides an example of farmers adopting a new kind of seed (Ryan and Gross 1943). Endogenous diffusion begins with one farmer adopting the innovation, having success and sharing that success with his two neighbors. Those two neighbors adopt the innovation and share their success with other acquaintances and so on. The practice spreads one person at a time, slowly at first, then much more rapidly before finally tapering off (Rossman 2012). Endogenous diffusion of vaccine refusal could take many forms, but based on the forgoing discussion of social class, it likely began with wealthier, more elite groups. This perspective gives primacy to within group diffusion, and in this case the groups are characterized by social class.

Diffusion Through Influence

Exogenous diffusion occurs when there is some influencing factor that incites immediate and constant growth (Rossman 2012; Henrich 2001). Diffusion stems from a force external to the group, wherein experts may discover an important innovation that is disseminated either in a targeted fashion to a specific group or as broadly as possible. Outside influences could be as mundane as directed marketing through advertising campaigns or as serious as national public health campaigns. Exogenous diffusion is also termed environmental learning because it suggests individuals have universal access within their environment to information about an innovation, and make rational, cost-benefit-driven decisions.

Exogenous diffusion is characterized by an r-curve that is concave in shape (Rossman 2012; Henrich 2001). This shape reflects the fact that a constant adoption rate is drawing from an ever-decreasing risk pool. This perspective gives primacy to global social diffusion. Differential access to information outlets makes social class relevant to this scenario. Upper and middle class

individuals likely have greater access to early sources of information about vaccine refusal.

Coleman et al. (1966) provide a specific example of exogenous diffusion in the prescription of tetracycline, in which doctors had a particular rate for adopting tetracycline as a treatment. The adoption rate is constant and draws from an ever-decreasing pool. If 1000 doctors have an adoption rate of ten percent, the first month would see 100 doctors adopt the practice (Coleman et al. 1966; Rossman 2012). The pool of potential adopters would reduce to 900, meaning the second month would see 90 doctors adopting tetracycline. For vaccine refusal, exogenous diffusion within the upper classes could have been incited by the 1998 medical study linking vaccines to autism. The study was published in a leading medical journal and facilitated wide exposure to the belief that the Measles, Mumps and Rubella vaccine causes autism.

There is also a possibility of a combination of endogenous and exogenous diffusion, where different processes occur for each social group. Rossman (2012) provides an example in which initial diffusion follows the exogenous r-curve for the group most compatible to the practice. Some outside influence spurs an environmental learning process. Diffusion becomes endogenous as it spreads to the less compatible group(s). In terms of vaccines, the initial influencing factor may be more compatible with the middle/upper class, causing immediate and constant diffusion among the pool of potential adopters. Because there is no strong outside influence for the working class, the process is a word-of-mouth type of diffusion.

Between-Group Diffusion

The above diffusion processes explain how practices spread in general, but do not attempt to explain how practices may spread across social groups. Vertical diffusion is a compelling hypothesis for between-group diffusion, specifically class-based diffusion; it brings clarity to the gray area of how practices spread from one group to another. It could involve one or more of the

types of diffusion discussed above, but is set apart by the specific direction of the diffusion path. Vertical diffusion, or top-down diffusion, generally refers to the spread of innovations or practices from the upper classes down towards the lower classes. When diffusion is discussed in the literature as a class process, it is often through a top-down lens. Dynamic Social Impact Theory (DSIT) also suggests that innovations start in the upper classes. When an innovation then spreads to lower status individuals, it may reflect the power the upper class holds in shaping social and cultural practices (Schensul et al. 2005). DSIT emphasizes the power of higher status actors to impact the behavior of others and is often a source of explanation for class-based diffusion (Schensul et al. 2005).

Besnsard (1995) comments that diffusion of children's names in France follows a trickle-down model in which names gain popularity in the upper classes and are then imitated in the lower classes. Bhrolchain and Beaujouan (2013) find that highly educated young people led the cohabitation movement of the 1970s before its spread to lower status groups. Another study explains how ecstasy use in New England began in the suburban middle and upper-middle class dance-rave scene (Schensul et al. 2005). The drug was marketed with an emphasis on social status and was associated with higher social positions, exhibited by possessing certain goods and having access to socially desirable spaces. As contact with urban minorities increased, typically through targeted dance-rave events, the use of ecstasy spread to poor urban areas. Some authors explain the status aspect of vertical diffusion with the cultural power component of DSIT, discussed above. Consistent with this theory, Patterson and Kaufman's (2005) seminal work on the global diffusion of cricket argues that high-status actors who have the power to affect cultural meanings can promote cultural practices. Under this paradigm, the practice is most compatible

for the middle and upper classes, and takes off there first. Because of the cultural power of the higher class status, the practice is promoted to the poor/working class.

While the support for vertical diffusion from the upper classes to the lower is strong, there are notable examples of the opposite. The realm of fashion offers some examples of diffusion from the lower classes to the upper. Two such instances include the "little black dress" and blue jeans. The little black dress was fashioned after maids' uniforms in the 1920s. The meaning of the style differed by social group; for the working class, it was a uniform marking their status as maids. When Chanel and others made the style popular for the upper classes, the little black dress marked their status as the kind of person who would have a maid (Davis 1989).

Blue jeans are perhaps an even clearer example of diffusion from the working class to the upper classes. The ubiquitous denim pants became popular with sailors and laborers in the mid-19th century, but did not cross class lines until the 1960s. Originally popular for their durability, blue jeans became synonymous with physical labor, the outdoors, and the American west, which came to represent populist sentiments of democracy, equality, unpretentiousness and the "common man" (Davis 1989). One of the earliest groups to adopt blue jeans were the free-spirited, but higher status artists and painters, followed by bikers, activists, the political counterculture, and hippies. The upward diffusion culminated in the designer production of jeans (Davis 1989). Designer versions of plain clothes like blue jeans become a way of marking high status while also being an unpretentious "common man."

The forgoing discussion demonstrates class as an important factor in adopting cultural practices. Bourdieu (1987) and Lareau (2003) help explain why compatibility between class orientation and a social innovation is important. However, their work stops short of explaining how or why the cultural practices spread within or between social groups. Social diffusion

literature provides extensive information on how practices spread within groups or in society in general, but tends to stop short of explaining cross-class processes. By combining these elements with DSIT and vertical diffusion, we can begin to postulate about how vaccine refusal spreads within and between social classes.

TRENDS IN NON-VACCINATION

In the year 2000, endemic measles, that is measles originating within the United States, was eliminated (Strebel et al. 2004). Prior to elimination, the nation faced a number of barriers to widespread immunization. A lack of public awareness and resource shortfalls —of both the public health system and individual families— are prime among those barriers (Robinson et al. 1993). However, throughout the 1990s access gradually increased. The primary source of change came from President Clinton's immunization initiative, which he began in 1993 after only 24 days in office (Robinson et al. 1993). The initiative was aimed at improving child health in the United States by increasing access to age-appropriate immunizations for preventable diseases. The initiative improved infrastructure, extended clinic hours, provided more staff and increased informational and educational campaigns (Robinson et al. 1993). The initiative also resulted in legislation that significantly reduced the cost of vaccination to patients. The target of these efforts was low-income families and the resource and education barriers they experienced (Robinson et al. 1994).

Since measles elimination in 2000, incidence of measles and other preventable diseases has increased, largely due to lower vaccination rates (Fiebelkorn et al. 2010). Of the measles cases that occurred between 2004 and 2008, 68% were classified as preventable (Fiebelkorn et al. 2010). Some patients lacked access to medical care, but many claimed personal exemptions

(Fiebelkorn et al. 2010). The recent reduction of vaccination rates has ironically taken place despite the fact that access to vaccinations has increased significantly in the last two decades. This post-elimination period has witnessed a rise in both measles and pertussis. Between 2001 and 2008, there were 38 measles outbreaks with 587 case patients (Fiebelkorn 2010). Between 2008 and 2013 there were 682 cases of measles, an average annual increase of 44 cases (Council on Foreign Relations 2014). During the same period (2008-2013) there were over 58,000 cases of pertussis in the United States (Council of Foreign Relations 2014). One report indicates that 50% of schools that participated in an immunization assessment survey reported rates lower than the 95% school coverage target for MMR (Centers for Disease Control 2011).

Class has explanatory power here because vaccine refusal has been identified as a largely middle and upper class phenomenon (Khazan 2014; Reich 2014; Smith et al. 2004). Historical and recent accounts provide evidence for vaccine-refusal as a middle and upper class practice. An occurrence that is arguably tied to the middle class is the campaign linking vaccines to autism that occurred in the late 1990s and early 2000s. In 1998 a study was published in a prominent British medical journal that linked the MMR vaccine to gastrointestinal disease and autism. The study was essentially funded by the financial resources of parents of children who had allegedly been injured by vaccines (Harris 2010). Subsequent research teams could not replicate the study and the work was eventually discredited and retracted from published record (Harris 2010; Muskat 2011)[1]. Unfortunately, the study gained significant traction in the 12 years that it remained in circulation and continues to fuel the anti-vaccination movement. The study was

[1] The lead investigator of the study was later found guilty of medical misconduct for subjecting 12 children to invasive tests for which no ethical approval was obtained and for receiving funding for the study from lawyers working for parents who were suing vaccine companies for damages (Harris 2010).

published in a prestigious medical journal[2], lending it credibility. News coverage of the study further imbedded the link between vaccines and autism into the public consciousness. The study also confirmed the fears of many —like Dissatisfied Parents Together— who had been questioning the safety of vaccines for years. Despite a lack of scientific evidence, personal beliefs are still being influenced in this area.

Further supporting the idea that vaccine refusal is rooted in the middle class are multiple studies that link the two. A study using the National Immunization Survey indicates children who had received no vaccinations were more likely to be from homes with annual incomes over $75,000 and have parents with higher levels of education when compared with children who were undervaccinated (Smith et al. 2004). Allen (2007) provides case examples of elite vaccine refusal within a private Waldorf School in Colorado as well as elite Colorado communities. The school and communities are wealthy, highly educated and have high rates of vaccine refusal. Popular media has also pointed to vaccine refusal among the affluent, suggesting some wealthy neighborhoods have vaccination rates comparable to third world countries (Khazan 2014). The ability to choose alternative medicine or private schooling is predicated upon financial and cultural capital available primarily to the middle and upper classes.

In more recent years, the flow of information about vaccine fears from elite sources to mass media may have opened the door for vaccine refusal to be adopted by groups outside the original pool of adopters. Eventually, popular media increased coverage of the possible dangers of vaccination. Kennedy and Gust (2008) reported that media influence was an important factor for families who did not vaccinate. Figure 1 demonstrates increased coverage, showing that

[2] The study was originally published in The Lancet (Harris 2010), which was ranked among the top 100 medical journals worldwide (Special Libraries Association 2009).

mentions of autism, a feared side effect of vaccines, in published books has steadily increased since the early 1990s with a pronounced rise since the early to mid-2000s. A crucial source of media influence is the public support the movement continues to receive from celebrities and other influential public figures.

(Figure 1 about here)

Jenny McCarthy has been a public spokesperson for the vaccine safety campaign for a number of years (Lowry 2014). She and actor Jim Carrey are both outspoken about the link between vaccines and autism, even leading a Green Our Vaccines rally in Washington DC alongside multiple anti-vaccine organizations (Autism Speaks 2008). MTV really show star Kristen Callavari also made a public announcement that she and her NFL quarterback husband Jay Cutler will not vaccinate their children due to fears of autism (Fox Business 2014). Actors are not the only public figures speaking out about the alleged dangers of vaccines. Financial tycoon and presidential hopeful Donald Trump has made multiple claims on television and social media that vaccines are linked to autism (Media Matters for America 2012; Willingham 2015).

Mass information campaigns (often supported by celebrity spokespeople like those listed above) have also brought information about vaccine refusal to the masses, potentially aiding the spread of the practice beyond more elite circles. Non-profits like the National Vaccine Information Center and the National Autism Association do not identify specifically as "anti-vaccine," but they question the safety of vaccines and draw attention to the potential links between vaccines and autism (Fournier 2012; National Vaccine Information Center 2014). The documentary *The Greater Good* follows three families who believe their children to be vaccine-injured (Nelson and Pilaro 2011). The footage is supplemented by interviews with sympathetic public health and medical professionals discussing their beliefs about the dangers of vaccines.

Outlets like *The Greater Good* are designed to spread the word that vaccines may be dangerous and that we as a nation need to "think again" about mass vaccination (The Greater Good Website 2012).

The question of how the vaccination rates fell in the face of increased access is at the heart of this study. Of sociological concern is how characteristics like social class can help us understand, and possibly forecast, the resurgence and spread of preventable diseases in the United States. Class is clearly an important factor for understanding and forecasting vaccine refusal, and like most in history, this case has come to encompass members of both the lower and upper classes. Theories of social diffusion provide a number of possible trajectories for the spread of vaccine refusal; each of these will be considered in the following section. However, the literature points to a particular class-based trajectory that seems to occur over and over: vertical diffusion. The top-down, upper-to-lower class trajectory will function as the key hypothesis for this study.

HYPOTHESES

The forgoing discussion inspires a number of questions regarding a class framework for how the practice of vaccine refusal may have spread, that include within- and between-class diffusion trajectories. Based upon social diffusion literature, I present 4 hypotheses that concern the role of social class in vaccine refusal. In opposition to the null hypothesis, I suggest endogenous, exogenous and combined processes, with specific trajectories reflecting the vertical diffusion model. If current trends follow any of the expected trajectories, we will be able to cautiously infer about future development of vaccine refusal.

Hypothesis #1: Vaccine refusal diffuses endogenously within and between classes. The

vertical diffusion model and Dynamic Social Impact Theory support this hypothesis. The initial diffusion process would involve vaccine refusal spreading via word of mouth and social networks through the upper and middle classes, as their worldview is most compatible with the practice. Vertical diffusion suggests the practice will eventually trickle down to those of lower socioeconomic status. DSIT posits the reason for this downward diffusion is the power held by the upper classes to set cultural preferences.

If this is the modal pattern we should expect a time lag between the diffusion processes for the upper classes and the lower classes. In the proposed scenario, refusal would originate in the upper class and diffuse slowly at first, then rapidly until some saturation point, then taper off. At some point, possibly during the greatest period of growth, vaccine refusal would cross over into the lower class category. Figure 2 illustrates the process.

(Figure 2 about here)

Hypothesis #2: Vaccine refusal diffuses exogenously by class. This hypothesis also suggests that the vaccine refusal trajectories are similar and time-lagged between social classes but are of a different functional form. The trajectory for each class category would follow the r-curve of exogenous diffusion. A lag in the timing of initial diffusion for each class could stem from differential sources of information about vaccine refusal. The 1998 vaccines-autism study may represent a more elite source of information while the numerous media sources cited above may represent a more popular source. Class still drives the diffusion process by influencing what types of information are accessible to each group. Figure 3 presents a trajectory reflecting exogenous diffusion by class.

(Figure 3 about here)

Hypothesis #3: Vaccine refusal diffuses through a combination of endogenous and

exogenous processes. This hypothesis encompasses two possibilities: 1) Vaccine refusal diffuses endogenously for the upper classes and exogenously for the lower classes, or, 2) Vaccine refusal diffuses exogenously for the upper classes and endogenously for the lower. In the latter situation, some outside influence—like a scholarly study linking vaccines to autism—would incite a constant growth pattern in the upper classes, which appears to be the most compatible with the group. At some point during the diffusion process the practice would crossover to the other class category, spreading slowly at first, then increasing rapidly. Figure 4 demonstrates a scenario that follows this pattern.

(Figure 4 about here)

Null Hypothesis: Vaccine refusal diffuses endogenously or exogenously for each class simultaneously. Vaccine refusal may spread within each class simultaneously, implying class is not an important factor in adoption. Diffusion would begin at approximately the same time, suggesting each class had similar access to information and that neither class directly influenced the other. Growth in the practice of vaccine refusal could take the form of the endogenous s-curve or the exogenous r-curve. Figure 5 shows two representations of a null hypothesis.

(Figure 5 about here)

DATA AND METHODS

The data for this study come from pooled, cross-sectional National Immunization Survey (NIS) public use data from 1995 to 2012. The NIS is a random-digit-dialing telephone survey with a follow-up mail survey sent to the target child's medical provider(s) (Centers for Disease Control 2014). The survey is administered in the 50 United States and the U.S. Virgin Islands. For this study I exclude the U.S. Virgin Islands. The target population is children ages 19-35 months.

This survey is the primary method used by the CDC to estimate national and state vaccination coverage. The survey collects detailed information on the target child's immunization history and demographic, socioeconomic and geographical information on the household. The information regarding immunization history is confirmed with provider surveys of immunization records, which are sent to the providers identified by each respondent.

The NIS data present a few analytical challenges. The first challenge is the categorical coding of continuous variables. To protect the identity of all respondents, the NIS research team conservatively codes income and education each into a four-category variable. Additionally, the annual NIS cannot determine the motivation behind a child having zero doses of recommended vaccines, therefore the measures created to indicate vaccine refusal are only approximations (Smith et al. 2004). There is also the possibility of selection bias; households that do not vaccinate may have a higher propensity to refuse to participate in the survey (Smith et al. 2004). One underlying factor may be mistrust in the medical community, which is associated with vaccine refusal (Lakoff 2015). Individuals who mistrust the medical community may be uncomfortable divulging personal information for a survey, causing them to be underrepresented in the sample. Finally, because the NIS uses complex survey methods with weighting, standard goodness of fit tests are unavailable. Following the suggestion of Archer, Lemeshow and Hosmer (2007), I utilize the F-adjusted mean residual test.

Dependent Variables

The primary dependent variable is children who have received zero of the vaccines that were recommended in all years from 1995-2012. Vaccines that have been recommended each year since 1995 include Hepatitis B (Hep), Haemophilus Influenzae type B (HiB), Poliovirus (IPV), Measles, Mumps and Rubella (MMR), and Diptheria, Tetanus, and Pertussis (DTP) (CDC 2015).

Table 1 presents descriptive statistics for each of the recommended vaccines. The proportion of the weighted sample that has received at least one dose of Hep, HiB, IPV and DTP is slightly above the coverage rates reported recently (CDC 2013b). The higher proportion likely reflect the fact that coverage rates are based on receiving the recommended number of doses, not just one or more. The proportion of the weighted sample who have at least one dose of MMR is very close to recent coverage rates, likely reflecting the fact that only one dose of MMR is recommended for the target age of the NIS sample (CDC 2013b).

There are some vaccines that people are more or less likely to refuse for various reasons; in the 1980s there was fear surrounding DTP vaccines and seizures, in the 1990s and early 2000s it was rotovirus vaccines and intussusception, and after 1998 fears of MMR and autism took off (Allen 2007). These fears, combined with a myriad of possible reasons, may cause some families who would not otherwise refuse vaccines to selectively refuse. To capture the concept of selective refusal, Table 1 also presents descriptive statistics for three possible dependent variables with different combinations of vaccines. All three dependent variables are coded as 1 (unvaccinated) if the target child received zero doses of the included immunizations, and had either adequate provider data or no reported providers. The most stringent of the three, Unvaccinated-5, includes all five immunizations that were recommended for all children in all years, listed above. This variable follows the example set by Smith et al. (2004) for measuring vaccine refusal. The vaccines included in the two other variables, Uncaccinated-4 and Unvaccinated-3, were selected based on historical and social context and on CDC (2013b) reports of vaccines with low coverage rates. Unvaccinated-4 includes DTP, MMR, HiB, and Hep. DTP and MMR generally have lower coverage rates (CDC 2013b) and are cited as vaccines associated with fears of damage (Allen 2007). Unvaccinated-3 includes DTP, HiB and Hep.

MMR was eliminated because the other three vaccines have lower or less stable coverage rates (CDC 2013b).

(Table 1 about here)

Independent Variables

Key independent variables pertain to time and social class. Time is a key independent variable because it is a crucial concept for examining diffusion processes. I use mother's education and family income to measure social class. Mother's education was recoded from a categorical variable into years of education that correspond to each educational category. I then took the log of the continuous variable and standardized it. Family income was recoded to the midpoints of each category, adjusted for inflation, and standardized. The descriptive statistics found in Table 2 reflect transformed education and income variables. The social class index variable was created as a parsimonious measure of social class. To isolate the independent and potentially offsetting effects of household income and education, social class is also measured categorically by a series of social status dummy indicators. The indicators account for four combinations of social status markers: High education/high income, high education/low income, low education/high income, and low education/low income, where high education and income are defined as greater than the mean and low values are defined as less than the mean. These variables examine how offsets in social status markers impact the likelihood of children being unvaccinated.

(Table 2 about here)

Control variables include demographic and geographic indicators. Race is an important control concept because vaccine refusal is theorized to be a privileged behavior. Between the

idea that white privilege may play into vaccine refusal[3] and the fact that racial minorities are socioeconomically disadvantaged, the expectation is that being non-white will reduce the likelihood of children being unvaccinated (Smith et al. 2004). Race is included as a series of dummy indicator variables. Marital status and number of children have also been theorized as predictors of vaccine refusal, with the expectation that being married and having higher numbers of children increase the likelihood of children being unvaccinated. Finally, some reports suggest living in the western United States may be related to increased vaccine refusal (Allen 2007; Khazan 2014). Census regions are included as a series of dummy indicators.

Analytic Approach

Vaccine refusal is measured as zero doses of the five vaccines that have been on the recommended schedule since 1995. The prevalence of vaccine refusal is quite low over all, regardless of the measure used, as seen in Table 1. I use binary logistic regression to estimate the log odds of being unvaccinated to indicate the relationship between time, social class and vaccine refusal. I also plot predicted probabilities to examine vaccine refusal trajectories over time. I first determine the functional form of the probability of being unvaccinated over time with log-odds coefficients and predicted probabilities. I then model the relationship between social class and vaccine refusal over time using log-odds coefficients and plotted predicted probabilities.

RESULTS

The general perception in media is that vaccine refusal has been on the rise. Both popular and scholarly outlets have highlighted the surge in vaccine-preventable diseases and suggested it is

[3] Children with no vaccines tend to be white and economically privileged compared to their undervaccinated counterparts, who are more likely to be of minority status and economically disadvantaged (Smith et al. 2004).

due in part to vaccine refusal (Douclef 2014, Fiebelkorn et al. 2010). Table 3 and Figure 6 present four representations of the probability of being unvaccinated from 1995 to 2012. The first model on Table 3 and panel A in Figure 6 show the impact of each year on the probability of being unvaccinated. The non-parametric model derives the trajectory directly from the data without a predetermined form and has the best model fit. While the non-parametric form is clearly the most accurate, a comparison of the four functional forms in Figure 1 indicates the increase in the probability of being unvaccinated is reasonably well predicted in each form. For this reason I use the linear function in the forthcoming analyses. All four models indicate an increase in the probability of being unvaccinated, and the non-parametric trajectory shows the beginning of the greatest growth starts at approximately time six, which is 2001. Notably, this is approximately two years after the publication of the study linking the MMR vaccine to autism.

(Table 3 about here)

(Figure 6 about here)

Table 4 presents the log odds coefficients for the effects of social class and demographic characteristics on the likelihood of being unvaccinated. Models 1a and 1b examine the impact of the composite measure of social class. Model 1a indicates that time has a significant impact when social class is held at the mean, increasing the odds by 1.19, or approximately 19%, holding all other variables constant. The strong impact of time supports the findings of Figure 6, that the practice of vaccine refusal has been spreading in the last 17 years. The effect of the composite indicator of class is negative at time zero (1995), but the relationship is not statistically significant. This relationship contradicts the theory that vaccine refusal began in the upper classes. The interaction between social class and time also does not have a significant

impact on the odds of being unvaccinated, suggesting the relationship does not strengthen or change over time.

When demographic control variables are added in Model 1b, the direction and significance of time, social class and the time/social class interaction remain largely the same. The demographic controls function largely as expected. Compared to being white, being Black, Hispanic or other race reduces the odds of being unvaccinated, holding all other variables constant. Additionally, having more than four children and being from the western region of the United States increases the odds of being unvaccinated, holding all other variables constant.

(Table 4 about here)

Figure 7 shows the predicted probabilities of being unvaccinated by social class over time. The graph plots the predicted probabilities for two standard deviations above and below the mean of the social class index. The trajectories rise for both social groups, though somewhat more steeply for the lower status group. Initial growth in the lower class contradicts the vertical diffusion hypothesis, which suggests vaccine refusal should have risen steeply for the higher status group first. However, the log odds coefficients from Model 1A on Table 4 suggest the difference between groups is non-significant.

(Figure 7 about here)

Models 2a and 2b present coefficients for education and income separately, to examine the independent effects of each class indicator. Education, which is an integral consideration for social class, is initially non-significant (at time zero) when income is at the mean, though the direction of the relationship conforms to expectations: an increase in education increases the odds of being unvaccinated in 1995, holding all other variables constant. However, in 1995, increases in income, when education is held at the mean, reduce the odds of being unvaccinated

by approximately 27%, which contradicts earlier suggestions that people of higher incomes are more likely to refuse vaccines. As expected based on models 1a and 1b, the interaction between education and income is non-significant.

Interestingly, the above relationships change over time. When income is held at the mean, as time and education increase, the odds of being unvaccinated decrease, holding all other variables constant. When time is interacted with income, with education held at the mean, there is another change in relationship. For every one-year increase in time and every unit increase in logged, standardized income, the odds of being unvaccinated increase by 4%. The interaction of time, education and income is non-significant. The opposing effects of education and income on vaccine refusal explain why a social class index combining the two was non-significant—the two indicators were canceling each other out. Additionally, the reversal in the relationships over time suggests the impact of class on vaccine refusal is evolving. Adding demographic control variables to model 2b leaves the results largely unchanged, and the demographic variables produce results consistent with models 1a and 1b; being any race other than white decreases the odds of being unvaccinated while having more than four children and living in the western U.S. increase the odds.

In Table 5 I model the same status offsets seen in Table 4, mean-centered but in the original metrics of thousands of dollars and years of education. The direction of the relationships between education and income are much the same as the logged, standardized models. Models 3a and 3b support the previous findings that initially increases in education increase the odds of being unvaccinated while increases in income decrease the odds (neither relationship is significant in these models), and the finding that over time the relationships reverse; as time and education increase, the odds of being unvaccinated decrease while increases in time and income

increase the odds. The results of models 2a-3b, particularly the changes over time, suggest that income replaced education as the positive predictor of vaccine refusal.

To further investigate the differing impact of income and education, in Table 6 I predict vaccine refusal for four separate groups: High education/high income, high education/low income, low education/high income, and low education/low income. As seen in Table 1, high values are defined as greater than the mean and low values are defined as less than the mean. In these models the most interesting findings are how geography impacts the odds of being unvaccinated. The western region of the U.S. appears to be a haven for vaccine refusal for everyone but the traditionally defined working class, those with low education and low income. The odds of refusing vaccines are more than doubled for the low education/high income group living in the west, and the odds for the high education/high income group also increase. For the high education/low income group, living in both the south and the west have marginal significance. Though living in the west has the same impact on this group as the others, it appears that in the south having above average education (but below average income) reduces the odds of being unvaccinated.

(Table 5 about here)

To further demonstrate the impact of status offsets, Figure 8 plots the predicted probabilities of being unvaccinated for four groups similar to those utilized in models four through seven. For this graph, high income or education is defined as being two standard deviations above the mean, and low income or education is two standard deviations below the mean. The most dramatic growth takes place for those who have income two standard deviations above the mean but education two standard deviations below the mean. The second group lags significantly behind the first, and consists of those whose income is two standard deviations

below the mean, but whose education is two standard deviations above the mean. There is very little growth for the two remaining groups: those with high income and high education, and those with low income and low education. The graph presents the case that the group potentially driving vaccine refusal has high income but low education. Figure 8 makes it clear that social class is not impacting vaccine refusal in conventional ways. Status offsets, rather than status congruence, predict the practice. The higher than average income seen in spread of the practice still suggests a certain amount of privilege, but the lower education raises questions about how status, resources and privilege influence vaccine refusal.

(Figure 8 about here)

CONCLUSION

Popular media and scholarly literature suggest that vaccine refusal has risen in recent years, bringing with it increases in vaccine preventable diseases. The present study confirms that vaccine refusal has risen sharply since 1995. Attempts to theorize about who refuses vaccines for their children suggest that vaccine refusal may be a middle and upper class phenomenon. Works by Bourdieu (1987) and Lareau (2003) provide a framework for why this may be. Middle and upper class families have a worldview that values intensive, individualized care and services for their children. They are comfortable confronting mainstream institutions like schools and medical professionals to demand accommodation. Bourdieu (1987) suggests all cultural practices are shaped by social class and by social and cultural capital. The middle and upper classes can construct practices that demonstrate their relative freedom from economic constraint, while working class practices are shaped by their daily encounters with economic necessity.

The present study connects the above conceptions of vaccine refusal and social class with social diffusion theories to examine how the practice has spread in recent years. The trajectories

seen in Figure 6 suggest that overall, vaccine refusal is spreading endogenously, based on the sharp increase that has taken place since approximately 2005-2006. However, based on the analyses presented here, it is difficult to confirm hypotheses about how vaccine refusal has spread by social class. The first models show that a social class index comprised of income and education has no significant effect on the likelihood of being unvaccinated, both initially and over time.

When the effects of education and income are separated out it becomes clear why an index measure of social class did not work, but does little confirm any particular hypothesis. If we define social class as only education, a rise in social class initially increases the likelihood of being unvaccinated, but over time the opposite becomes true. This change suggests that over the years the practice spread to lower education groups, providing some support for the vertical diffusion hypothesis. However, the relationship between income and vaccine refusal is exactly opposite. In 1995 increases in income decrease the odds of being unvaccinated, but when time is considered in interaction, increases in income increase the likelihood of being unvaccinated. Figure 8 best demonstrates the complicated relationship between social class and vaccine refusal: those groups with status offsets have the highest rates and greatest growth of vaccine refusal.

The truly interesting finding of this study is the fact that having status offsets predicts the likelihood of being unvaccinated. Though this complicates the hypotheses laid out in this study, the question has changed— what is it about having mismatched income and education levels that has made some more likely to refuse vaccines over the last 17 years? Are individuals with status offsets are more vulnerable in certain ways? Perhaps status anxiety due to the offset influences parents to adopt practices that distinguish them from the working class and demonstrates their relative freedom from economic constraint. It also seems likely that the answer to this question

could be different for each of the two mismatched groups. It is possible that parents who have achieved higher levels of income without the corresponding levels of education view themselves as mavericks who can successfully make health decisions for themselves, without the added expertise of the medical community. Or possibly their vaccine refusal practices and their mismatched income and education are both results of their contrarian worldviews.

Parents who have high education and low income may have different experiences all together. There may be some unknown which influences this group to refuse vaccines and to choose careers whose value is more social and emotional than financial. Alternatively, if parents obtained higher education but hold low paying positions, whether by choice or misfortune, they may also have more motivation to distinguish themselves from the working class in visible ways. Additionally, they may be drawing upon the confidence and self-efficacy that is strengthened through higher education to confront and contradict the medical establishment, much as Lareau (2003) suggests.

The objectives of this study were to examine the role of social class in the practice of vaccine refusal and to explain how social class may impact the spread of contrarian ideas. Though the finding that status offsets are the best class-based predictors of vaccine refusal complicates the original hypotheses, the objectives have still been met. This study contributes a nuanced understanding of the ways in which social class influences the spread of social phenomena. The study broadens the monolithic conception of social class as either increasing or decreasing the propensity for certain practices linearly and acknowledges that social class identity is complicated and influences individuals and families in dynamic ways.

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Table 1 Weighted Descriptive Statistics for Dependent Variables

Variables	Mean	S.E.	Min	Max	Description
Vaccines Recommended in all years (≥1 dose)					
Diptheria, Tetanus and Pertussis	.9819	.0004	0	1	1 if one or more doses; 0 if no doses
Measles, Mumps and Rubella	.9126	.0008	0	1	1 if one or more doses; 0 if no doses
Poliovirus	.9761	.0005	0	1	1 if one or more doses; 0 if no doses
Haemophilus Influenzae type B	.9802	.0004	0	1	1 if one or more doses; 0 if no doses
Hepatitis B	.9683	.0005	0	1	1 if one or more doses; 0 if no doses
Unvaccinated Indicators					
Unvaccinated-5	.0070	.0003	0	1	1 if zero doses of all 5 vaccines; 0 if 1 or more doses
Unvaccinated-4	.0070	.0003	0	1	1 if zero doses of DTP, MMR, HiB, HEP; 0 if 1 or more doses
Unvaccinated-3	.0069	.0003	0	1	1 if zero doses of DTP, HiB, HEP; 0 if 1 or more doses

Source: National Immunization Survey, 1995-2012

Table 2 Weighted Descriptive Statistics for Independent Variables

Variables	Mean	S.E.	Min	Max	Description
Time	--	--	0	17	0 = 1995; 17 = 2012
Social Class					
Income	33.186	.0429	3.75	50	Income in thousands of dollars
Education	12.247	.0056	10	16	Years of education
Social Class Index	-.190	.0021	-1.51	2.05	Composite of standardized income and standardized education
Race					
White*	.550	.0012	0	1	1 if White; else 0
Hispanic	.235	.0011	0	1	1 if Hispanic; else 0
Black	.139	.0008	0	1	1 if Black; else 0
Other Race	.077	.0006	0	1	1 if other race; else 0
Family Characteristics					
Marital Status	.700	.0012	0	1	1 if married; else 0
Children	.140	.0009	0	1	1 if more than four children; 0 if four children or less
Region					
Northeast*	.164	.0004	0	1	1 if Northeast; else 0
Midwest	.221	.0005	0	1	1 if Midwest; else 0
West	.246	.0008	0	1	1 if West; else 0
South	.369	.0008	0	1	1 if South; else 0

Source: National Immunization Survey, 1995-2012
**Reference Category*

Table 3 Weighted Logistic Regression Models Predicting Functional Form

	Nonparametric		*Linear*		*Quadratic*		*Cubic*	
Name	β	(s.e.)	β	(s.e.)	β	(s.e.)	β	(s.e.)
Time 1	1.1632	.7021	--	--	--	--	--	--
Time 2	2.3767*	.6912	--	--	--	--	--	--
Time 3	.4495	.8378	--	--	--	--	--	--
Time 4	.3877	.8400	--	--	--	--	--	--
Time 5	.3057	.7785	--	--	--	--	--	--
Time 6	1.5480*	.7271	--	--	--	--	--	--
Time 7	2.8214***	.6352	--	--	--	--	--	--
Time 8	3.2426***	.6323	--	--	--	--	--	--
Time 9	3.3897***	.6356	--	--	--	--	--	--
Time 10	3.4029***	.6320	--	--	--	--	--	--
Time 11	3.2842***	.6308	--	--	--	--	--	--
Time 12	3.8008***	.6322	--	--	--	--	--	--
Time 13	3.6605***	.6286	--	--	--	--	--	--
Time 14	3.8089***	.6284	--	--	--	--	--	--
Time 15	3.7863***	.6329	--	--	--	--	--	--
Time 16	4.0016***	.6292	--	--	--	--	--	--
Time 17	4.1800***	.6326	--	--	--	--	--	--
Time (Continuous)	--	--	.1759***	.0088	.4849***	.0566	.7098***	.2025
Time*time	--	--	--	--	-.0142***	.0027	-.0383	.0211
Time*time*time	--	--	--	--	--	--	.0008	.0007
Constant	-8.2189***	.6160	-6.8988***	.1084	-8.3420***	.2751	-8.9260***	.5930
Goodness of Fit P-value	1.000		.000		.000		.000	
N	322,549		322,549		322,549		322,549	

Note: ***p<.001; **p<.01; *p<.05

Data Source: National Immunization Survey

Table 4 Weighted Logistic Regression Models Predicting Non-vaccination

	Standardized Social Class				**Standardized Education and Income**			
	Model 1a		*Model 1b*		*Model 2a*		*Model 2b*	
Name	β	(s.e.)	β	(s.e.)	β	(s.e.)	β	(s.e.)
Social class index	-.0894	.1243	-.2015	.1388	--	--	--	--
Social class index*time	-.0010	.0110	-.0062	.0114	--	--	--	--
Time	.1726***	.0089	.1718***	.0090	.1827***	.0107	.1750***	.0107
Education	--	--	--	--	.2546	.1435	.2467	.1462
Income	--	--	--	--	-.3140**	.1115	-.3775***	.1179
Education*income	--	--	--	--	-.1357	.1330	-.0986	.1374
Education*time	--	--	--	--	-.0426***	.0121	-.0408***	.0122
Income*time	--	--	--	--	.0351**	.0114	.0247*	.0117
Education*income*time	--	--	--	--	-.0109	.0137	-.0109	.0139
Children	--	--	1.0174***	.1071	--	--	1.0063***	.1062
Marital Status	--	--	.1929	.1292	--	--	.1498	.1272
Black	--	--	-.6090	.1593	--	--	-.5623***	.1598
Hispanic	--	--	-1.0326***	.1531	--	--	-.9520***	.1483
Other race	--	--	-.5147**	.1755	--	--	.4888**	.1753
Midwest	--	--	.0909	.1335	--	--	.0883	.1333
South	--	--	-.1412	.1365	--	--	-.1334	.1362
West	--	--	.5863***	.1374	--	--	.5798***	.1374
Constant	-6.9120***	.1123	-7.1380***	.1724	-6.8818***	.1263	-7.0448***	.1820
Goodness of Fit P-value	.000		.2029		.0000		.1937	
N	292,309		292,220		292,309		292,220	

Note: ****p<.001; **p<.01; *p<.05*

Data Source: National Immunization Survey

Table 5 Weighted Logistic Regression Models Predicting Non-vaccination

	Mean-Centered Unstandardized Education and Income			
	Model 3a		*Model 3b*	
Name	β	(s.e.)	β	(s.e.)
Time	.1798***	.0102	.1768***	.0103
Education	.0680	.0687	.0665	.0702
Income	-.0137	.0075	-.0200**	.0079
Education*income	-.0038	.0042	-.0025	.0043
Education*time	-.0152**	.0057	-.0150**	.0057
Income*time	.0017***	.0067	.0013*	.0007
Education*income*time	-.0001	.0004	-.0002	.0004
Children	--	--	.9969***	.1062
Marital Status	--	--	.1641	.1281
Black	--	--	-.5626***	.1602
Hispanic	--	--	-.9860***	.1489
Other race	--	--	-.4963**	.1753
Midwest	--	--	.0880	.1132
South	--	--	-.1374	.1362
West	--	--	.5815***	.1373
Constant	-6.8970***	.1263	-7.0881***	.1819
Goodness of Fit P-value	.0000		.2266	
N	292,309		292,220	

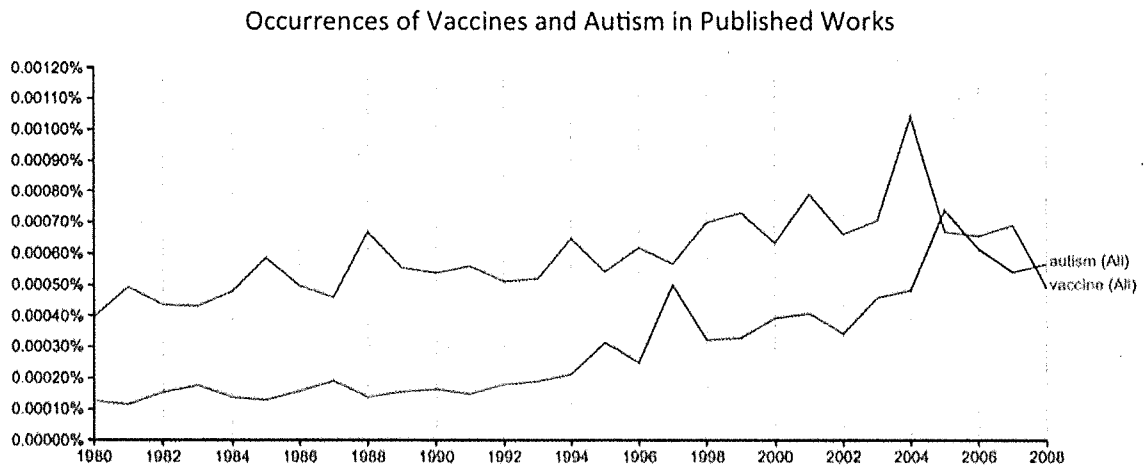
Note: ***$p<.001$; **$p<.01$; *$p<.05$

Data Source: National Immunization Survey

Table 6 Weighted Logistic Regression Models Predicting Non-vaccination with Factor Variables

	Model 4 High Education, High Income 4		*Model 5 High Education, Low Income 3*		*Model 6 Low Education, High Income 2*		*Model 7 Low Education, Low Income 1*	
Name	β	(s.e.)	β	(s.e.)	β	(s.e.)	β	(s.e.)
Time	.1554***	.0153	.1877***	.0251	.2044***	.0164	.1770***	.0155
Children	1.2106***	.1783	1.1340***	.3035	1.3470***	.1611	.7285***	.1655
Marital Status	-1.0338***	.2856	.2345	.3326	.0491	.1752	.2501	.1631
Black	-.0633	.3291	-1.5021***	.4426	-.2436	.2490	-.6208**	.2063
Hispanic	-.3383	.2666	-.0948	.3638	-.8437***	.2230	-1.0300***	.1788
Other race	-.6636*	.2793	-.9512**	.3257	-.3691	.3024	-.5107**	.2829
Midwest	-.0624	.2101	.0052	.3506	.6355*	.2484	-.0863	.2137
South	.2179	.2020	-.5999 †	.3601	.0665	.2481	-.2703	.2150
West	.6586**	.2210	.5690 †	.3202	.8313**	.2766	.2973	.2199
Constant	-6.2862***	.3422	-6.7975***	.5783	-7.5916***	.3535	-6.7891***	.2508
Goodness of Fit P-value	.9244		.0000		.9071		.8646	
N	110,475		21,128		84,103		106,586	

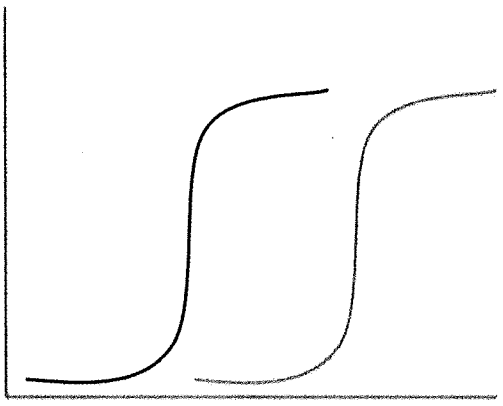
Note: ***p<.001; **p<.01; *p<.05 p<.10
Data Source: National Immunization Survey



Source: Google Books Ngram Viewer
Note: Graph reflects the percentage of all words that are "autism " and "vaccine" in all digitized Google books

Figure 1

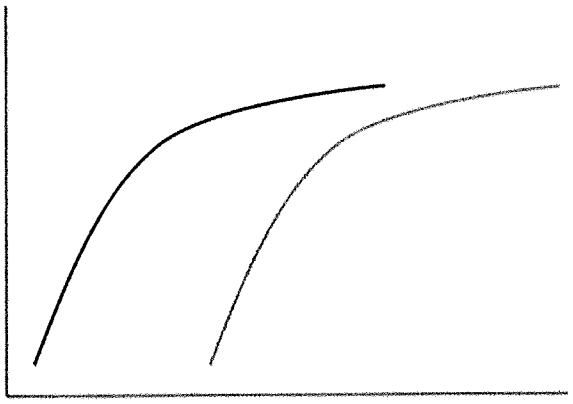
Hypothesis 1: Vaccine refusal diffuses endogenously within and between classes



Upper Classes
Lower Classes

Figure 2

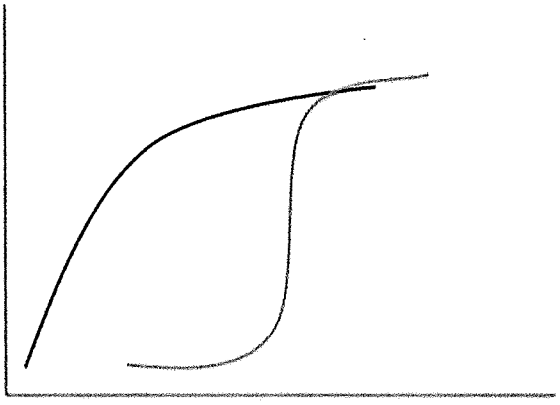
Hypothesis 2: Vaccine refusal diffuses exogenously for each class



Upper Classes
Lower Classes

Figure 3

Hypothesis 3: Vaccine refusal diffuses through a combination of endogenous and exogenous processes

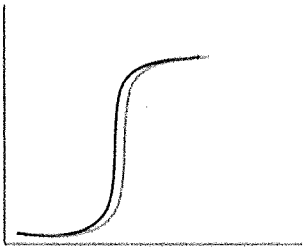


Upper Classes
Lower Classes

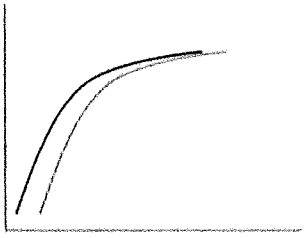
Figure 4

Null Hypotheses

Vaccine refusal diffuses endogenously for each class simultaneously



Vaccine refusal diffuses exogenously for each class simultaneously



Upper Classes

Lower Classes

Figure 5

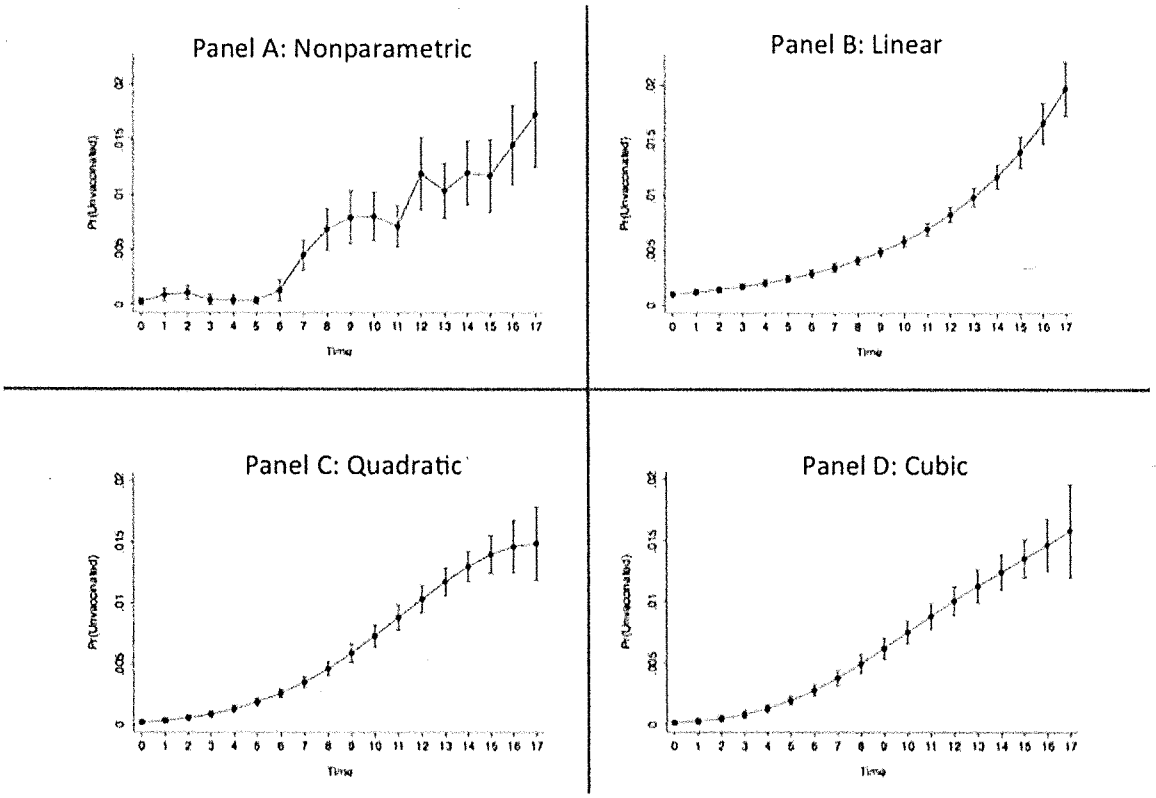


Figure 6

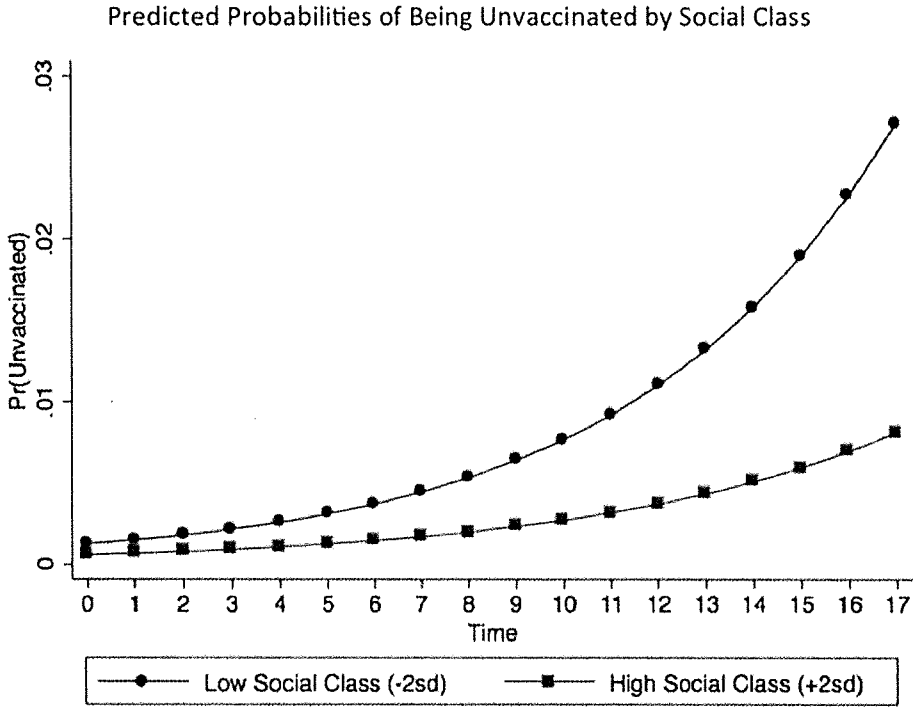


Figure 7

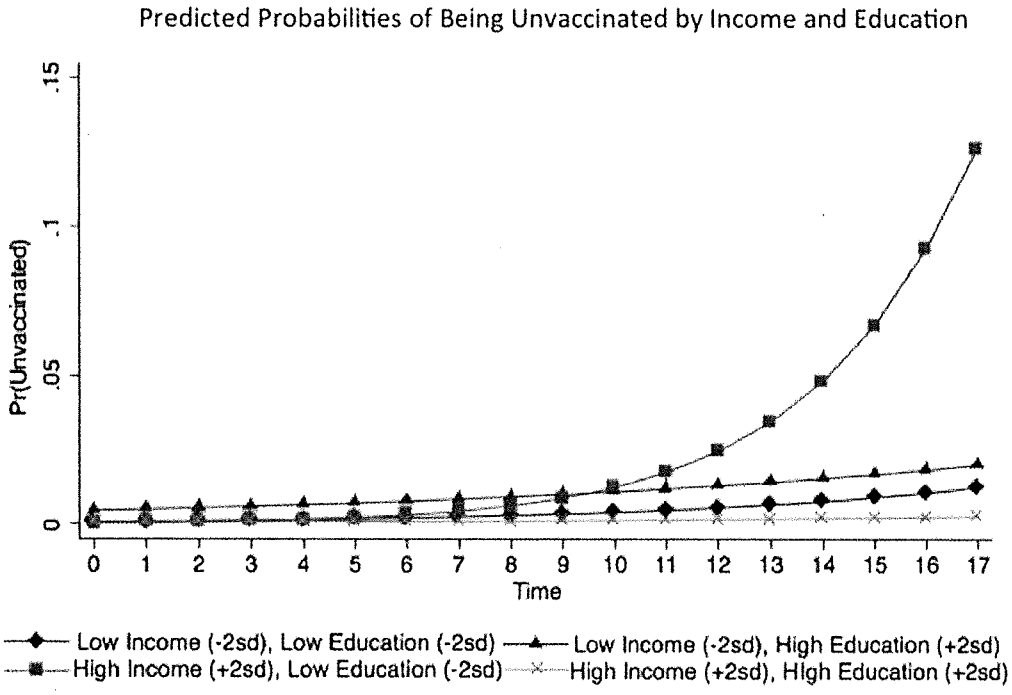

Predicted Probabilities of Being Unvaccinated by Income and Education
Pr(Unvaccinated)
0
.05
.1
.15
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Time
Low Income (-2sd), Low Education (-2sd)
Low Income (-2sd), High Education (+2sd)
High Income (+2sd), Low Education (-2sd)
High Income (+2sd), High Education (+2sd)

Figure 8