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Omolade Oladejo Date

Comparative Analysis of the Parent Attitudes about Childhood Vaccines (PACV) Short Scale and the Five Categories of Vaccine Acceptance Identified by Gust et al.

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An abstract of

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Abstract

Comparative Analysis of the Parent Attitudes about Childhood Vaccines (PACV) Short Scale and the Five Categories of Vaccine Acceptance Identified by Gust et al.
By Omolade Oladejo

Background: Vaccine hesitancy is a threat to the use of vaccines in combating vaccine-preventable diseases in the United States and in the world at large. There is a need to develop a standardized tool to aid in identifying, measuring and classifying the unique needs of vaccine hesitant parents. This type of classification will assist in designing tailored interventions to address these needs. Although there is no widely used standardized tool for measuring parental vaccine hesitancy, the Parental Attitude about Childhood Vaccines (PACV) short scale developed by Opel et al., and the five categories of vaccine acceptance (Immunization advocates, Go along to get along, Health advocates, Fencesitters and Worried; hereafter 'Gust et al. vaccine acceptance categories'), identified by Gust et al., have been acknowledged as potentially useful tools. However, the PACV short scale requires further validation in heterogeneous populations and other geographical locations. Moreover, we need to evaluate how the Gust et al. vaccine acceptance categories correspond with the PACV short scale.

Objective: To analyze the PACV short scale and the Gust et al. vaccine acceptance categories to assess the ability of the PACV short scale in identifying, measuring and classifying vaccine hesitant parents.

Methods: As part of a larger study on vaccine attitudes, using the PACV short scale and Gust et al. vaccine acceptance categories, we assessed the correlation between the two measures using Spearman correlation coefficient, and the association between the two measures, using the Cochran-Mantel-Haentszel test of association. We used logistic regression modelling to compare the association between a child's up-to-date immunization status and (a) the PACV short scale and (b) the Gust et al. vaccine acceptance categories.

Results / Findings: The PACV short scale and the Gust et al. vaccine acceptance categories were positively correlated ($r = 0.6$, $df = 198$, $p < 0.05$), and the Cochran-Mantel-Haentszel test of association yielded a statistically significant association ($p < 0.05$). The two scales similarly predicted children's up-to-date immunization status for all recommended childhood vaccines

Conclusion:
The ability of the PACV short scale to identify and classify parental vaccine hesitancy is similar to classification using the Gust et al. vaccine acceptance categories. Additionally, the PACV short scale and the Gust et al. vaccine acceptance categories both measure linear entities. Based on the above similarities, it is recommended that the PACV short scale be used to screen parents at their first pediatric visit to identify and classify these parents according to their level of vaccine hesitancy. The PACV short scale is easier to administer to parents and measures vaccine hesitancy similarly to classifying parents according to the Gust et al. vaccine acceptance categories, which is a more complex process. A clearer understanding of how to classify parental vaccine hesitance can be used to design tailored interventions based on these classifications, to address the specific needs of these vaccine hesitant parents.

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TABLE OF CONTENTS

CHAPTER 1: BACKGROUND AND LITERATURE REVIEW

Vaccine hesitancy is a threat to combating vaccine-preventable diseases in the United States and in the world at large.[1] Reports of outbreaks in the U.S. of vaccine-preventable diseases such as measles and pertussis have demonstrated the impact of parental vaccine hesitancy on vaccine-preventable diseases.[19,21] Vaccine hesitancy, which dates back to as early as the time vaccines were invented, persists despite the overwhelming success of vaccines in reducing morbidity and mortality.[21,22] Although most parents believe that vaccines protect their children from diseases,[5,22] varying levels of vaccine hesitancy remain. Parents' varying levels of resistance range from concerns about the safety and necessity of vaccines, to a lack of trust in vaccine manufacturers and advocates.[5, 11, 12] Vaccine hesitancy should be prioritized if vaccine uptake is to be increased to allow continued control of vaccine-preventable diseases in the U.S.

The World Health Organization (WHO) defines vaccine hesitancy as a "delay in acceptance or refusal of vaccines despite the availability of vaccine services," and refers to the issue as being "complex and context specific, varying across time, place and vaccines."[24] WHO adds that vaccine hesitancy is influenced by factors such as complacency (not perceiving a need for, or not valuing, the vaccine), convenience (lack of access) and confidence (not trusting a vaccine or a provider).[24]

One of the major steps in addressing vaccine hesitancy, and improving and maintaining vaccine confidence, is the ability to identify vaccine hesitant parents, to understand the reasons for their decisions. It is, therefore, important to have a standardized tool (e.g., short questionnaire) for screening, identifying, and understanding parents' attitudes towards immunizations available for use. Such a tool needs to be accessible and easily used by healthcare providers. This type of tool will also assist in addressing the specific vaccine concerns of these

parents, thereby reducing vaccine hesitancy. Currently, there is no widely used, standardized tool for measuring vaccine hesitancy. However, there are ongoing efforts to develop a valid and reliable tool.[19]

Pediatricians and other healthcare providers have played a major role in promoting vaccine uptake in the U.S. in the past, but recently, the trend has changed. Parents who, until now, relied on healthcare providers for decisions about childhood immunizations, now seek to be actively involved in the decision-making process.[21] This change can be attributed to public misconceptions, misinformation, and inaccurate scientific opinions, augmented by the easy access to unreliable information on the Internet.[21] Therefore, ongoing efforts to reduce vaccine hesitancy, which appears to be a threat to efforts to combat vaccine-preventable diseases, also requires a tremendous effort at improving and maintaining public confidence in vaccines.[1]

The Centers for Disease Control and Prevention (CDC) ranked vaccination as one of the top 10 public health achievements of the twentieth century in the United States.[4] High immunization coverage in the U.S. has led to a significant reduction in morbidity, mortality and healthcare costs associated with vaccine-preventable diseases.[4] However, amidst the recorded success in childhood immunization uptake in the U.S., there are concerns about diminishing trust in vaccines in the country. Recent reports [21] have documented that parental concern about vaccine-preventable diseases, which has served as the major motivation for vaccine uptake, is now being challenged by parents' fear of the vaccines themselves. This has led to parents delaying or refusing recommended childhood immunizations.[21] The consequences of this delay or refusal of childhood immunization are not only detrimental to the child's health by increasing the risk of contracting vaccine-preventable diseases, but also increase the risk that vulnerable populations will be infected because they do not have the immunity to protect them from

vaccine-preventable diseases. Vulnerable populations include those who are under-age for immunizations, medically unfit for immunizations, or whose immune-compromised state does not enable them to adequately respond to vaccines.[22]

In their study, Siddiqui et al. demonstrated that concerns about vaccine components, efficacy and side effects, as well as socio-cultural and political factors, have a significant influence on parents' attitude towards immunization.[21] Understanding the factors which influence parent's attitude towards immunization would offer an enhanced way to address their concerns.

Although the CDC reports that routinely recommended childhood immunization uptake generally remains high in the U.S., it has expressed concerns about low levels of coverage of some vaccines in some states and communities, adding that these areas risk experiencing outbreaks of vaccine-preventable diseases. For example, although uptake of measles, mumps, and rubella (MMR), poliovirus, hepatitis B and varicella vaccines was greater than 90% in 2013, and increases were observed for rotavirus and hepatitis A vaccines, the CDC expressed concern that approximately 1% of children received no vaccines at all. This concern can be related to the fact that the un-immunized children pose a potential risk to the vulnerable populations, including those who cannot be vaccinated for medical reasons. For example, in 2014, the U.S. recorded the highest cases of measles since 1994 with around 667 reported cases from 27 states, raising concerns for vulnerable populations and communities with unvaccinated populations.[2]

Salmon et al. also reported in their review [19] that the causes of vaccine hesitancy are complex, influenced by many factors; hence, a multi-team approach is required to address it. This multi-team approach must also include individuals – specifically parents, in the case of childhood immunizations – healthcare providers, as well as policymakers at all levels.[19] Given

that healthcare providers play a major role in communicating with parents, especially in childhood immunization uptake, there is a need to assist them in identifying, understanding, and effectively communicating with vaccine hesitant parents in order to promote childhood immunization uptake.[21]

In addressing this issue, ongoing efforts are being made to develop a standardized tool to assist healthcare providers in identifying, understanding and classifying vaccine hesitant parents. Although no widely used standardized tool for measuring parental vaccine hesitancy exists, the Parental Attitude about Childhood Vaccines (PACV) short scale developed by Opel et al.[15] and the five categories of vaccine acceptance identified by Gust et al.[9] ; hereafter 'Gust et al. vaccine acceptance categories', have been acknowledged in addressing this burden.[13,22] Given that the PACV short scale is still recommended for further validation in heterogeneous populations and other geographical locations,[15,22] a comparative analysis of the PACV short scale and the Gust et al. vaccine acceptance categories will be useful in further validation of the predictive capacity of the PACV short scale tool. This comparison is also expected to assist in designing interventions from the PACV short scale, based on the Gust et al. vaccine acceptance categories, towards addressing vaccine hesitant parents in effort to increase childhood immunization uptake.[9, 15]

Gust et al.[9] conducted a study as part of ongoing efforts to address vaccine hesitancy in parents. Five clusters of parents with similar attitude towards childhood vaccines were identified. This study was based on the concept of audience segmentation, which entails grouping people based on shared characteristics so as to design better interventions in line with their specific needs. The study was based on concerns that parental attitude towards vaccinations was classified as dichotomous – pro-vaccine or anti-vaccine – which translates to being a vaccine

refuser or acceptor. The researchers sought to demonstrate that parental vaccine hesitancy varies by shared characteristics and that it goes beyond the dichotomous classifications. [9]

The study analyzed responses to questions from the ConsumerStyles and HealthStyles surveys.[9] The five groups of parents identified were: Immunization Advocates (those who actively pursue vaccines), Go along to get alongs (those who follow the advice of their doctors and societal expectations), Health Advocates (those who seek out vaccine information), Fencesitters (those who are unsure of their vaccine decision) and Worried (those who are very concerned about vaccine adverse reactions). The group identification was based on responders' beliefs about immunizations and immunization safety, interest and involvement in health issues, the influence of family and friends, and dependence on a doctor's advice, amongst other factors. This categorization is expected to help healthcare providers understand the spectrum of vaccine hesitant parents and assist them in tailoring interventions to address their varying needs. Study result shows that while the category of parents who had the most concern about immunization was the Worried group, categories that were supportive of immunizations also had concerns about immunizations and immunization safety. The findings demonstrate that parents' attitudes and beliefs about immunizations are not dichotomous, but that overlaps in attitudes exist between the two groups.[9]

The five categories of parents' attitudes towards childhood immunization generated from the study are expected to assist healthcare providers in identifying parents' attitudes towards vaccination. However, the researchers recommended that a short screening survey be administered to parents at their first pediatric visit to enable healthcare providers to identify these different categories of parents. This will, in turn, assist them in communicating effectively with parents in order to address their peculiar needs, thereby reducing vaccine hesitancy.[9]

In a continued effort to address vaccine hesitancy, Opel et al. developed and validated the PACV Survey tool for measuring vaccine hesitancy in parents.[15] SAGE working group on vaccine hesitancy regarded Opel et al. as the first researchers to develop a survey tool for measuring parental vaccine hesitancy.[13] The PACV survey tool was developed from reviews of previous studies and surveys related to parental vaccine and health beliefs with additions from focus groups discussions conducted with parents and pediatricians. The items were further reviewed by immunization experts and only the items recommended by the experts were retained before the survey was pretested on a group of parents and subjected to further evaluation. Due to the limitations of the study, especially regarding the generalizability of the study results, it was subjected to further validation in other groups and settings to assess the tool's validity and reliability.[15] Although findings from the validation of the survey tool in other studies were used to further refine the tool, it is still subject to further validation in other settings, given that the tool was developed and validated for high-income settings in the U.S.[13, 16, 22]

The PACV survey, initially refined to15 items under three domains on vaccines – Behavior, Safety and Efficacy and General Attitudes[17] – was later refined to five items (PACV short scale). The PACV survey was particularly refined to make it user-friendly for parents, increase the potential for adoption by healthcare providers in clinical settings, and increase its precision and predictive power. The PACV short scale scores on a summary range of 0-10. Although currently it is only available for use in research settings, the researchers recommended the PACV short scale for adoption in clinical settings as a short survey for screening parents at their first pediatric visit. In addition, the researchers explained that the survey tool is expected to assist healthcare providers in identifying, understanding, and effectively communicating with

vaccine hesitant parents. The five-item PACV survey screening tool continues to be subjected to validation in different geographic populations in the U.S., as well as globally.[10]

Larson et al.[14] conducted a study to compare confidence in vaccines and vaccination programs across some countries (Georgia, India, Nigeria, Pakistan, and the United Kingdom). Findings from this multi-country survey of confidence in vaccines and vaccination programs revealed that vaccine confidence varies within, and between countries.[14] The need for a standardized tool that would permit comparison of vaccine attitudes across countries cannot be overemphasized if global immunization programs must be successful.

More recently, the World Health Organization (WHO) called for the inauguration of a group of experts referred to as the Strategic Advisory Group of Experts (SAGE) working group on vaccine hesitancy.[25] SAGE working group on vaccine hesitancy was tasked with the responsibility of defining the term vaccine hesitancy, outlining the determinants of vaccine hesitancy, and developing tools for measuring and addressing the nature and extent of vaccine hesitancy. The group admitted that a spectrum of vaccine attitudes exists between distinct vaccine acceptance and vaccine refusal, and that those in between occupy a spectrum referred to as “vaccine hesitancy”. Similar to previous studies, the group categorized the three main factors that influence parental vaccine decisions as contextual, individual and group, and vaccine-specific. These contextual factors include socio-cultural, environmental, economic or political factors, to name a few.[25] For example, previous studies have demonstrated that individual factors such as education, race or peer pressure impact individual perceptions of the risk and benefits of vaccines, which may influence vaccine decisions.[7,20] Additionally, vaccine-specific factors such as concerns for safety of vaccines, were also said to influence parental vaccine decisions.[20]

Therefore, the importance of understanding these factors in designing tailored interventions to address parental vaccine hesitancy cannot be overemphasized.

Although the SAGE working group on vaccine hesitancy admitted there is no universal standardized tool to measure vaccine hesitancy in place, they acknowledged the works of Opel et al. in developing and testing the validity and reliability of the PACV survey tool for measuring vaccine hesitancy in parents. The group identified the need for a universally validated tool for identifying vaccine hesitant populations at all levels, and across the globe. This universally validated tool is expected to enable comparison of the state of vaccine hesitancy within and across countries in an effort to assess and monitor vaccine hesitancy globally. The group also emphasized the importance of determining the changes in the prevalence of vaccine hesitancy over time through serial, cross-sectional surveys using standardized questions and methods. To develop a uniform measure for vaccine hesitancy applicable worldwide, the group adapted the PACV survey questions and recommended a series of survey questions to improve the measurement of parental vaccine hesitancy.[25]

It is critical to ensure that the PACV survey screening is validated across different settings and populations. It is also important to subject the PACV survey screening tool to further evaluation to promote its adoption as a standardized screening tool for measuring vaccine hesitancy in clinical settings. Therefore, a comparative analysis of the Parent Attitudes about Childhood Vaccines (PACV) short scale and the Gust et al. vaccine acceptance categories will be an important step in improving the PACV short scale survey tool as part of validating and assessing its reliability. Findings of a correlation between these classification systems could be used to promote adoption of the PACV as a standardized tool for identifying and understanding parental vaccine hesitancy. This will assist healthcare providers in identifying, understanding,

and classifying vaccine hesitant parents according to the varying categories of vaccine hesitancy. Understanding and classifying these vaccine hesitant parents accordingly may also serve as a guide for designing tailored interventions to address their specific needs based on Gust et al. vaccine acceptance categories. These interventions could result in a significant reduction in vaccine hesitancy, increased vaccine confidence, and ultimately the optimization of childhood immunization uptake in the U.S. and the world at large.

CHAPTER II: MANUSCRIPT

1. INTRODUCTION

Vaccine hesitancy is a threat to the use of vaccines in combating vaccine-preventable diseases in the United States and in the world at large.[1]

To address this issue, there is a need to develop a standardized tool to aid in identifying, understanding and classifying parents in relation to vaccine hesitancy. Moreover, this will assist in designing interventions targeted at addressing the varying and unique needs of vaccine hesitant parents. Although there is no widely used standardized tool for measuring parental vaccine hesitancy, the Parental Attitude about Childhood Vaccines (PACV) short scale developed by Opel et al.,[15] and the five categories of vaccine acceptance (Immunization Advocates, Go along to get along, Health Advocates, Fencesitters and Worried; hereafter 'Gust et al. vaccine acceptance categories'), identified by Gust et al.,[9] have been acknowledged as potentially useful tools.[1, 19] However, the PACV short scale requires further validation in heterogeneous populations and other geographical locations. This is due to the limitations of the study, especially regarding the generalizability of study results since the study sample was not representative of the general population.[1, 15, 16] Moreover, it will provide needed context to evaluate how the Gust et al. vaccine acceptance categories, correspond with the PACV short scale.

This study conducted a comparative analysis of the PACV short scale and the Gust et al. vaccine acceptance categories. This offers a means to improve the usefulness of the PACV short scale through validating and assessing its reliability. The improvement of the PACV short scale will assist healthcare providers in identifying, understanding, and classifying vaccine hesitant parents according to the varying categories of vaccine hesitancy. This type of classification of

vaccine hesitant parents, may also serve as a way to design tailored interventions to address their specific needs.

2. DATA AND METHODS

2.1. Study design

Data were a subset of a larger vaccine attitude survey. The survey was self-administered and could be completed in 5 minutes. The survey instrument was administered through a link accessed by recruited Amazon Mechanical Turk (MTurk) workers. Respondents were eligible participants who confirmed their interest in participation, electronically signed informed consent form, and agreed to take the survey on MTurk. A series of short screening questions only allowed participants to continue to the main portion of the survey if they were aged 18 years or older, resided in the United States, and had a child 12 years of age or younger. Respondents were compensated with $1.00 via MTurk. Data collected from the surveys where entered into an Excel document which was imported into SAS 9.4 (Cary, NC, USA) for analysis.

The survey was developed based on the Parent Attitudes about Childhood Vaccines (PACV) survey and the HealthStyles survey. The 5-item PACV short scale and the eight items from the HealthStyles survey used by Gust et al.[9] were the vaccine hesitancy outcomes analyzed in this study. The PACV survey contains questions answered on a 3-point scale (Yes, No and Don't Know), within 3 categories: behavior, safety and efficacy, and general attitudes. The eight items from the HealthStyles survey questions were adopted from the previous analysis conducted by Gust et al. for immunization attitudes and beliefs among parents, using a 5-point scale (Strongly Disagree, Agree, Neutral, Slightly Disagree and Strongly Disagree). The data analyzed by Gust et al. in their study was a subset of the annual HealthStyles survey. The HealthStyles

survey is a nationally representative survey administered in the U.S. each year to solicit information regarding media habits, product use, interests and lifestyle, as well as health orientations and practices.[9] Additional variables used in this study included three socio-demographic variables (gender, age and parent's education), as well as respondent's youngest child's immunization status.

2.2. Study population

Recruitment occurred until a total of 600 respondents with young children aged 0-5 years and 600 respondents with pre-adolescent children aged 6-12 years completed the study. This resulted in a total of 1,200 respondents

2.3. Statistical analyses

Survey data were analyzed using SAS 9.4 (32) (English) software (The SAS Institute, Cary NC). The PACV short scale questions are each scored on a 0-2 scale, with a summary score ranging between 0 and 10.[19] PACV summary scores were categorized into three ordinal categories (PACV levels) of low (score 0-4), medium (score 5-6), and high (score 7-10) parental vaccine hesitancy.

The five categories of vaccine acceptance identified in the data (5 Gust Categories) were based on Gust et al. vaccine acceptance categories.[9] The 5 Gust Categories were analyzed as ordinal categories from the lowest to the highest in the order of: Immunization Advocates (those who actively pursue vaccines), Go along to get along (those who follow the advice of their doctors and societal expectations), Health Advocates (those who seek out vaccine information), Fencesitter (those who are unsure of their vaccine decision) and Worried (those who are very concerned about vaccine adverse reactions).[9]

Socio-demographic variables were dichotomized for the ease of meaningful interpretation. For age, categories were 18-39 years and 40 years and older. For parental education, categories were less than a college graduate and college graduate or higher. Childhood immunization status was based on whether the youngest child's immunization status was up to date, per parental self-report. Children were considered not up-to-date if the child received most, some or none of the recommended childhood vaccines, as opposed to receiving all vaccines on schedule.

Descriptive statistics (frequencies and proportions) were computed for all variables. PACV and Gust category status was visualized using a 100% stacked bar chart.

We evaluated the correlation between PACV level and the 5 Gust Categories using the Spearman's correlation coefficient. A Cochran-Mantel-Haentszel test of association was conducted to assess the association between the two ordinal, categorical outcome variables.

Associations between the two ordinal, categorical outcome variables and socio-demographic factors were assessed using chi square test of association. This was conducted to determine any significant relationship between PACV level and the 5 Gust Categories, and the socio-demographic factors; age, gender and education status.

Using two separate logistic regression models, we assessed the association between vaccine hesitancy measures (PACV level and 5 Gust categories) as predictors and the youngest child's immunization status as the outcome. The three socio-demographic variables were included in the models as covariates based on reported associations in previous literatures.[7, 8,16,18] The significance threshold was set at 0.05 ($p<0.05$).

2.4. Ethics & financial disclosures

The survey received IRB approval from the Institutional Review Board of Emory University in the United States.

3. RESULTS

Responses from 1,200 respondents were analyzed. . About two-thirds of the respondents were female (n=783, 65.7%). Missing values excluded 8 respondents in the response to gender resulting in a total, n=1,192 for the variable gender. Most of the respondents were of the 18-39 years of age category (n=885, 73.8%). Approximately 60% of the respondents were college graduates or higher (n=723, 60.3%). Based on PACV summary scores, the majority of the respondents had a low level of parental vaccine hesitancy (n=862, 71.8%), with approximately equal split of the remaining parents with medium level of parental vaccine hesitancy (n=156, 13%) and high parental vaccine hesitancy (n = 182, 15.2%). (Table 1).

The distributions of the respondents by the 5 Gust Categories were as follows; Immunization Advocates (n=496, 41.3%), Go along to get along (n = 441, 36.8%), Health Advocates (n=47, 3.9%), Fencesitters (n=86, 7.2%), and Worried (n=130, 10.9%). The majority of the respondents had their youngest child immunized up to date for all recommended childhood vaccines (n=1009, 84.1%). The frequency distributions of the variables by the total number of survey respondents are presented in Table 1.

The distributions of the PACV levels across the 5 Gust categories are shown in Figure 1. Parental vaccine hesitancy increased across the 5 Gust Categories, from the Immunization Advocates category up-to-the Worried category, where respondents in the Immunization

Advocates category had the lowest level of parental vaccine hesitancy, and those in the Worried category had the highest level of parental vaccine hesitancy.

There was a strong correlation between PACV level and the five categories of vaccine acceptance (Spearman's correlation coefficient, r_s = 0.60, df = 198, p <0.05). The Cochran-Mantel-Haentszel test of association conducted between PACV level and the 5 Gust Categories yielded a significant relationship (CMH = 549.61, df = 1, p <0.05). Only education had a significant association with PACV level (Spearman, χ^2 (N= 1,200) = 8.47, df = 2, p < 0.05). Interestingly, all three sociodemographic categories were significantly associated with the 5 Gust Categories (all χ^2 p <0.05).

In comparison to respondents with high parental vaccine hesitancy, respondents with low parental vaccine hesitancy had about 94% lower odds of not being up-to-date for all recommended childhood vaccines (OR = 0.06, CI = 0.04 – 0.09). Respondents with medium parental vaccine hesitancy had approximately 82% lower odds of not being up-to-date for all recommended childhood vaccines compared to respondents with high parental vaccine hesitancy (OR = 0.18, CI = 0.11 – 0.30). Respondents with college graduate or higher education level had approximately 59% higher odds of not being up-to-date for all recommended childhood vaccines compared to respondents with less than college graduate (OR = 1.59, CI = 1.09 – 2.31). The odds of not being up-to-date for all recommended childhood vaccines in respondents aged 40 years and above, was approximately 44% lower, compared to respondents in the aged 39 years and below (OR = 0.56, CI = 0.37 – 0.86). (Table 2).

The odds of not being up-to-date for all recommended childhood vaccines for respondents in the Immunization Advocates category was approximately 96% lower, compared

to respondents in the Worried category (OR = 0.04, CI = 0.03 – 0.07). For respondents in the Go along to get along category, the odds of not being up-to-date for all recommended childhood vaccines was approximately 89% lower, compared to the respondents in the Worried category (OR = 0.11, CI = 0.07 – 0.18). Respondents in the Health Advocates and the Fencesitters categories were more likely to be up-to-date for all recommended childhood immunizations compared to respondents in the Worried category (OR = 0.35, CI = 0.17 – 0.74), and (OR = 0.36, CI = 0.20 – 0.65), respectively. Respondents with college graduate or higher education level had approximately 58% higher odds of not being up-to-date for all recommended childhood vaccines compared to respondents with less than college graduate (OR = 1.58, CI = 1.20 – 2.28). The odds of not being up-to-date for all recommended childhood vaccines in respondents aged 40 years and above was approximately 36% lower compared to respondents aged 39 years and below (OR = 0.64, CI = 0.42 – 0.97). (Table 3).

4. DISCUSSION AND CONCLUSION

There was a positive strong correlation between PACV level and the 5 Gust Categories, indicating that there is a positive strong linear relationship between PACV level and the 5 Gust Categories. Although PACV level had three ordinal categories as against the five ordinal categories of the 5 Gust Categories, the correlation test result showed that each step higher in the PACV levels is associated with an increase in parental vaccine hesitancy, as was also observed with increasing moves up through the 5 Gust Categories. This indicates that the PACV short scale and the Gust et al. vaccine acceptance categories, both measure linear entities, and are similar in their abilities to identify, measure and classify parental vaccine hesitancy. These findings were similar across multiple different tests of association, indicating that the ability of

the PACV short scale tool to identify and classify parental vaccine hesitancy is comparable with the classification done based on Gust et al. vaccine acceptance categories.

In predicting child's immunization status of not being up-to-date for all recommended childhood vaccines, the PACV short scale predicated a similar pattern to that predicted by the 5 Gust Categories. This indicates that the ability of the PACV short scale in identifying and classifying parental vaccine hesitancy is similar to that done through the classification of parents according to Gust et al. vaccine acceptance categories.

In conclusion, the study results demonstrated that the ability of the PACV short scale to identify, measure and classify parental vaccine hesitancy similar to classification done based on the Gust et al. vaccine acceptance categories. This is supported with the overlap shown in Figure 1. Results presented also showed that the PACV short scale and Gust et al. vaccine acceptance categories, both measure linear entities in identifying and classifying vaccine hesitant parents. Based on the above similarities, it is recommended that the PACV short scale be used to screen parents at their first pediatric visit to identify, measure and classify these parents according to their varying categories of vaccine hesitancy. It is easier to administer the PACV short scale to parents and it measures vaccine hesitancy equally as well as the more complex process of identifying the five categories of vaccine acceptance. Conclusions from the identification and classification of parental vaccine hesitancy can be used to design tailored interventions based on Gust et al. vaccine acceptance categories, to address the specific needs of vaccine hesitant parents.

CHAPTER III: PUBLIC HEALTH IMPLICATIONS

Vaccine hesitancy is a threat to combatting vaccine-preventable diseases in the U.S., and the world at large. There is a need to develop a standardized tool to aid in identifying, understanding and classifying parents in relation to vaccine hesitancy. Moreover, this will assist in designing interventions targeted at addressing the varying and unique needs of vaccine hesitant parents. The PACV short scale and the Gust et al. vaccine acceptance categories have been acknowledged as potentially useful tools. Findings from this study may promote the adoption of the PACV short scale for use in clinical settings in the U.S. This will assist healthcare providers in identifying, understanding, and classifying vaccine hesitant parents according to the varying categories of vaccine hesitancy. The findings from this study may also serve as a guide for designing tailored interventions to address specific needs of vaccine hesitant parents based on the Gust et al. vaccine acceptance categories. This could result in a significant reduction in vaccine hesitancy, and an increase in vaccine confidence and the optimization of childhood immunization uptake in the U.S. and the world at large.

Future recommendations for research will be to further validate the PACV short scale in other geographical settings and populations across the world. This may validate its adoption as a standardized tool for identifying, measuring, and classifying vaccine hesitant parents.

LIST OF TABLES

i. Table 1

Frequency distributions of survey respondents by gender, age, education, PACV level and 5 Gust Categories (Total sample size, N = 1200).

Variables	n (%)
Gender	
Male	409 (34.31)
Female	783 (65.69)
Age	
18-39years	885 (73.75)
≥40years	315 (26.25)
Education	
Less than college graduate	477 (39.75)
College graduate and higher	723 (60.25)
PACV level	
Low parental vaccine hesitancy	862 (71.83)
Medium parental vaccine hesitancy	156 (13.00)
High parental vaccine hesitancy	182 (15.17)
5 Gust Categories	
Immunization Advocates	496 (41.33)
Go along to get along	441 (36.75)
Health Advocates	47 (3.92)
Fencesitters	86 (7.17)
Worried	130 (10.83)
Youngest child's immunization status	
Up-to-date on all recommended childhood vaccines	1009 (84.08)
Not up-to-date on all recommended childhood vaccines	191 (15.92)

n = number of observations.

ii. Table 2

Associations between the respondent's youngest child's immunization status of not being up-to-date for all recommended childhood vaccine and, the respondent's PACV levels, age, gender and education.

Effect	Odds ratio	95% Confidence Interval
PACV level		
High parental vaccine hesitancy	1.00	(Reference)
Medium parental vaccine hesitancy	0.18*	0.11 – 0.30
Low parental vaccine hesitancy	0.06*	0.04 – 0.09
Gender		
Male	1.00	(Reference)
Female	1.12	0.77 – 1.63
Education		
Less than college graduate	1.00	(Reference)
College graduate and higher	1.59*	1.09 – 2.31
Age		
18-39 years	1.00	(Reference)
≥40 years	0.56*	0.37 – 0.86

*P-values < 0.05.

iii. Table 3

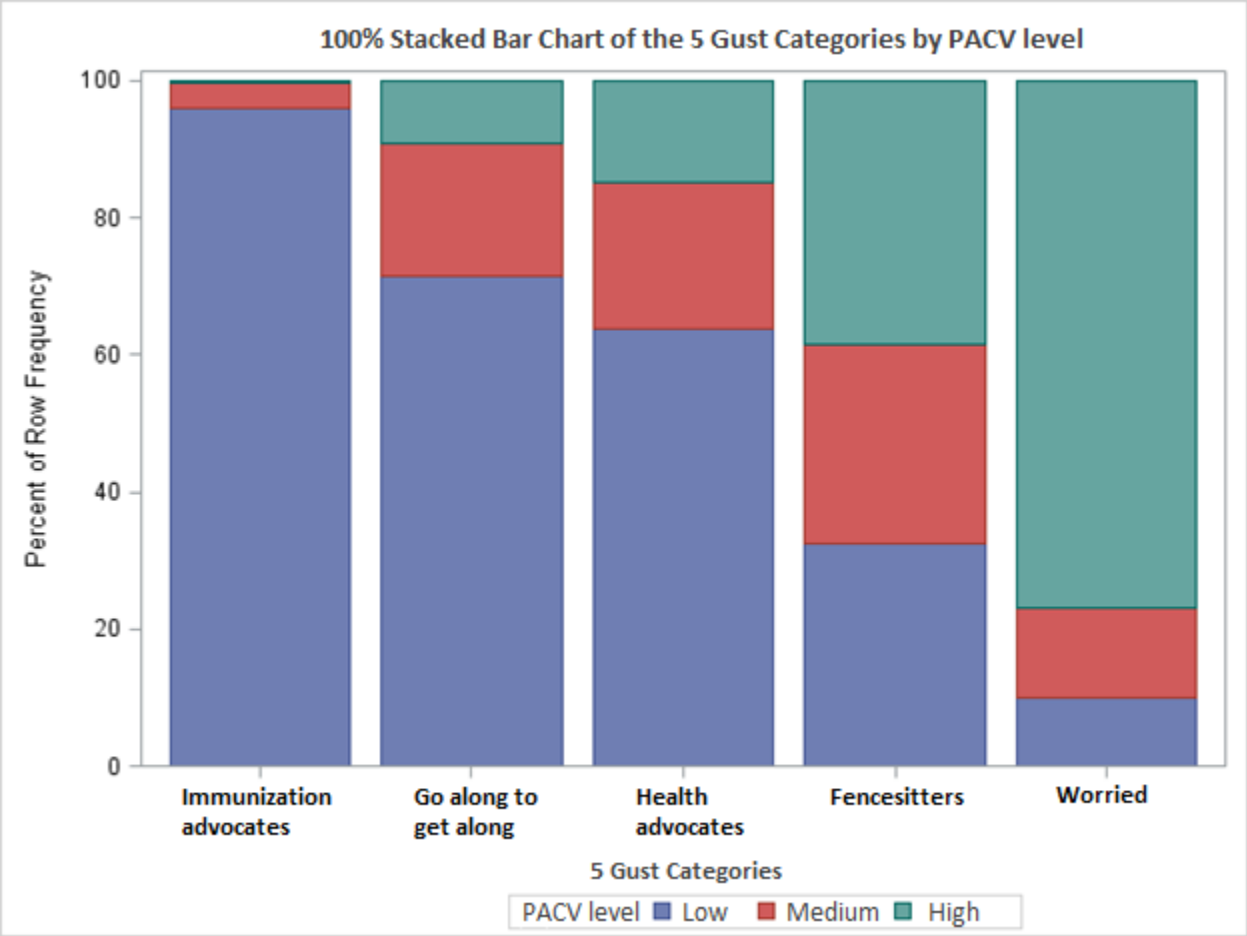
Associations between the respondent's youngest child's immunization status of not being up-to-date for all recommended childhood vaccine and, the respondent's 5 Gust Categories, age, gender and education.

Effect	Odds ratio	95% Confidence Interval
5 Gust Categories		
Worried	1.00	(Reference)
Fencesitters	0.36*	0.20 – 0.65
Health Advocates	0.35*	0.17 – 0.74
Go along to get along	0.11*	0.07 – 0.18
Immunization Advocates	0.04*	0.03 – 0.07
Gender		
Male	1.00	(Reference)
Female	1.08	0.74 – 1.57
Education		
Less than college graduate	1.00	(Reference)
College graduate and higher	1.58*	1.20 – 2.28
Age		
≥40 years	1.00	(Reference)
18-39 years	0.64*	0.42 – 0.97

*P-values < 0.05.

FIGURE

Figure 1
Comparison of distributions of PACV and 5 Gust Categories for 1,200 individuals surveyed on vaccine attitudes, 2015.



References

1. Assessing the State of Vaccine Confidence in the United States: Recommendations from the National Vaccine Advisory Committee: Approved by the National Vaccine Advisory Committee on June 10, 2015. (2015). *Public Health Rep, 130*(6), 573-595.
2. CDC. (2015). Measles (Rubeola). Measles Cases and Outbreaks: Measles Cases. Retrieved from http://www.cdc.gov/measles/cases-outbreaks.html on January, 6, 2016.
3. CDC. (2015). Morbidity and Mortality Weekly Review (MMWR). National, State, and Selected Local Area Vaccination Coverage Among Children Aged 19-35 Months – United States, 2014. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6433a1.htm on January, 6, 2016.
4. CDC. (2011). Morbidity and Mortality Weekly Review (MMWR). Ten Great Public Health Achievements – United States, 2001-2010. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6019a5.htm on February, 6, 2016.
5. Freed, G. L., Clark, S. J., Butchart, A. T., Singer, D. C., & Davis, M. M. (2010). Parental vaccine safety concerns in 2009. *Pediatrics, 125*(4), 654-659. doi: 10.1542/peds.2009-1962
6. Gilkey, M. B., Magnus, B. E., Reiter, P. L., McRee, A. L., Dempsey, A. F., & Brewer, N. T. (2014). The Vaccination Confidence Scale: a brief measure of parents' vaccination beliefs. *Vaccine, 32*(47), 6259-6265. doi:10.1016/j.vaccine.2014.09.007
7. Gowda, C., & Dempsey, A. F. (2013). The rise (and fall?) of parental vaccine hesitancy. *Hum Vaccin Immunother, 9*(8), 1755-1762. doi:10.4161/hv.25085
8. Gust, D. A., Woodruff, R., Kennedy, A., Brown, C., Sheedy, K., & Hibbs, B. (2003). Parental perceptions surrounding risks and benefits of immunization. *Seminars in Pediatric Infectious Diseases, 14*(3), 207-212.
9. Gust, D., Brown, C., Sheedy, K., Hibbs, B., Weaver, D., & Nowak, G. (2005). Immunization attitudes and beliefs among parents: beyond a dichotomous perspective. *Am J Health Behav, 29*(1), 81-92.
10. Identifying, Understanding and Talking with Vaccine-Hesitant Parents. (2014). Retrieved from http://www.globe-network.org/sites/default/files/en/network/resource/4.opel-douglas-identifying-understanding-and-talking-to-vaccine-hesitant-parents.pdf on January, 6, 2016.
11. Kennedy, A., Basket, M., & Sheedy, K. (2011). Vaccine attitudes, concerns, and information sources reported by parents of young children: results from the 2009 HealthStyles survey. *Pediatrics, 127 Suppl 1*, S92-99. doi: 10.1542/peds.2010-1722N
12. Kennedy, A., Lavail, K., Nowak, G., Basket, M., & Landry, S. (2011). Confidence about vaccines in the United States: understanding parents' perceptions. *Health Affairs, 30*(6), 1151-1159. doi: 10.1377/hlthaff.2011.0396
13. Larson, H. J., Jarrett, C., Schulz, W. S., Chaudhuri, M., Zhou, Y., Dube, E., Wilson, R. (2015). Measuring vaccine hesitancy: The development of a survey tool. *Vaccine, 33*(34), 4165-4175. doi: 10.1016/j.vaccine.2015.04.037

14. Larson, H. J., Schulz, W. S., Tucker, J. D., & Smith, D. M. (2015). Measuring vaccine confidence: introducing a global vaccine confidence index. *PLoS Curr, 7*. doi:10.1371/currents.outbreaks.ce0f6177bc97332602a8e3fe7d7f7cc4
15. Opel, D. J., Mangione-Smith, R., Taylor, J. A., Korfiatis, C., Wiese, C., Catz, S., & Martin, D. P. (2011). Development of a survey to identify vaccine-hesitant parents: the parent attitudes about childhood vaccines survey. *Hum Vaccin, 7*(4), 419-425.
16. Opel, D. J., Taylor, J. A., Mangione-Smith, R., Solomon, C., Zhao, C., Catz, S., & Martin, D. (2011). Validity and reliability of a survey to identify vaccine-hesitant parents. *Vaccine, 29*(38), 6598-6605. doi:10.1016/j.vaccine.2011.06.115
17. Opel, D. J., Taylor, J. A., Zhou, C., Catz, S., Myaing, M., &Mangione-Smith, R. (2013). The relationship between parent attitudes about childhood vaccines survey scores and future child immunization status: a validation study. *JAMA Pediatr, 167*(11), 1065-1071. doi: 10.1001/jamapediatrics.2013.2483
18. Prislin, R., Dyer, J. A., Blakely, C. H., & Johnson, C. D. (1998). Immunization status and sociodemographic characteristics: the mediating role of beliefs, attitudes, and perceived control. *American Journal of Public Health, 88*(12), 1821-1826.
19. Salmon, D. A., Dudley, M. Z., Glanz, J. M., & Omer, S. B. (2015). Vaccine Hesitancy: Causes, Consequences, and a Call to Action. *Am J Prev Med, 49*(6 Suppl 4), S391-398. doi:10.1016/j.amepre.2015.06.009
20. Shui, I. M., Weintraub, E. S., & Gust, D. A. (2006). Parents concerned about vaccine safety: Differences in race/ethnicity and attitudes. *American Journal of Preventive Medicine, 31*(3), 244-251. doi: 10.1016/j.amepre.2006.04.006
21. Siddiqui, M., Salmon, D. A., & Omer, S. B. (2013). Epidemiology of vaccine hesitancy in the United States. *Hum Vaccin Immunother, 9*(12), 2643-2648. doi:10.4161/hv.27243
22. Vaccine hesitancy and strategies to address it. (2015). Retrieved from https://www.nebmed.org/uploadedFiles/Nebmed/News/Pdfs/Immunizations%20FINAL.pdf on March, 6, 2016.
23. Whitney, C. G., Zhou, F., Singleton, J., & Schuchat, A. (2014). Benefits from immunization during the vaccines for children program era - United States, 1994-2013. *MMWR: Morbidity and Mortality Weekly Report, 63*(16), 352-355.
24. WHO. (2015). Immunization, Vaccines and Biologicals. Addressing Vaccine hesitancy. Retrieved from http://www.who.int/immunization/programmes_systems/vaccine_hesitancy/en/ on January, 6, 2016.
25. WHO. (2014). Report of the SAGE Working Group on Vaccine Hesitancy. 1st October, 2014. Retrieved from http://www.who.int/immunization/sage/meetings/2014/october/1_Report_WORKING_GROUP_vaccine_hesitancy_final.pdf on March, 9, 2016.