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Measuring vaccine hesitancy: Field testing the WHO SAGE Working Group on Vaccine Hesitancy survey tool in Guatemala

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Abstract

Background: Despite safe and effective childhood immunizations, decreased acceptance of vaccines has become an emerging global problem. The WHO SAGE Working Group on Vaccine Hesitancy developed a common diagnostic tool, the Vaccine Hesitancy Scale (VHS), to identify and compare hesitancy in different global settings. We field tested the VHS in rural and urban Guatemala.

Methods: We analyzed data from the enrollment visit of a study conducted at four public health clinics in Guatemala. Infants ages 6 weeks-6 months presenting for their first wellness visit were

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enrolled March-November 2016. Parents completed a demographic survey that included the 10 dichotomous and 10 Likert scale VHS questions. Chi-square or Fisher's exact for categorical and ANOVA test for continuous variables were used to assess significance levels in survey differences. We conducted a factor analysis to assess the Likert scale questions.

Results: Of 1088 families screened, 871 were eligible and 720 (82.7%) participated. No parent had ever refused a vaccination, and only eight parents (1.1%) had been reluctant or hesitated to get a vaccination for their children. However, only 40.8% (n=294) of parents said that they think most parents like them have their children vaccinated with all the recommended vaccines. Factor analysis identified two underlying constructs that had eigenvalues of 1.0 or greater and a substantive lack of variability in response across the Likert scale. There were consistent differences between how study clinics responded to the ordinal scaling.

Conclusion: Our results suggest problems with interpretation of the VHS, especially in the presence of vaccine shortages and using a Likert scale that does not resonate across diverse cultural settings. Our factor analysis suggests that the Likert scale items are more one-dimensional and do not represent the multiple constructs of vaccine hesitancy. We suggest more work is needed to refine this survey for improved reliability and validity.

Keywords

childhood immunization; vaccine hesitancy; survey; SAGE; WHO; Guatemala

1. Introduction

Immunization is one of the greatest public health achievements, protecting children from serious illness and saving millions of lives every year. Despite a growing number of safe and effective childhood vaccines, decreased acceptance of specific vaccines or vaccination programs by both individuals and communities has become an emerging problem in high-income [1–3] as well as low-and middle-income (LMIC) countries [4]. The reasons for this are multifaceted, culture-specific, and often not completely understood. In 2012, the World Health Organization (WHO) Strategic Advisory Group of Experts (SAGE) on Immunization recognized this global challenge and established the Working Group (WG) on Vaccine Hesitancy [5]. The WG contributed to several important areas of this relatively new field of research [6–12] and created the following definition: "*Vaccine hesitancy refers to delay in acceptance or refusal of vaccination despite availability of vaccination services. Vaccine hesitancy is complex and context specific, varying across time, place and vaccines. It is influenced by factors such as complacency, convenience and confidence"* [7]. Vaccine hesitancy, therefore, occurs on a continuum between those who undoubtedly accept all vaccines to those who undoubtedly refuse all vaccines. The vaccine hesitant individual remains somewhere between these two extremes, including those who refuse certain vaccines while accepting others, delay vaccinations, or accept vaccinations but have concerns.

In order to inform interventions that improve vaccine coverage, it is important to understand the complex and interplaying factors that influence vaccination decisions and the determinants of vaccine hesitancy in a specific population. No uniform, global metric for

quantifying vaccine hesitancy currently exists. While several cross-sectional surveys have been used to measure parental attitudes, beliefs, and behaviors surrounding vaccination [13–20], most of these surveys have only focused on a limited number of factors influencing vaccine hesitancy, have not had formal testing of validity and reliability, and have been conducted in high-income settings. One of the major tasks of the WG was to develop a common diagnostic tool, the Vaccine Hesitancy Scale (VHS), to identify and compare hesitancy in different global settings [12]. VHS questions are either closed-ended, Likert scale, or open-ended in nature. These questions were developed in conjunction with a global pilot test of indicators for vaccine hesitancy and a literature review for similar survey tools. Questions were further adapted from the Parent Attitudes About Childhood Vaccines (PACV) survey previously developed by Opel et al. [21] and found to be valid and reliable in a high-income population [22,23]. The PACV survey has also been adapted for use with adolescent vaccines [24], influenza vaccination [25], and a multi-ethnic Malaysian population [26]. In their work to develop a common survey tool that could be used globally to identify and compare vaccine hesitancy, the WG further adapted the PACV survey to have more global relevance, especially for LMICs.

While this effort has generated a useful initial tool to assess vaccine hesitancy and its relevance in delayed or incomplete vaccination, the WG encouraged further evaluation of the VHS to determine whether it offers both a valid and reliable estimate of vaccine hesitancy across diverse cultural settings. In the context of a larger randomized intervention study exploring the impact of a Short Message Service (SMS) technology to provide families with text message reminders for childhood immunizations, we conducted baseline assessments that incorporated both the closed-ended and Likert scale VHS questions. Our study team has worked in collaboration with the Ministry of Health of Guatemala [27]. The current study analyzes the reliability and validity of the VHS measure applied in urban and rural Guatemala using a factor analysis as described in more detail below. Our objective is to provide insight into the shared understanding of the VHS construct using the tool in diverse global settings.

2. Materials and Methods

2.1 Study Design

We analyzed cross-sectional data collected at the enrollment visit from a study conducted at four public health clinics of the Ministry of Public Health and Social Assistance in Guatemala. The government clinics serve a low-income population with two of the clinics located in an urban setting surrounding Guatemala City (Zona 11 and Villa Nueva) and two in the rural southwest region of the country (Colomba and Coatepeque, Quetzaltenango). Participation was voluntary and patients were not given any incentives. Of note, Guatemala experienced significant political instability during our study period, which led to considerable vaccine shortages experienced by all of our clinics. The Colorado Multiple Institutional Review Board, Universidad del Valle Ethics Committee, and Guatemala National Ethics Committee of the Ministry of Public Health and Social Assistance approved the research. Written informed consent was obtained from all parents or guardians (henceforth referred to as parent).

2.2 Participants

Eligible participants included parents of infants between the ages of 6 weeks to 6 months presenting for their first wellness visit. At least one parent needed to own an active mobile phone capable of receiving SMS, be able to use SMS, and be literate and able to decipher the messages for themselves or by a surrogate in the household. Children were excluded if they were not medically cleared to receive vaccines, the study clinic was not the patient's primary clinic, the consenting parent was under 18 years of age, or the parent did not speak Spanish. Equal numbers of rural and urban participants were enrolled.

2.3 Data collection

Data collection occurred between March to November 2016. Parents completed a demographic survey that included the 10 dichotomous (yes/no) and 10 Likert scale (strongly agree, agree, neither agree nor disagree, disagree, or strongly disagree) VHS questions. In order to maintain the original instrument, no modifications were made and no items were added. The English language survey was translated into Spanish by a native Guatemalan. A study nurse assigned to each clinic verbally administered the surveys to participants in a quiet and confidential location. Study data were collected and managed using REDCap (Research Electronic Data Capture), a secure and web-based electronic data capture tool hosted at the University of Colorado Denver [28].

2.4. Statistical analysis

We analyzed parent demographics and survey responses using descriptive statistics. Chi-square or Fisher's exact for categorical and ANOVA test for continuous variables were used to assess significance levels in demographic and survey differences. All statistical tests were considered to be significant at a two-tailed p value less than 0.05. To analyze reliability and validity of the Likert scale questions, we conducted an exploratory factor analysis (EFA). We first examined correlations between all survey items. We then completed a factor extraction. This is an important step to explore statistically possible linear combinations of variables and whether they represent the domains of complacency, convenience, and confidence as specified in the WG vaccine hesitancy definition [7]. We then conducted a principle component analysis, a process that helps to group those items together into factors that will maximize the variance in the data using a measure known as an eigenvalue. We retained only the factors that have eigenvalues of at least 1.0 [29]. We then explored the strength of the correlation of items within each factor and considered if any of the items within a factor might be redundant using a varimax rotation. This is a process that allows researchers to simplify factor analysis results by identifying those items that are most correlated with a factor, allowing for parsimony in the final solution. This approach also allows for the factors selected to account for a large percentage of the total variation of the measured survey questions, ideally 50% or more [30]. All analyses were conducted using SAS (SAS 9.4, SAS Institute, Cary, NC).

3. Results

Of 1088 families screened, 871 were eligible and 720 (82.7%) participated. Table 1 summarizes the demographic characteristics of the study participants, showing high literacy overall and high engagement from fathers who were also largely employed.

Table 2 provides parental responses to the closed-ended (Q1-Q10) and Likert scale (L1-L10) VHS questions. No parent in our study reported ever refusing a vaccination, and only eight parents (1.1%) said that they had been reluctant or hesitated to get a vaccination for their children. No parent could think of a reason why children should not be vaccinated, and only three parents (0.4%) did not believe that vaccines could protect children from serious diseases. However, a majority of those interviewed (n=426, 59.2%) thought that parents like them do not have their children vaccinated with all the recommended vaccines, with more urban versus rural parents expressing this view (69.7% vs. 48.6%; $p<0.0001$). Time, distance and cost to get to the clinic and/or timing of the clinic and wait at the clinic were significant factors thought to prevent immunization more in the urban compared to rural population (12.5% vs. 6.1%; $p=0.0032$). While 205 (56.9%) parents in the urban clinics compared to 4 (1.1%) parents in the rural clinics believed that it was more difficult for children from some ethnic or religious groups in their community to get vaccinated ($p<0.0001$), more rural than urban parents thought that their local leaders (religious or political, teachers, health care workers) did not support childhood vaccinations (45.6% vs. 18.6%; $p<0.0001$). While the overall study population had very favorable attitudes towards vaccination, there were notable differences in the Likert scale level of agreement between clinics.

Evaluation of the scree plot of eigenvalues for the Likert scale questions only identified two underlying constructs that had eigenvalues of 1.0 or greater. The first eigenvalue represented 59.6% of the variation in the factor with the second only adding 16.1% more to the explanation of variation with a total of 76.3%. After the initial rotation, we observed that while there were clear factor loadings on two factors, several of the items had factor loadings of <0.70, suggesting that an optimum factor structure may exist when limiting the items to only those with loadings of 0.70 or greater on one of the two factors. When we optimized the rotation in this manner, we obtained a more parsimonious factor structure (Table 3). There are still two factors, but only seven items. Model fit of the two-factor solution was better than the one-factor solution, and the 7-item scale was a better fit than the 10-item scale (Table 4). There are five items loading on Factor 1, and they are primarily related to vaccine confidence and positive attitudes towards vaccines. There are two items loading on Factor 2, related to vaccine risk and complacency as well as perceptions that vaccines are not beneficial. We explored whether there were any demographic differences in factor solutions. Unemployed mothers answered slightly higher for Factor 1 questions, but no other differences were found (Table 5). While we observed differences in survey responses by clinic, these did not affect the interpretation of results.

4. Discussion

This exploratory factor analysis provides insight from an LMIC into the overall design and applicability of the VHS [12]. Our work uncovered important findings beyond an

exploratory factor analysis suggesting that the closed-ended and Likert scale questions of the survey appear to have limitations in their approach to assessing vaccine hesitancy. We are one of the first studies to field test questions from this survey. While one recent study by Shapiro et al. (2018) assessed the psychometric properties and validation of the VHS in Canada [31], to our knowledge, the measure has not yet been psychometrically evaluated in an LMIC. Furthermore, while one study in Guatemala used a cross-sectional survey to explore parental attitudes and preferences specifically for pertussis and poliomyelitis vaccines in urban versus rural populations [32], there is a need for a broader, validated, and reliable tool to measure the changing prevalence of vaccine hesitancy in LMICs that explores the complex factors affecting hesitancy. Field testing the VHS is an important step in modifying and implementing such a tool.

According to our study results, the VHS applied in both rural and urban settings of Guatemala reported no prior vaccine refusal and almost no hesitancy. Interestingly, however, only 40.8% (n=294) of parents said that they think most parents like them have their children vaccinated with all the recommended vaccines. We know that in Guatemala there are important structural issues to consider that may contribute more to limited vaccine compliance than hesitancy. For example, the political instability that occurred during our study led to considerable country-wide vaccine shortages and likely played a role in vaccine timeliness and compliance, which may have impacted parental attitudes and perceptions around immunization. We believe it is critical to consider how shortages, a reality experienced by many LMICs, affect vaccine timing and completion and, subsequently, may impact parents' vaccine hesitancy survey responses. We further posit that a failure to do so risks conflating attitudes towards vaccines with compliance, instead of making attitudes distinct from access issues as intended in the WG vaccine hesitancy definition. Additionally, we found that factors such as difficulty accessing services (such as time, distance, and cost), religious and ethnic backgrounds, and the support of local leaders had varying influences on rural verus urban VHS responses, highlighting these important socio-cultural influences on vaccine attitudes [33–37].

Our results suggest difficulty understanding and using the Likert scale format. We had very few neutral responses of "neither agree nor disagree". We also had a consistent difference between how study clinics responded to the ordinal scaling, with one clinic almost always responding "agree" while the other three clinics almost always responded "strongly agree". This lack of spread and stark difference between clinics seems to imply a user-bias in how the study nurses may have asked the questions and interpreted and recorded the participant's answers. Research has previously suggested that Likert-type scale formats may be culturally biased because some populations have difficulty understanding the ordered continuum of responses [38]. Additionally, results from Likert scales may be partially dependent on the range of possible responses [39]. Different cultures may not understand these gradations of agreement and disagreement. For some populations, a graded response format measuring multiple degrees of variation may be too abstract and, in fact, meaningless. It has been suggested that a Likert-type scale format may be better understood and utilized amongst populations with a higher level of underlying education [40]. For more diverse populations with cultural differences and varying degrees of education, such as those using the survey

tool, dichotomous response categories (e.g. yes/no, agree/disagree, or true/false), vignettes, or a pictorial representation of answers may be preferred and easier to interpret [40,41].

Another important finding in our study is the revelation of a two-factor structure within the VHS Likert scale items, similar to the findings from the recent study in Canada [31]. It is interesting to note how closely aligned the results are from these two studies conducted in both a high income country and an LMIC as well as with parents of both young and older children. The first component (consisting of five items) in our study represented "confidence" in vaccination, and the second component (consisting of two items) represented vaccine "risk" and "complacency". The WG's vaccine hesitancy definition incorporates concepts from the "3 Cs" model of vaccine hesitancy and its determinants [7]. This model highlights three categories as drivers of vaccine hesitancy: complacency (e.g. not valuing or perceiving a need for vaccination), convenience (e.g. accessibility and availability of immunization services), and confidence (e.g. trust in vaccines, vaccine delivery systems, and vaccine policies). While the WG's vaccine hesitancy definition encompasses all three of these concepts, both our study and the Shapiro et al. study [31] found that the Likert scale questions of the VHS primarily address the issue of vaccine confidence. Additionally, both studies found that these "confidence" questions are worded positively while the questions focused on "risk" and "complacency" are worded negatively, conflating the content and direction of the items. Our factor analysis findings, therefore, suggest that the Likert scale items collectively are more one-dimensional primarily measuring the concept of confidence and do not correlate well with the other constructs of complacency and convenience included in the definition of vaccine hesitancy. Future modification of the VHS would benefit from including multiple dimensions of vaccine hesitancy, especially related to the concept of convenience, with both positively and negatively worded items.

This study has several limitations. While we field tested both the closed-ended and Likert scale questions of the survey tool, we did not use the proposed open-ended series of questions due to participant time constraints and this being a secondary objective of our larger study. These open-ended questions will likely be important to understanding the other survey responses, especially in regards to access issues, and should be assessed in future studies. Furthermore, an in-depth qualitative exploration will be needed to understand the various contextual and socio-cultural influences on vaccine hesitancy that could assist in modifying the survey tool [42,43]. We conducted only an exploratory factor analysis and not a confirmatory factor analysis. The confirmatory analysis is more common where there are two distinct samples, which would allow the exploratory analysis with one sample and confirmatory analysis with a second sample. Given that we had only one sample, we were limited to the exploratory analysis. It will be important to consider future opportunities to conduct a confirmatory analysis with another similar sample in Guatemala. Additionally, the decision to use a 0.70 limit for factor loadings to inform the final item selection for each factor could be considered overly conservative, particularly where there are items near this threshold that are clearly similar and could have been included. We erred on the more conservative side given the well accepted standards for factor analysis and to also consider minimizing respondent burden. If respondents could answer fewer questions to represent a factor, we felt that was appropriate and worthwhile. A further limitation is that while our study nurses were trained and practiced conducting the survey prior to the study

commencement, they were not routinely observed administering the survey to participants. We, therefore, do not know if the study nurses were consistent in how they asked the questions and interpreted or recorded the answers. Although the VHS was translated into Spanish by a native Guatemalan, we did not perform a back-translation for validation. Most importantly, our study population included infants presenting for their initial wellness visit which includes initiation of the primary immunization series. Therefore, our sample is biased to those likely to vaccinate and may have had lower than normal hesitancy. It is also possible that parents may have been less likely to admit to vaccine hesitancy during face-to-face interviews compared to other anonymous surveys. We found low levels of hesitancy and vaccine refusal in our study, and therefore, we could not derive any meaningful vaccine hesitancy score and validate the survey in the included Guatemalan populations. In the future, it could be beneficial to follow vaccine uptake in the infants we studied to correlate intention with behavior. Future studies will be needed in broader populations with more vaccine hesitancy to test both the validity and reliability of the VHS.

5. Conclusion

Vaccine hesitancy is an evolving and important modern public health problem to consider. Understanding this complex issue from a global perspective is imperative to inform effective interventions that address the varying causes of underimmunization and counteract the global gap in immunization, especially since the majority of vaccine-preventable diseases occur in LMICs. Vaccine-hesitant parents represent a heterogeneous group, making the development of a survey tool difficult. There is a need for a standardized measurement tool to understand, evaluate, and monitor vaccine hesitancy in diverse global settings that has undergone robust psychometric assessments. The VHS offers a strong initial step towards this goal. Our study is an important field test of this survey in rural and urban Guatemala. We suggest more work is needed to refine this survey for improved reliability and validity.

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Highlights

- The Vaccine Hesitancy Survey (VHS) was field tested in urban and rural Guatemala
- Vaccine shortages and access in LMICs are important structural issues to consider
- Participants had difficulty understanding and using the Likert scale format
- Factor analysis showed a two-factor structure within the VHS Likert scale items
- More work is needed to refine this survey for improved global utility

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Table 1.

Demographic characteristics of study participants

	Rural Clinics	Urban Clinics				
Characteristic	**Coatepeque n=230, n (%)**	**Colomba n=130, n (%)**	**Villa Nueva n=180, n (%)**	**Zona 11 n=180, n (%)**	**p value[a]**	**Study Cohort n=720, n (%)**
CHILD CHARACTERISTICS						
Child's gender						
Male	122 (53.0)	62 (47.7)	85 (47.2)	89 (49.4)	0.64	358 (49.7)
Female	108 (47.0)	68 (52.3)	95 (52.8)	91 (50.6)		362 (50.3)
MOTHER CHARACTERISTICS						
Mother's age (years)						
Mean (SD)	23.8 (±5.0)	25.1 (±5.3)	25.1 (±5.9)	25.6 (±5.7)	0.004	24.8 (±5.5)
Mother is able to read and write						
No	7 (3.0)	3 (2.3)	1 (0.6)	5 (2.8)	0.35	16 (2.2)
Yes	223 (97.0)	127 (97.7)	179 (99.4)	175 (97.2)		704 (97.8)
Mother's education						
No education	0(0)	6 (4.6)	0(0)	4(2.2)	<.0001	10 (1.4)
Completed or some primary education	53 (23)	57 (43.8)	45 (25.0)	29 (16.1)		184 (25.6)
Completed or some secondary education	50 (21.7)	25 (19.2)	51 (28.3)	47 (26.1)		173 (24.0)
Completed or some higher education	127 (55.2)	42 (32.3)	84 (46.7)	100 (55.6)		353 (49.0)
Mother's employment status						
Unemployed	145 (63.0)	112 (86.2)	144 (80.0)	113 (62.8)	<.0001	514 (71.4)
Employed	85 (37.0)	18 (13.8)	36 (20.0)	67 (37.2)		206 (28.6)
Mother owns a mobile phone[b]						
No	16 (7.4)	8 (6.2)	10 (5.6)	10 (5.6)	0.93	44 (6.3)
Yes	213 (92.6)	122 (93.8)	170 (94.4)	170 (94.4)		675 (93.8)
FATHER CHARACTERISTICS[c]						

	Rural Clinics	Urban Clinics				
Characteristic	**Coatepeque n=230, n (%)**	**Colomba n=130, n (%)**	**Villa Nueva n=180, n (%)**	**Zona 11 n=180, n (%)**	**p value[a]**	**Study Cohort n=720, n (%)**
Father is involved in caring						
No	48 (20.9)	21 (16.2)	27 (15.0)	23 (12.8)	0.15	119 (16.5)
Yes	182 (79.1)	109 (83.8)	153 (85.0)	157 (87.2)		601 (83.5)
Father's age (years)						
Mean (SD)	28.6 (±7.0)	27.0 (±5.8)	28.1 (±6.6)	29.3 (±7.2)	0.04	28.4 (±6.8)
Father is able to read and write						
No	3(1.6)	5 (4.6)	1 (0.7)	1 (0.6)	0.07	10 (1.7)
Yes	179 (98.4)	104 (95.4)	152 (99.3)	156 (99.4)		591 (98.3)
Father's education						
No education	2(1.1)	5 (4.6)	1 (0.7)	1 (0.6)	<.0001	9(1.5)
Completed or some primary education	19 (10.4)	31 (28.4)	29 (19)	24 (15.3)		103 (17.1)
Completed or some secondary education	35 (19.2)	31 (28.4)	38 (24.8)	40 (25.5)		144 (24)
Completed or some higher education	126 (69.2)	42 (38.5)	85 (55.6)	92 (58.6)		345 (57.4)
Father's employment						
Unemployed	5(2.7)	0(0)	2(1.3)	1 (0.6)	0.26	8(1.3)
Employed	177 (97.3)	109 (100)	151 (98.7)	156 (99.4)		593 (98.7)
Father owns a mobile phone[b]						
No	99 (66.0)	38 (34.9)	40 (26.1)	44 (28.2)	<.0001	221 (38.9)
Yes	51 (34.0)	71 (65.1)	113 (73.9)	112 (71.8)		347 (61.1)
HOUSEHOLD CHARACTERISTICS						
Number of children living in the house						
Mean (SD)	1.8 (±0.8)	2.2 (±1.3)	1.8 (±0.9)	1.9 (±1.1)	0.004	1.9 (±1.0)
Family monthly income level[d]						
< Q1000	76 (33)	58 (44.6)	63 (35)	10 (5.6)	<.0001	207 (28.8)
Q1001– 2000	30 (13)	51 (39.2)	42 (23.3)	32 (17.8)		155 (21.5)

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	Rural Clinics	Urban Clinics				
Characteristic	**Coatepeque n=230, n (%)**	**Colomba n=130, n (%)**	**Villa Nueva n=180, n (%)**	**Zona 11 n=180, n (%)**	**p value[a]**	**Study Cohort n=720, n (%)**
Q2001– 3000	53 (23)	16 (12.3)	36 (20.0)	61 (33.9)		166 (23.1)
Q3001– 4000	38 (16.5)	4 (3.1)	18 (10.0)	43 (23.9)		103 (14.3)
>Q4001	33 (14.3)	1 (0.8)	21 (11.7)	34 (18.9)		89 (12.4)
Landline present in home						
No	123 (53.5)	112 (86.2)	155 (86.1)	149 (82.8)	<.0001	539 (74.9)
Yes	107 (46.5)	18 (13.8)	25 (13.9)	31 (17.2)		181 (25.1)
Family owns a radio						
No	97 (42.2)	50 (38.5)	40 (22.2)	30 (16.7)	<.0001	217 (30.1)
Yes	133 (57.8)	80 (61.5)	140 (77.8)	150 (83.3)		503 (69.9)
Family owns a television						
No	13 (5.7)	26 (20)	6 (3.3)	8 (4.4)	<.0001	53 (7.4)
Yes	217 (94.3)	104 (80)	174 (96.7)	172 (95.6)		667 (92.6)
Family owns a refrigerator						
No	33 (14.3)	68 (52.3)	44 (24.4)	58 (32.2)	<.0001	203 (28.2)
Yes	197 (85.7)	62 (47.7)	136 (75.6)	122 (67.8)		517 (71.8)
Family owns an electric or gas stove						
No	20 (8.7)	54 (41.5)	1 (0.6)	4 (2.2)	<.0001	79 (11)
Yes	210 (91.3)	76 (58.5)	179 (99.4)	176 (97.8)		641 (89)
Family owns a car						
No	180 (78.3)	108 (83.1)	107 (59.4)	102 (56.7)	<.0001	497 (69)
Yes	50 (21.7)	22 (16.9)	73 (40.6)	78 (43.3)		223 (31)
Number of amenities[e]						
< 2	30 (13)	64 (49.2)	18 (10)	19 (10.6)	<.0001	131 (18.2)
3	74 (32.2)	21 (16.2)	42 (23.3)	40 (22.2)		177 (24.6)
4	90 (39.1)	34 (26.2)	56 (31.1)	58 (32.2)		238 (33.1)
5	36 (15.7)	11 (8.5)	64 (35.6)	63 (35)		174 (24.2)

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	Rural Clinics	Urban Clinics				
Characteristic	**Coatepeque n=230, n (%)**	**Colomba n=130, n (%)**	**Villa Nueva n=180, n (%)**	**Zona 11 n=180, n (%)**	**p value[a]**	**Study Cohort n=720, n (%)**
Food insecurity score[f]						
0	203 (88.3)	121 (93.1)	111 (61.7)	140 (77.8)	<.0001	575 (79.9)
1	13(5.7)	2(1.5)	4(2.2)	13 (7.2)		32 (4.4)
2	3(1.3)	1 (0.8)	10 (5.6)	5 (2.8)		19 (2.6)
3	6(2.6)	0(0)	4(2.2)	3(1.7)		13 (1.8)
>4	5(2.2)	6 (4.6)	51 (28.3)	19 (10.6)		81 (11.3)
Depression score[g]						
Minimal or no depression (0–4)	222 (96.5)	130 (100)	159 (88.3)	172 (95.6)	<.0001	683 (94.9)
Mild depression (5–9)[h]	8(3.5)	0(0)	21 (11.7)	8 (4.4)		37 (5.1)

[a] Chi-square test or Fisher's exact for category and ANOVA test for continuous variables.

[b] One participant (Coatepeque = 1) left this answer blank for mothers, and thirty-three participants (Coatepeque = 32, Zona 11 = 1) responded "I don't know" for fathers.

[c] Father characteristics include a total of n = 601.

[d] Q=Guatemalan Quetzal (Q1 = $0.14 USD)

[e] Amenities scale includes ownership of radio, television, refrigerator, stove, and car.

[f] Food insecurity is measured with USAID's Flousehold Food Insecurity Access Scale (H FI AS) (score 0 – 27). H igher scores equal more food insecurity.

[g] Depression is measured with the PFIQ-9 (score 0 – 27).

[h] One individual had a PFIQ-9 score of 10 but was added into the mild depression group for analysis.

Table 2.

Vaccine Hesitancy Survey (VHS) questions

			Rural Clinics				Urban Clinics				
	All Centers		Coatepeque		Colomba		Villa Nueva		Zona 11		p
VHS Questions	N	%	N	%	N	%	N	%	N	%	value[a]
Q1. Do you believe that vaccines can protect children from serious diseases?											
No	3	0.4%	1	0.4%	1	0.8%	0	0.0%	1	0.6%	0.7463
Yes	717	99.6%	229	99.6%	129	99.2%	180	100.0%	179	99.4%	
Q2. Do you think that most parents like you have their children vaccinated with all the recommended vaccines?											
No	426	59.2%	95	41.3%	80	61.5%	120	66.7%	131	72.8%	<.0001
Yes	294	40.8%	135	58.7%	50	38.5%	60	33.3%	49	27.2%	
Q3. Have you ever been reluctant or hesitated to get a vaccination for your children?											
No	712	98.9%	228	99.1%	130	100.0%	180	100.0%	174	96.7%	0.0085
Yes	8	1.1%	2	0.9%	0	0.0%	0	0.0%	6	3.3%	
Q4. Have you ever refused a vaccination for your children?											
No	720	100%	230	100%	130	100%	180	100%	180	100%	NA
Q5. Has distance, timing of clinic, time needed to get to clinic or wait at clinic, and/or costs in getting to clinic prevented you from getting your children immunized?											
No	653	90.7%	208	90.4%	130	100.0%	163	90.6%	152	84.4%	<.0001
Yes	67	9.3%	22	9.6%	0	0.0%	17	9.4%	28	15.6%	
Q6. Are there other pressures in your life that prevent you from getting your children immunized on time?											
No	707	98.2%	229	99.6%	130	100.0%	169	93.9%	179	99.4%	<.0001
Yes	13	1.8%	1	0.4%	0	0.0%	11	6.1%	1	0.6%	
Q7. Are there any reasons you can think of why children should not be vaccinated?											
No	720	100%	230	100%	130	100%	180	100%	180	100%	NA
Q8. Do you think that it is difficult for some ethnic or religious groups in your community/region to get vaccinations for their children?											
No	511	71.0%	227	98.7%	129	99.2%	91	50.6%	64	35.6%	<.0001
Yes	209	29.0%	3	1.3%	1	0.8%	89	49.4%	116	64.4%	

			Rural Clinics				Urban Clinics				
	All Centers		Coatepeque		Colomba		Villa Nueva		Zona 11		p
VHS Questions	N	%	N	%	N	%	N	%	N	%	value[a]
Q9. Have you ever received or heard negative information about vaccinations?											
No	650	90.3%	210	91.3%	115	88.5%	163	90.6%	162	90.0%	0.8503
Yes	70	9.7%	20	8.7%	15	11.5%	17	9.4%	18	10.0%	
Q10. Do leaders (religious or political leaders, teachers, health care workers) in your community support vaccinations for infants and children?											
No	231	32.1%	157	68.3%	7	5.4%	1	0.6%	66	36.7%	<.0001
Yes	489	67.9%	73	31.7%	123	94.6%	179	99.4%	114	63.3%	
L1. Childhood vaccines are important for my child's health.											
Strongly agree	543	75.4%	229	99.6%	130	100.0%	7	3.9%	177	98.3%	<.0001
Agree	177	24.6%	1	0.4%	0	0.0%	173	96.1%	3	1.7%	
L2. Childhood vaccines are effective.											
Strongly agree	537	74.6%	227	98.7%	130	100.0%	5	2.8%	175	97.2%	<.0001
Agree	182	25.3%	2	0.9%	0	0.0%	175	97.2%	5	2.8%	
Disagree	1	0.1%	1	0.4%	0	0.0%	0	0.0%	0	0.0%	
L3. Having my child vaccinated is important for the health of others in my community.											
Strongly agre	488	67.8%	223	97.0%	113	86.9%	4	2.2%	148	82.2%	<.0001
Agree	189	26.3%	5	2.2%	4	3.1%	174	96.7%	6	3.3%	
Neither agree nor disagree	5	0.7%	1	0.4%	1	0.8%	0	0.0%	3	1.7%	
Disagree	28	3.9%	1	0.4%	12	9.2%	2	1.1%	13	7.2%	
Strongly disagree	10	1.4%	0	0.0%	0	0.0%	0	0.0%	10	5.6%	
L4. All childhood vaccines offered by the government program in my community are beneficial.											
Strongly agree	517	71.8%	228	99.1%	125	96.2%	4	2.2%	160	88.9%	<.0001
Agree	198	27.5%	2	0.9%	5	3.8%	176	97.8%	15	8.3%	
Neither agree nor disagree	5	0.7%	0	0.0%	0	0.0%	0	0.0%	5	2.8%	
L5. New vaccines carry more risks than older vaccines.											
Strongly agree	77	10.7%	57	24.8%	7	5.4%	0	0.0%	13	7.2%	<.0001
Agree	31	4.3%	5	2.2%	5	3.8%	3	1.7%	18	10.0%	

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			Rural Clinics				Urban Clinics				
	All Centers		Coatepeque		Colomba		Villa Nueva		Zona 11		p
VHS Questions	N	%	N	%	N	%	N	%	N	%	value[a]
Neither agree nor disagree	146	20.3%	6	2.6%	71	54.6%	2	1.1%	67	37.2%	
Disagree	430	59.7%	162	70.4%	46	35.4%	175	97.2%	47	26.1%	
Strongly disagree	36	5.0%	0	0.0%	1	0.8%	0	0.0%	35	19.4%	
L6. The information I receive about vaccines from the vaccine program is reliable and trustworthy.											
Strongly agree	477	66.3%	217	94.3%	125	96.2%	2	1.1%	133	73.9%	<.0001
Agree	215	29.9%	6	2.6%	5	3.8%	178	98.9%	26	14.4%	
Neither agree nor disagree	13	1.8%	1	0.4%	0	0.0%	0	0.0%	12	6.7%	
Disagree	13	1.8%	6	2.6%	0	0.0%	0	0.0%	7	3.9%	
Strongly disagree	2	0.3%	0	0.0%	0	0.0%	0	0.0%	2	1.1%	
L7. Getting vaccines is a good way to protect my child/children from disease.											
Strongly agree	528	73.3%	226	98.3%	125	96.2%	4	2.2%	173	96.1%	
Agree	189	26.3%	1	0.4%	5	3.8%	176	97.8%	7	3.9%	<.0001
Neither agree nor disagree	1	0.1%	1	0.4%	0	0.0%	0	0.0%	0	0.0%	
Disagree	2	0.3%	2	0.9%	0	0.0%	0	0.0%	0	0.0%	
L8. Generally I do what my doctor or health care provider recommends about vaccines for my child/children.											
Strongly agree	502	69.7%	219	95.2%	122	93.8%	3	1.7%	158	87.8%	<.0001
Agree	200	27.8%	3	1.3%	6	4.6%	176	97.8%	15	8.3%	
Neither agree nor disagree	10	1.4%	5	2.2%	2	1.5%	0	0.0%	3	1.7%	
Disagree	7	1.0%	3	1.3%	0	0.0%	1	0.6%	3	1.7%	
Strongly disagree	1	0.1%	0	0.0%	0	0.0%	0	0.0%	1	0.6%	
L9. I am concerned about serious adverse effects of vaccines.											
Strongly agree	292	40.6%	76	33.0%	115	88.5%	0	0.0%	101	56.1%	<.0001
Agree	214	29.7%	27	11.7%	11	8.5%	154	85.6%	22	12.2%	
Neither agree nor disagree	11	1.5%	9	3.9%	0	0.0%	0	0.0%	2	1.1%	
Disagree	177	24.6%	117	50.9%	4	3.1%	26	14.4%	30	16.7%	
Strongly disagree	26	3.6%	1	0.4%	0	0.0%	0	0.0%	25	13.9%	
L10. My child/children does or do not need vaccines for diseases that are not common anymore.											

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			Rural Clinics				Urban Clinics				
	All Centers		Coatepeque		Colomba		Villa Nueva		Zona 11		p
VHS Questions	N	%	N	%	N	%	N	%	N	%	value[a]
Strongly agree	21	2.9%	3	1.3%	8	6.2%	0	0.0%	10	5.6%	<.0001
Agree	9	1.3%	0	0.0%	1	0.8%	6	3.3%	2	1.1%	
Neither agree nor disagree	57	7.9%	4	1.7%	5	3.8%	0	0.0%	48	26.7%	
Disagree	558	77.5%	223	97.0%	108	83.1%	174	96.7%	53	29.4%	
Strongly disagree	75	10.4%	0	0.0%	8	6.2%	0	0.0%	67	37.2%	

[a]Chi-square test or Fisher's exact where appropriate

Table 3.

Rotated and optimized rotated factor patterns

Vaccine Hesitancy Scale (VHS) Likert Survey Question	Rotated Pattern		Optimized Rotated Pattern	
	VHS Factor 1: Confidence	VHS Factor 2: Complacency/Risks	VHS Factor 1: Confidence	VHS Factor 2: Complacency/Risks
LI: Childhood vaccines are important for my child's health	0.94527	0.11779	0.95850	0.11770
L2: Childhood vaccines are effective	0.92966	0.11737	0.94004	0.12354
L4: All childhood vaccines offered by the government program in my community are beneficial	0.91189	0.02911	0.91155	0.03995
L7: Getting vaccines is a good way to protect my child/children from disease	0.90937	0.08271	0.91662	0.08396
L8: Generally, 1 do what my doctor or health care provider recommends about vaccines for my child/children	0.73796	0.03508	0.75407	0.03676
L6: The information 1 receive about vaccines from the vaccine program is reliable and trustworthy	0.67689	−0.07002	—	—
L3: Having my child vaccinated is important for the health of others in my community	0.47557	0.10477	—	—
L10: My child/children does or do not need vaccines for diseases that are not common anymore	−0.05611	0.77924	−0.07952	0.83317
L5: New vaccines carry more risks than older vaccines	0.22108	0.70604	0.22743	0.71048
L9: 1 am concerned about serious side effects of vaccines	0.00926	0.32579	—	—

Table 4.

EFA model fit for one and two factor models*

	χ^2df	RMSEA	CFI	SRMR
All 10 items, 1 factor	4.2	0.067	0.976	0.037
All 10 items, 2 factors	3.4	0.058	0.948	0.025
7 items (without L3, L6, L9), 1 factor	4.4	0.069	0.989	0.041
7 items (without L3, L6, L9), 2 factors	2.3	0.043	0.997	0.014
Suggested value for good fit	*2–5*	*≤0.06*	*≥0.95*	*<0.08*

[a]EFA indices selected to report the model fit include: 1.) Wheaton et al.'s relative/normed chi-square (χ /df), 2.) Root Mean Square Error Approximation (RMSEA), 3.) Comparative Fit Index (CFI), and 4.) Standard Root Mean Square Residual (SRMR).

Table 5.

Effect sizes of the two Vaccine Hesitancy Survey (VHS) factors

		VHS Factor 1		VHS Factor 2	
Characteristics	**N (%)**	**Mean (SD)**	**ANOVA[a]**	**Mean (SD)**	**ANOVA[a]**
Child's gender					
Male	358 (49.7)	1.27 (0.42)	F=0.28	3.69 (0.66)	F=0.18
Female	362 (50.3)	1.29 (0.43)	*p*=.596	3.67 (0.70)	*p*=.675
Mother's age category					
< 20 years old	133 (18.5)	1.33 (0.45)	F=1.25	3.63 (0.64)	F=0.72
20 – 29 years old	445 (61.8)	1.26 (0.41)	*p*=.291	3.68 (0.68)	*P*=.539
30 – 39 years old	133 (18.5)	1.31 (0.45)		3.70 (0.75)	
> 39 years old	9(1.3)	1.31 (0.44)		3.94 (0.53)	
Mother's employment status					
Unemployed	514 (71.4)	1.30 (0.44)	F=4.14	3.68 (0.66)	F=0.0
Employed	206 (28.6)	1.23 (0.39)	*p*=.042	3.68 (0.75)	*p*=.984
			η^2=0.006		
Mother's education					
No education	10 (1.4)	1.02 (0.06)	F=2.22	3.25 (0.59)	F=2.64
Completed or some primary education	184 (25.6)	1.28 (0.42)	*p*=.085	3.61 (0.69)	*p*=.049
Completed or some secondary education	173 (24.0)	1.33 (0.45)		3.75 (0.63)	η^2=0.011
Completed or some higher education	353 (49.0)	1.26 (0.42)		3.69 (0.71)	
Site location					
Coatepeque	230 (31.9)	1.03 (0.13)	F=1890.26	3.57 (0.70)	F=14.2
Colomba	130 (18.1)	1.03 (0.10)	*P*<.0001	3.52 (0.59)	*P*<.0001
Villa Nueva	180 (25.0)	1.98 (0.15)	η^2=0.888	3.94 (0.24)	η^2=0.056
Zone 11	180 (25.0)	1.08 (0.18)		3.66 (0.92)	
Family monthly income level[b]					
≤Q1000	207 (28.8)	1.32 (0.45)	F=1.77	3.58 (0.69)	F=1.91
Q1001–2000	155 (21.5)	1.30 (0.44)	*p*=.133	3.67 (0.58)	*p*=.107
Q2001–3000	166 (23.1)	1.26 (0.41)		3.72 (0.64)	
Q3001–4000	103 (14.3)	1.19 (0.37)		3.72 (0.78)	

		VHS Factor 1		VHS Factor 2	
Characteristics	N (%)	Mean (SD)	ANOVA[a]	Mean (SD)	ANOVA[a]
≥Q4001	89 (12.4)	1.29 (0.42)		3.78 (0.78)	

[a]Where results were significant, effect sizes were calculated using eta squared, η^2

[b]Q=Guatemalan Quetzal (Ql=$0.14 USD)