

Trust in Information Sources as a Predictor of Parents' Knowledge, Attitudes, and Practices  
(KAP) Regarding PCV13 Vaccination for Children in China: A Mixed Methods Study

by

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Defense Date: November 21<sup>st</sup>, 2023

Approved:

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Marius Wamsiedel

Thesis submitted in partial fulfillment of the requirements for the degree  
of Master of Science in the Department of  
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ABSTRACT

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## **Abstract**

Background: Pneumococcal vaccines could protect children from being infected by some of the deadly *Streptococcus pneumoniae* bacteria. However, since the pneumococcal vaccines have not yet been listed in China's National Immunization Program (NIP), their coverage remains low due to the non-mandate and self-paid features. Parents are usually the key decision makers regarding their children's PCV13 vaccine taking. Their exposure to vaccine information from trusted sources might influence this decision-making process. This study aims to explore the association between trust in information sources and parents' knowledge, attitudes, and practices regarding PCV13 vaccination for children in the Yangtze River Delta region, China.

Methods: This study applied an explanatory sequential mixed-method design, combining a web-based quantitative survey (N = 1,871) and qualitative interviews (N = 19). Adult parents who had at least one child aged less than 24 months (including 24 months) and lived in the Yangtze River Delta region were recruited. A Five-Point Likert scale measured the level of trust in different sources. Adjusted Ordinary Least Square (OLS) regression model was applied to estimate the association between participants' level of trust in different information sources and the primary outcomes. Semi-structured individual interviews were conducted. A thematic analytic approach was adopted to analyze the transcripts.

Results: CDC received the highest trust score (4.48/5). High levels of uncertainty were identified in parents' PCV13 knowledge. Age, gender, education, and annual

household income were related to varied trust levels in specific sources. After controlling the effect of covariates, trust in healthcare institution sources was significantly associated with better PCV13 knowledge, less vaccine hesitancy, and a higher likelihood of vaccine uptake. Trust in official media was negatively associated with vaccine uptake. Trust in online community sources was positively associated with vaccine uptake. The qualitative study also identified parents' trust in healthcare-related sources. Parents would consult multiple sources for vaccine information. Insufficient information provision during the vaccination process was one of the key drivers of vaccine information seeking. Parents had varied informed levels about PCV13 when making vaccination decisions.

Conclusion: Healthcare institution sources were highly trusted and crucial in enhancing parents' vaccine knowledge and acceptance of PCV13. The influence of online community sources on vaccine uptake is worth more attention. Public health policymakers could utilize media platforms with high engagement among parents for future optional vaccine promotion. Public health workers could consider embedding vaccine information provision into the pediatric vaccination process to inform parents' decision-making better.

## **Dedication**

This thesis is for my husband Bruce, my daughter Luxi, my parents, and my grandmother. Thank you for your love and support for my pursuit of *health for all*.

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Lastly, I would like to thank all parents who participated in this study, especially the interviewees who contributed valuable sharing on their children's vaccination journey.

## 1. Introduction

Pneumococcal diseases caused by *streptococcus pneumoniae* remain a major public health threat worldwide. Children under five years who have not fully developed their immune systems are particularly susceptible to pneumococcal infection, which includes pneumonia, meningitis, and other severe conditions. China was among the ten countries with the highest mortality of pneumococcal death in children under five years old in 2000 (O'Brien et al., 2009). Recent data showed that annual pneumococcal deaths in China had dropped by 49% from 15,600 (uncertainty range: 10,800 – 17,300) to 8,000 (5,500 – 8,900), while unevenly distributed disease burdens remained across different regions (Lai et al., 2022). Implementing pneumococcal conjugate vaccines (PCV) into routine childhood immunization schedules has been proven to significantly reduce invasive pneumococcal disease (IPD) and its related hospitalization (Versluys et al., 2022).

Vaccine coverage is primarily influenced by the policies and practices that make it easier or harder to access. Seven-valent PCV was launched in China in 2008 and then replaced by 13-valent (PCV13) in 2016. However, the China National Immunization Program (NIP) has not yet included PCV13 as a mandatory routine vaccine for children. Therefore, PCV13 remains an optional Category II vaccine and requires out-of-pocket payment by the children's family. Due to this non-mandate feature, high expenditure (US\$ 68.12 per dose in 2021), and low awareness, the estimated 2021 three-dose PCV13 coverage was 16.13% among children under five years in nine provinces across China,

much lower than the global average of 48% (Lai et al., 2022; L. Liu et al., 2023). Parents are usually the decision makers for children's PCV13 vaccination (Ni et al., 2023). While policy-shaping efforts are underway to introduce PCV13 into the NIP, increasing parents' awareness and acceptance of PCV13 could be a short-term intervention to enhance vaccine coverage and reduce pneumococcal disease burdens.

PCV13 coverage rates were the highest in the eastern China provinces, especially around the Yangtze River Delta (YRD) - China's most developed economic cluster. The area encompasses Shanghai and part of Jiangsu, Zhejiang, and Anhui provinces, contributing approximately a quarter of China's GDP(chinadaily.com.cn, 2020). The first-dose PCV13 vaccine coverage in Zhejiang, Shanghai, Anhui, and Jiangsu were 59.57%, 50.16%, 46.96%, and 43.95%, respectively (L. Liu et al., 2023; Wang et al., 2021). With the continuous expansion of production and supply of PCV13 from imported and domestic manufacturers, vaccine coverage increased gradually since 2019(L. Liu et al., 2023). In addition, studies showed that parents in this region had a high willingness to pay for the optional vaccine (Hou et al., 2014; Tung et al., 2022; L. Wu et al., 2022). Therefore, findings to support the awareness raising and PCV13 acceptance would be meaningful for the vaccine coverage's further expansion in this region.

Knowledge, attitudes, and practices (KAP) are valuable indicators in public health research to monitor and predict people's health behaviors(Luo et al., 2022). Previous evidence supports that trust in information sources is essential to fuel an individual's understanding of the message and enhance their willingness to change or act on specific

health behavior, including vaccine uptake (Clayman et al., 2010; Fridman et al., 2020). On the other hand, emerging new digital platforms place trust studies in a more complicated context. New media and web-based platforms form a dynamic information environment in China, which has fundamentally shaped people's information-seeking patterns. Internet users in China hit 1.03 billion in 2022 (Xinhua, 2022). Over 71.79% of adults used the Internet to access health education, with *Baidu* and *WeChat* as their top two search tools (Zhang et al., 2017). Other emerging platforms, such as *Xiaohongshu* (Little Red Book, an app similar to *Instagram*), *Douyin* (the Chinese version of *TikTok*), and *Zhihu* (An online question-and-answer community similar to *Quora*), have unique positioning in providing health-related information. Along with the information sources evolution, how trust in these sources influences parents' knowledge, attitudes, and vaccination decision-making for the optional Category II vaccines remains unknown.

This study combines a quantitative survey and qualitative interviews to explore the association between trust in different information sources and parents' knowledge, attitudes, and practices regarding children's PCV13 vaccination in the Yangtze River Delta region. During the COVID-19 outbreak, researchers in China, the UAE, and the United States examined trust in information sources and their relations with the suggested protecting behaviors. Other vaccine studies addressed the exposure to information sources and its association with parents' vaccine beliefs, knowledge, and the children's vaccination status regarding different types of pediatric vaccines (Ashkenazi et al., 2020; De La Cruz-Sánchez et al., 2023; Li and Zhou, 2022; Osuagwu et al., 2023). To the

author's knowledge, this study is the first in China to explore the linkage between trust in information sources and its influence on parents' KAP of children's PCV13 vaccination. I hope the study will shed light on better vaccine information dissemination strategies for health communicators and public health policymakers.

## **2. Literature Review**

Trust enables the function of society as it reduces the complexities of collaboration and increases communication effectiveness. Today, trust remains at the forefront of sociological studies with even greater attention after the COVID-19 pandemic (Schilke et al., 2021). During the pandemic, governments relied on public trust profoundly to implement the pandemic response, including vaccination delivery, containment, and social mobilization. Higher public trust in government was associated with positive health outcomes – lower COVID-19 infection rates, higher vaccination rates, and less mortality (United Nations, 2021).

Trust could also be directed to vaccines. Among multiple determinants of vaccination, trust in individuals, institutions, and the whole system stands out as an underpinning factor. Larson believed trust is the utmost factor in vaccine acceptance compared to any piece of information (Larson, 2020). Internet and emerging digital platforms are shaping people's information-seeking patterns. Vaccine hesitancy was found to be influenced by the widespread misinformation in the online public discourse (Garett and Young, 2021). Therefore, trust formation of credible sources is at the core of enhancing vaccination compliance to tackle some of the urgent public health challenges.

### ***2.1 Concept of Trust***

The concept 'trust' is characterized by diverse meanings in different life scenarios and social contexts. Generally, trust is based on trusting beliefs resulting from the interaction between the trustor and the trustees and their perceived information about the



trustee's nature (Lee and See, 2004; Mayer et al., 1995; Rousseau et al., 1998). Trustors rely on the trustees to perform certain acts and expect the outcome of their interest, which indicates that trust in itself, firstly, consists of a goal or specific desire. Secondly, belief is a critical component of trust, representing the mental state of an agent towards another agent (Castelfranchi and Falcone, 1998).

Although most of the previous studies distinguish between trust and credibility, the dispute over the conceptual difference remains unresolved. Some research addressed trust as an antecedent condition to credibility (Flanagin and Metzger, 2007; Hong, 2006; Rains and Karmikel, 2009). Another study used the two terms interchangeably (Hargittai et al., 2010). A study about trust in health websites defined trust as a result of users' evaluation of the credibility of an information source (Vega et al., 2010). Tseng and Fogg state a clear distinction between the two concepts, with the definition of credibility being "synonymous with believability" (Tseng and Fogg, 1999). In this study, my focus is trust, not credibility, in information sources.

## ***2.2 Trust in information sources***

An individual accepts information partly based on trust in information sources (Berlo et al., 1969). The more trust a source is perceived to have, the higher the likelihood that the information receiver would accept the information the source delivers (Berlo et al., 1969). As for how trust plays this vital role, some researchers believe that trust could reduce uncertainty in assessing the information when people use information intermediaries, such as experts and opinion leaders, to guide their evaluation (Metzger and Flanagin, 2013).

Trust in various sources may shape one's health perception and subsequently influence health behaviors when exposed to health-related information. Health information sources are changing profoundly with the emergence and widespread of the Internet. The new digital platforms have become the primary information source for many people. Trust studies are facing considerable challenges due to the evolving complexity of the media environment.

By extending the definition to the paradigm of trust in analytic philosophy, Freiman divided trust into interpersonal and institution-based trust (Freiman, 2023). Interpersonal trust is "an attitude we have towards people whom we hope will be trustworthy" (McLeod, 2006). As we also gain information from collective sources, the trust could be directed to the attitudes towards institutional entities (Faulkner, 2018), such as government, healthcare institutions, commercial entities, and social groups. In addition, as a mental status, trust could be degreed or graded by the subjective certainty of the pertinent beliefs rather than generate a simple binary outcome (Castelfranchi and Falcone, 2000). Therefore, in this study, we mainly focused on a broader web-based source environment and divided the information sources into two major categories, namely, institution-based sources (healthcare institutions, official media) and interpersonal or network-based sources (personal network, online community), and asked respondents to grade their trust level in different sources.

Institution-based trust is highly related to social and cultural context. Previous research in different countries and regions showed diverse results. Studies in China conducted in the early stage of the COVID-19 pandemic reported the highest trust level

towards central government media among adult respondents(Wu and Shen, 2022). A survey in Taiwan targeting parents from 2022 to 2023 indicated the traditional mass media and medical staff in the healthcare settings were the most trusted sources(T.-L. Liu et al., 2023). In the United States, trust in government information sources decreased compared with results before COVID-19 (Latkin et al., 2020). As for the health information received from interpersonal sources, younger adults in China tended to distrust the health information shared by their parents(S. Wu et al., 2022). Higher trust in health information from the religious leaders was found in an Israel study (Ashkenazi et al., 2020). This study was conducted after the World Health Organization officially declared the end of the pandemic. Since there is limited post-pandemic evidence showing trust in health-related information sources in China, it would be valuable to seek the answer to the first research question:

*RQ1: What is the participants' level of trust in different vaccine information sources?*

In the digital space, individual and organizational providers contributed vast information. Though people have easier access to the information, they would shoulder more burden of information assessment by themselves rather than rely on professional gatekeepers in the traditional media environment (Flanagin and Metzger, 2008; Lim and Simon, 2011). Therefore, source credibility was found to be largely subject to the receivers' perception other than the source's objective characteristics (Berlo et al., 1969). In previous studies, gender, income, and education were significantly associated with trust in information sources (Fareed et al., 2021; Maykrantz et al., 2021). Given the

importance of enhancing parents' beliefs towards vaccines, understanding the level of trust in different information sources across demographic and socio-economic factors would be valuable to improve health messaging. Therefore, we propose the second research question:

*RQ2: How are demographic and socio-economic factors associated with trust in different vaccine information sources?*

### **2.3 Trust in information sources and vaccination KAP**

The knowledge, attitudes, and practices (KAP) are valuable indicators for public health policymakers to monitor and predict vaccine compliance. Previous evidence supports that trust in information sources is essential to enhance an individual's understanding of the message, their willingness to act, and the actual health behavior change (Clayman et al., 2010; Fridman et al., 2020).

#### **2.3.1 Trust in information sources and knowledge of vaccines**

Although no previous studies specified the association between trust in information sources and its correlation with vaccine knowledge, existing literature displays using different information source and its association with the study participants' vaccine knowledge. Israel researchers found parents' exposure to 'internet and social media sources' was negatively associated with their measles vaccine knowledge quiz scores. Conversely, those who chose the Ministry of Health (MoH) and physicians as the primary information source had higher knowledge quiz scores (Ashkenazi et al., 2020). Another study in southern Italy found that participants with reference sources of

‘pediatricians’ and ‘scientific magazines’ were correlated with correct vaccine knowledge (Tabacchi et al., 2017). A study in the United States saw that COVID-19 vaccine knowledge increased most when the source of information was a generic group of people (Vlasceanu and Coman, 2022). As the category of sources differed by context and study design, this study would seek the participants’ level of trust in information sources which parents frequently consulted to inform their understanding of the optional vaccines. Therefore, the third research question is described below:

*RQ3: What is the association between participants’ level of trust in vaccine information sources and their PCV13 vaccine knowledge?*

### **2.3.2 Trust in information sources and attitudes toward vaccines**

Trust plays an underlying role in fueling positive responses when receiving vaccine information (Goodson and Larson, 2021). Existing studies consistently found that exposure to government and healthcare information sources could enhance vaccine acceptance or confidence. Researchers in China found that exposure to government new media and mass media increased the study participants’ confidence in COVID-19 vaccines (Wang et al., 2022). Similarly, evidence in Europe, Turkey, and the Caribbean supported that using national authorities’ sources increased positive vaccine beliefs (De Freitas et al., 2021; De La Cruz-Sánchez et al., 2023; Karabela et al., 2021). A social-ecological study on COVID-19 vaccine hesitancy in the United States reported greater odds of vaccine confidence among those who indicated trust in information sources of Johns Hopkins University, the state health department, and the CDC (Latkin et al., 2020). Conversely, mixed results of vaccine beliefs were found in people who consulted

personal networks for the vaccine information. Evidence in China, the United States, and sub-Saharan Africa found higher odds of vaccine hesitancy among people exposed to vaccine information from friends and families (Bhagianadh and Arora, 2022; Nowak et al., 2021; Vlasceanu and Coman, 2022; Wang et al., 2022). On the contrary, researchers from the London School of Hygiene & Tropical Medicine indicated information from social media influencers and ‘people like me’ sources would help reduce vaccine hesitancy (Goodson and Larson, 2021). Since the association between trust in information sources and attitudes towards optional vaccines in China remained unknown, I will explore the association in this study by addressing the forth research question:

*RQ4: What is the association between participants’ level of trust in vaccine information sources and their attitudes towards the PCV13 vaccine?*

### **2.3.3 Trust in information sources and vaccination practices**

Trust in different information sources was also a predictor for adopting health behavior. In the context of the COVID-19 response, trust in formal information sources, such as government and mainstream media, contributed to the preventive behavior upon the pandemic threat in China(Liu and Saltman, 2020). Similar findings amid infectious disease outbreaks supported this association in other regions and countries(Blair et al., 2017; Bults et al., 2011; Figueiras et al., 2021; Liao et al., 2010). Regarding vaccine uptake, exposure to healthcare-related sources stood as a positive predictor. For example, a 2016 study in France surveyed 3,938 parents and found those who referred to healthcare professionals as vaccine information sources had better vaccine uptake practices for their children(Charron et al., 2020). Studies in China also reported trust in

healthcare providers would increase vaccination(Liu and Chu, 2022). Thus, I would answer the association between trust in information sources and vaccination practices by addressing the final research question:

*RQ5: What is the association between participants' level of trust in vaccine information sources and their children's PCV13 uptake?*

## **3. Methods**

### ***3.1 Study Design***

This study applied an explanatory sequential mixed-method design. A web-based quantitative survey (N = 1,871) was rolled out first from May 10<sup>th</sup>, 2023, to June 7<sup>th</sup>, recruiting adult parents who have at least one child aged less than 24 months (including 24 months) and live in seven cities of Yangtze River Delta region, namely, Shanghai, Suzhou, Hangzhou, Wuxi, Nanjing, Shaoxing, and Ningbo. Then, a qualitative study of 19 parents was conducted from June 5<sup>th</sup>, 2023, to September 15<sup>th</sup>, 2023.

### ***3.2 Quantitative Study***

#### **3.2.1 Data collection and participants**

A web-based self-administered anonymous survey was conducted by *Weidiao* (Zhongyue Online Technology Co., Ltd, Qingdao, Shandong), a professional Chinese survey platform with non-governmental background ([www.weidiao.com](http://www.weidiao.com), similar as the *SurveyMonkey*). The company owns a database of more than 10 million samples across over 20 provinces in China by the time the study began. It reports 2.5 million active users in its dedicated online platform matrix, including apps, website, and WeChat mini program and account. The database was formed on a voluntary-based registration through open advertisement in multiple online and offline channels. 93.2% of their total samples are in the age group of 20 to 49, who are our primary target group of people.



61.24% of the total database samples are male, 38.76% female. The platform has been used for several social science studies in recent years.<sup>12</sup>

A pilot run was conducted on 100 participants via *Weidiao* before the formal launch of the survey to ensure the clarity of the survey questions and test the duration of completing the survey. Since no survey question was revised after the pilot phase, I included pilot-run data in the final study analysis. The survey participants were recruited from May 10<sup>th</sup>, 2023 to June 7<sup>th</sup>, 2023. The survey invitation was distributed on *Weidiao*'s platforms through email, WeChat, and app notice to individuals whose registered information met the study's criteria by location and age. People who were interested in participating could click the survey link. After providing their consent, they could begin to answer the questionnaire. Participants' IP address was recorded in the system and used to verify their locations. Parental status and the participant's youngest child's age were required as two filtering questions before answering the rest of the survey questions.

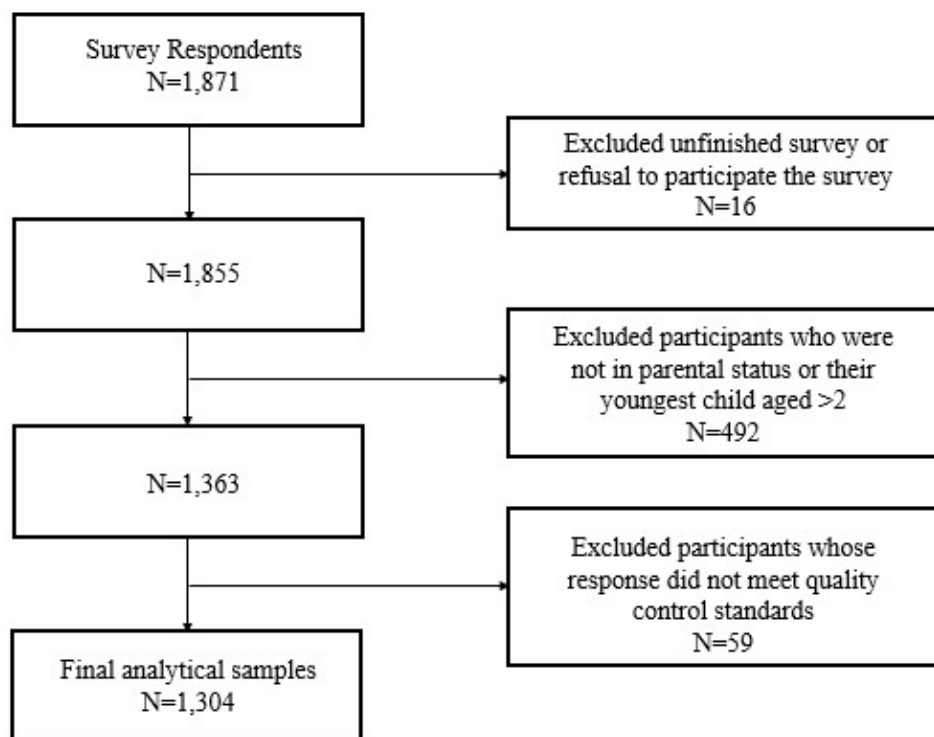
A total of 1,871 respondents opened the survey link. Among the 1,855 completed surveys, we excluded 492 participants who did not meet our study enrollment criteria. *Weidiao* also used attention filter questions and 'trap' questions as standard quality control for the survey. One of the attention filter questions asked the respondents, "What is the number of hours in a day?" and the options given were "[1] 14; [2] 20; [3] 24;

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<sup>1</sup> Li, H. and Zheng, L. (2021). Associations between early life harshness, parents' parenting style, and relationship quality in China. *Personal Relationships*. doi: <https://doi.org/10.1111/per.12391>.

<sup>2</sup> Zhang, X., Liu, D., Wang, Y. and Du, H. (2021). Behavioral Intentions of Urban Rail Transit Passengers during the COVID-19 Pandemic in Tianjin, China: A Model Integrating the Theory of Planned Behavior and Customer Satisfaction Theory. *Journal of Advanced Transportation*, [online] 2021, p.e8793101. doi:<https://doi.org/10.1155/2021/8793101>.

[4]30”. Traps were set to the options of different questions. For example, respondents who chose ‘Yes’ in children’s PCV13 vaccination status but answered ‘never heard of PCV before’ in the information source question will be defined as not passing the quality control check. Other quality control measurements included the similarity of trust level grading towards all information sources and predominant ‘I am not sure’ options to the knowledge section. Therefore, we excluded 59 completed surveys after applying these quality control standards. Our final analytic sample included 1304 respondents. (Figure 1).



**Figure 1. Analytic sample flow chart.**

### **3.2.2 Measurement**

The study questionnaire included three major parts – 1) social-demographic information; 2) sources of vaccine information and levels of trust in different sources; and 3) knowledge, attitudes, and practices (KAP) of PCV13 vaccination. Measures for knowledge towards PCV13 were designed according to the 2020 version of expert consensus on immunoprophylaxis of pneumococcal disease (Chinese Preventive Medicine Association and Vaccine and Immunology Branch of the Chinese Preventive Medicine Association, 2020). Items for sources of information were combined categories used in previous COVID-19 information sources and trust studies (Goodson and Larson, 2021; Li and Zhou, 2022; Liu and Li, 2021). They were modified according to Category II vaccine information distribution in practice. (See Appendix A: Survey Questionnaire)

#### **3.2.2.1 Dependent variables**

The primary outcomes were parents' knowledge, attitudes, and practices regarding their children's PCV13 vaccination. The PCV13 knowledge used six narratives, covering the vaccine category, vaccine schedule, the benefits of PCV13 vaccination, and the knowledge of potential adverse effects after the injection. Parents were required to evaluate the correctness of the narrative by a Five-Point Likert scale: [1] wrong, [2] maybe wrong, [3] I am not sure, [4] maybe correct, and [5] correct. The answers of 'maybe correct,' 'I am not sure,' and 'maybe wrong' were combined into a single category of 'uncertainty'. All narratives are correct based on current China policy and the expert consensus. These six questions are averaged to construct an index of parents' knowledge (Cronbach's  $\alpha=0.68$ ,  $M=2.44$ , and  $SD=0.35$ ).

Parental attitudes towards the PCV13 were assessed through a general attitudes narrative – “In all, I am hesitant to vaccinate my child with PCV13.” A Five-point Likert scale was applied to evaluate the attitudes. Respondents were required to choose [1] disagree, [2] somewhat disagree, [3] neutral, [4] somewhat agree, [5] agree, for each narrative. (M=2.59, and SD=1.21)

PCV13 vaccination practice was asked through two separate questions. Parents were first asked whether or not their child had been PCV13 vaccinated. Those who responded ‘Yes’ will end the survey. For those who answered ‘No’ to the first question, a follow-up question was asked about their plan of children’s PCV13 vaccination. Respondents were required to choose one of the four options: [1] No vaccination plan; [2] Not for now, but I will seek further information; [3] Plan to, but I haven’t made an appointment; [4] I’ve already made a vaccination appointment. Those who had been vaccinated were categorized into [5] Vaccinated (M=4.07, and SD=1.31).

### **3.2.2.2 Independent variables**

A multiple-choice question about which source the participants had used to obtain information on the PCV13 was provided. The participants were required to choose based on their information-seeking and exposure experiences. Nine sources were listed: CDC, vaccination clinics, hospitals, medical media, official media, family/friends, maternal apps, online forums, and social media. The last option is addressed as ‘I never heard about PCV13’ to filter participants unaware of the vaccine. Then, respondents were asked to rate the trust level for all the nine information sources. A Five-Point Likert scale of

trust level was set for the rating, ranging from [1] distrust at all, [2] somewhat distrust, [3] neutral, [4] somewhat trust, and [5] fully trust.

Information sources were combined into source clusters to increase statistical power. CDC, vaccination clinics, hospitals, and medical media were combined into one ‘Healthcare institutions’ group (Cronbach’s  $\alpha=0.77$ ,  $M=4.93$ , and  $SD=0.62$ ). Maternal apps, online forums, and social media were grouped into ‘Online community’ (Cronbach’s  $\alpha=0.81$ ,  $M=2.94$ , and  $SD=0.72$ ). Official media stands as an independent source type ( $M=4.18$ , and  $SD=0.81$ ). Family and friends represent the participants’ personal network ( $M=3.63$ , and  $SD=0.78$ ).

### **3.2.2.3 Covariates**

Covariates included age (18-24, 25-34, 35-45, >45), gender (female and male), annual household income (<20,000, 20,000~49,999, 50,000~99,999, 100,000~300,000, >300,000), education attainment (secondary school and below, high school and technical secondary school, junior college, Bachelor’s degree, postgraduate and above), and the number of children (1, or >1).

### **3.2.3 Statistical Analysis**

Quantitative analyses were performed using STATA/SE version 17 (Stata Corp, College Station, TX, USA). Primarily, descriptive statistics analysis was conducted to summarize the participants’ demographic and socio-economic characteristics, sources of information use, levels of trust in different sources, and parents’ knowledge, vaccine hesitancy, and vaccination plan. Frequencies, proportions, and means with standard

deviations were applied to the descriptive data display. Six people reported that ‘I never heard about PCV13’ was not included in the analysis of information sources used (N=1,298).

To answer RQ2, Ordinary Least Square (OLS) regression was applied to estimate the association of demographic and socio-economic factors and the levels of trust in different information source groups. Adjusted OLS regression models were used for RQ3, RQ4, and RQ5, estimating the effect of trust in information source groups on the three primary outcomes. The statistical differences were considered significant when the p-value was <0.05.

### ***3.3 Qualitative Study***

#### **3.3.1 Author reflexivity**

I acknowledged my role as a young mother of a three-year-old and a global health master's program student. The social identities could potentially impact the research, especially when I facilitated the on-site participant recruitment in a vaccination clinic, conducted in-depth individual interviews, and analyzed the data. During the on-site recruitment at the vaccination clinic, I purposively revealed my identity as new to motherhood and a student pursuing a master's degree in the global health program at Duke Kunshan University. The practice enabled a connection and built trust with mothers with higher education backgrounds. The identity might also facilitate better interaction with mother informants during the interviews, in which I initiated the conversation with a casual chat about child care and then began asking the interview questions.

I believe that PCV13 vaccination is a valuable public health intervention, providing protection against the pneumococcal infection and its sequelae. I also rely on medical sources to inform my vaccination decision-making. As a global health student and a trained health communicator, I have considerable prior knowledge of PCV13 vaccines and information sources of vaccines in the context of China's media environment. Therefore, I tried to remain neutral during the data collection and analysis process, setting aside my views and beliefs of PCV13 and the perception of different information sources. I tried my best to give no judgment to the informant's responses and objectively reflected on their sharing.

### **3.3.2 Participants**

The eligible criteria for the study participants were adult parents with at least one child aged 24 months or below by the time of the study and living in the study's target YRD region. The recruitment was regardless of the children's PCV13 vaccination status. Participants were recruited via a convenience sampling technique through two main channels. At the immunization department of Xinzhuang Community Health Center, Minhang District, Shanghai, I approached parents accompanying their babies to the immunization department for vaccination in the post-vaccination observation area. I explained the purpose and procedure of qualitative research to parents. After confirming their interest in participating, the researcher connected them through *WeChat*. She then made a follow-up arrangement with each participant to fix a specific time for the interview. Parents were also recruited through the *Weidiao* platform, which published the study recruitment advertisements on the platform. Parents who showed interest in the study

could be connected to the researcher via *WeChat* with the facilitation of the *Weidiao* team. I then arranged a follow-up call with the parents at an agreed time. The study interviewer (Z.P.) obtained verbal informed consent from all participants due to 1) logistically unpractical to meet every interviewee in person for consent signing; 2) interviewees expressed their preference to remain anonymous in participating in the study.

### **3.3.3 Data collection**

Data collection was conducted between June 5<sup>th</sup>, 2023, and September 15<sup>th</sup>, 2023. The study planned to recruit around 20 parents for interviews. In all, 22 parents expressed their interest in participating in the study. Three did not response when the researcher followed up with them for the interview appointments. In all, nineteen parents were interviewed using a semi-structured interview guide developed by the researcher under the supervision of the research mentor (See Appendix B: Semi-structured interview guide). Interviews were conducted in Chinese. All interviews used *WeChat* voice calls as chosen by the participants. Two slightly different interview guides were used. One was for participants whose children took PCV13 vaccination. The other was applied to parents whose children have not yet been vaccinated PCV13. In addition to mitigate some potential social desirability bias in the responses, I reminded all the informants at the beginning of the interview that there would be no right or wrong answer to the questions asked. Parents could report whatever they believe without worrying about being judged.

As part of the sequential explanatory mixed-methods design, the qualitative study followed the framework of the quantitative survey. It explored in more detail about parents' information-seeking patterns and vaccination decision-making. The two



interview guides included pre-determined questions covering similar themes: parents' general attitudes toward vaccines and PCV13, specific knowledge about PCV13 vaccines, sources of the vaccine information, trust of sources, and their ways to evaluate different sources and make vaccination decisions. At the end of the interview, I collected the participants' demographic and socio-economic information. Each interview was about 30 minutes on average and was audio recorded and transcribed verbatim. After the interview, I combined the notes and transcription within 24 hours.

### **3.3.4 Analysis**

Audio recordings of the interviews were deidentified and transcribed for analysis. Data analysis was performed using Nvivo 12 Pro (version 12.6.1.9, QSR International Pty, Ltd). The transcribed interviews were coded and analyzed using a thematic analytic approach followed the procedure of familiarizing with the interview, coding, developing a working analytical framework, applying the analytical framework, charting data in the framework matrix, and interpreting the data (Gale et al., 2013).

### ***3.4 Ethical consideration***

Ethical clearance was provided by the Institutional Review Board at Duke Kunshan University, Kunshan, China (FWA00021580). The study adhered to the principles of the 1967 Helsinki Declaration for research involving human subjects..

## **4. Results**

### ***4.1 Quantitative study***

#### **4.1.1 Descriptive statistics**

The demographic and socio-economic characteristics of the respondents of the web-based survey are reported in Table 1. Of the 1304 participants, 749 were female (57.4%). 77.6% are aged 25 to 34. More than half of the participants had higher education degree, with 61.35% obtaining a Bachelor's degree and above. 70.2% reported annual household income ranging from CNY100,000 to 300,000 (USD 13,698 to USD 41,095, by exchange rate 7.3). 922 participants (70.7%) reported only having one child.

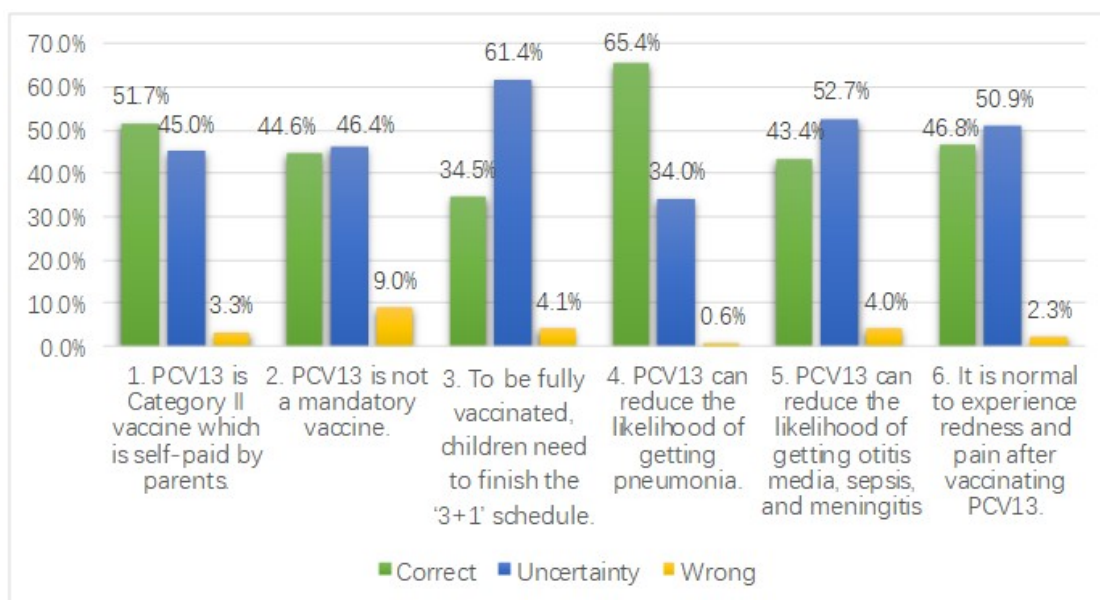
Table 2 illustrates the results of information sources parents had been used or exposed to and the level of trust in different information sources. Vaccine clinic was used by the largest proportion of participants (N=712, 54.9%), followed by hospitals (N=625, 48.2%) and family or friends (N=614, 47.3%). By ranking the trust levels in different information sources, CDC received the highest trust score of 4.48 out of 5 (SD = 0.71). Other sources received over the 4.0 trust mark were official media (mean = 4.18, SD = 0.81), vaccination clinics (mean = 4.16, SD = 0.81), and hospitals (mean = 4.04, SD = 0.82). The lowest trust scores were found in social media sources (mean = 2.73, SD = 0.88).

**Table 1: Demographic characteristics of the web-based survey participants (N=1304).**

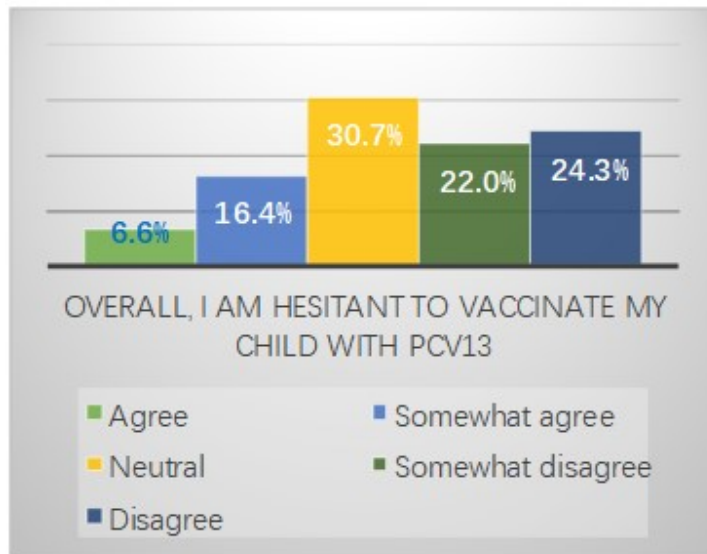
<b>Variable</b>		<b>n (%)</b>
Age	18-24	79 (6.1%)
	25-34	1012 (77.6%)
	35-45	171 (13.1%)
	>45	42(3.2%)
Gender	Female	749(57.4%)
	Male	555(42.6%)
Education attainment	Secondary school and below	56(4.3%)
	High school and technical secondary school	159(12.2%)
	Junior college	289(22.2%)
	Bachelor degree	719(55.1%)
	Postgraduate and above	81(6.2%)
Annual household Income	<20,000	0 (-)
	20,000 to 49,999	20 (1.5%)
	50,000 to 99,999	230(17.6%)
	100,000 to 300,000	915(70.2%)
	>300,000	139(10.7%)
Number of children	1	922 (70.7%)
	>1	382 (29.3%)

**Table 2: Participants' vaccine information sources and their trust levels in different information sources. (N=1298).**

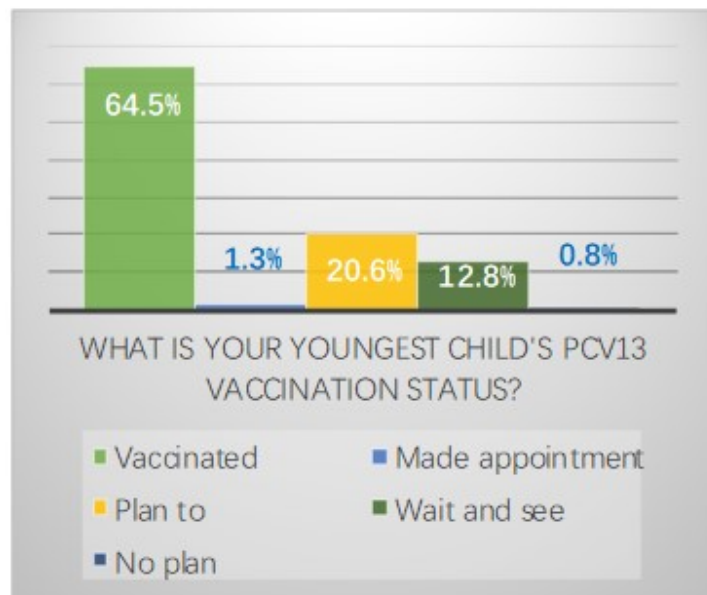
Category	Sources	Trust level (Mean, SD)	Frequency
<b>Healthcare institutions</b>	CDC	4.48(0.71)	497
	Vaccination clinics	4.16(0.81)	712
	Hospitals	4.04(0.82)	625
	Medical media	3.68(0.86)	328
<b>Official media</b>	Official media	4.18(0.81)	476
<b>Personal network</b>	Family/friends	3.63(0.78)	614
<b>Online community</b>	Maternal Apps	3.28(0.91)	358
	Online forum (Tieba, Wechat Group, etc.)	2.85(0.89)	431
	Social media(Xiaohongshu, Weibo, etc.)	2.73(0.88)	198



**Figure 2. Participants' PCV13 knowledge.**



**Figure 3. Participants' attitudes towards PCV13.**



**Figure 4. Children's PCV13 vaccination status and future vaccination plan.**

Parents' PCV13 knowledge, as displayed in Figure 2, appears to have varied results across the six different narratives. The highest proportion of correct responses (65.4%) was found for Narrative Four of 'PCV13 can reduce the likelihood of getting pneumonia'. The highest uncertainty (61.4%) was shown in Narrative Three about the PCV13 vaccination schedule. Only 34.5% of parents put a 'Right' response in this narrative. Compared with the result of Narrative Four, Narrative Five on PCV13's efficacy to prevent otitis media, sepsis, and meningitis had a higher 'Uncertainty' (52.7%). All narratives showed less than a 10% rate of 'Wrong' response, indicating our study participants' low prevalence of being misinformed on PCV13. The highest 'Wrong' (9.0%) was found in Narrative Two, indicating that some parents might consider PCV13 as a mandatory vaccine. (See Appendix C)

Figure 3 and Figure 4 showed vaccine hesitancy and parents' vaccination plans for their children, respectively. Only 6.6% of the parents agreed with the 'Overall, I am hesitant to vaccinate my child with PCV13'. 46.3% of parents disagreed or partially disagreed with this statement. About one-third (30.7%) of parents stay neutral. 841 participants (64.5%) confirmed their children's PCV13 vaccination status, with 20.6% reporting 'plan to' and 12.8% 'wait and see'.

#### **4.1.2 Multiple linear regression analysis**

To address RQ2, Table 3 shows the association between participants' demographic and socio-economic factors and the level of trust in different health information sources among our study participants. In general, as age increased, participants showed a 0.07 decrease in trust in information from their personal network

( $p < 0.05$ ). Compared with females, males have significantly lower trust in personal networks and online community ( $p < 0.001$ ). With the increase in annual household income, a 0.10 trust increase in the online community was identified. Education was associated with a 0.06 increase in official media trust ( $p < 0.05$ ) and a 0.09 increase in personal network trust ( $p < 0.001$ ).

RQ3 explores the association between trust in information sources and knowledge. As demonstrated in Table 4, adjusted results showed that parents' knowledge level was associated with trust in the healthcare institution's source. For every 1-point increase in trust score, parents' knowledge score will increase by 0.08 ( $p < 0.001$ ). No significant association was shown between trust in other source clusters and the PCV13 knowledge.

Moreover, Table 4 also answered our RQ4 on the association between trust in information sources and attitudes towards the PCV13 vaccine. Trust in healthcare institutions was related to lower parents' vaccine hesitancy ( $p < 0.001$ ). Trust in other information source clusters did not show significant difference in the attitudes outcome.

As for the RQ5 of the association between trust in information sources and the vaccination plan, parents who placed higher trust in healthcare institutions ( $p < 0.01$ ) and online community sources ( $p < 0.001$ ) were found to be more positive in the vaccination uptake plan. However, trust in official media negatively affected vaccine uptake ( $p < 0.01$ ). The table also listed the association between the control variables and the primary outcomes. With the increase in parents' age, there was a higher likelihood of not vaccinating their children with PCV13. Male participants had lower PCV13 knowledge levels than females but were more likely to vaccinate their children with PCV13.

Increased education levels would reduce parents' PCV13 vaccine hesitancy and increase their likelihood of making the vaccination plan.



**Table 3: OLS regression results of predictors of the socio-demographic variables.**

Variables	Trust in different information source categories							
	Healthcare institutions		Official media		Personal network		Online community	
	SMDs ( $\beta$ )	SE	SMDs ( $\beta$ )	SE	SMDs ( $\beta$ )	SE	SMDs ( $\beta$ )	SE
<b>Constant</b>	4.03***		3.90***		2.82***		2.98***	
Age	-0.05	(0.03)	-0.05	(0.04)	-0.07*	(0.04)	0.04	(0.04)
Male	-0.06	(0.03)	0.04	(0.05)	-0.17***	(0.04)	-0.16***	(0.04)
Annual household income	0.03	(0.03)	0.04	(0.04)	0.01	(0.04)	0.10*	(0.04)
Education	0.03	(0.02)	0.06*	(0.03)	0.09***	(0.02)	0.08**	(0.02)
Number of children	-0.02	(0.04)	0.05	(0.05)	0.01	(0.05)	-0.02	(0.05)

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

**Table 4: Adjusted OLS regression results of predictors of parents' knowledge, attitudes, and practices regarding children's PCV13 vaccination.**

		Knowledge		Vaccine hesitancy		Vaccine Uptake	
		SMDs ( $\beta$ )	SE	SMDs ( $\beta$ )	SE	SMDs ( $\beta$ )	SE
<b>Constant</b>		1.94***	(0.10)	4.67***	(0.35)	2.58***	(0.38)
<b>Predictors</b>	Healthcare institutions	0.08***	(0.02)	-0.49***	(0.07)	0.24**	(0.07)
	Official media	0.01	(0.01)	0.07	(0.05)	-0.11**	(0.05)
	Personal network	-0.01	(0.01)	-0.03	(0.05)	0.02	(0.05)
	Online community	0.02	(0.01)	-0.05	(0.05)	0.21***	(0.06)
<b>Covariates</b>	Age	0.01	(0.02)	0.11	(0.06)	-0.22***	(0.06)
	Male	-0.08***	(0.02)	0.03	(0.07)	0.23**	(0.07)
	Annual household income	0.02	(0.04)	-0.03	(0.06)	0.01	(0.07)
	Education	0.01	(0.01)	-0.08*	(0.04)	0.08*	(0.04)
	Number of children	0.02	(0.02)	0.09	(0.07)	0.03	(0.08)
<b>R2</b>		0.05		0.08		0.05	

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

## 4.2 Qualitative study

Nineteen parents participated in the study. Informants' characteristics and their youngest child's age and PCV13 vaccination status are summarized in Table 5. All parents were between the ages of 30 to 40. Seventeen participants confirmed their youngest child's PCV13 vaccination status. Most of them had higher education background and were full-time employed. Five reported having more than one child.

**Table 5: Characteristics of interview participants and their youngest child's age and PCV13 vaccination status.**

Code	Age	Sex	City	Employment	Education	No. of child	Child age	PCV13 Status
P1	40	Male	Shanghai	Full-time	Bachelor degree	1	2 Months	No
P2	33	Female	Shanghai	Full-time	Master degree	1	2 Months	Yes
P3	32	Female	Shanghai	Full-time	Bachelor degree	1	4 Months	Yes
P4	34	Female	Shanghai	Full-time	Master degree	1	4 Months	Yes
P5	32	Female	Shanghai	Full-time	Master degree	1	7 Months	Yes
P6	33	Female	Shanghai	Full-time	Master degree	1	20 Months	Yes
P7	30	Female	Shanghai	Full-time	Bachelor degree	1	4 Months	Yes
P8	35	Male	Shanghai	Full-time	Bachelor degree	3	12 Months	No
P9	32	Female	Shanghai	Full-time	Master degree	1	2 Months	Yes
P10	30	Female	Shanghai	Unemployed	High School	1	24 Months	Yes
P11	30	Female	Shanghai	Full-time	Master degree	1	4 Months	Yes
P12	33	Female	Suzhou	Unemployed	Bachelor degree	1	8 Months	Yes
P13	32	Female	Suzhou	Full-time	Bachelor degree	2	5 Months	Yes
P14	33	Female	Shanghai	Full-time	Master degree	1	3 Month	Yes
P15	32	Female	Suzhou	Full-time	Bachelor degree	1	12 Months	Yes
P16	36	Female	Shanghai	Full-time	Bachelor degree	1	5 Months	Yes
P17	31	Female	Ningbo	Full-time	Bachelor degree	2	12 Months	Yes
P18	31	Male	Hangzhou	Full-time	Bachelor degree	2	18 Months	Yes
P19	30	Male	Ningbo	Full-time	Bachelor degree	2	24 Months	Yes

Five themes emerged from the thematic analysis: (i) Seeking information from multiple sources; (ii) Drivers of information seeking; (iii) Trust in different information sources; (iv) Knowledge and attitudes towards PCV13; (v) Vaccination decision making. Details of the themes were as follows.

#### **4.2.1 Theme I - Seeking information from multiple sources**

Parents were asked to recall their first exposure to information on PCV13 in the semi-structured interviews. Most of them were informed by the vaccination clinic workers or from the clinic's appointment system (N=16). The system would send vaccination notices to the users through mobile apps or text message based on their children's vaccination schedule.

Parents consulted multiple sources for more information about PCV13 after receiving the vaccination notice. Several information sources were frequently mentioned. The social media platform *Xiaohongshu* was a salient source among many female participants (N=11). *Xiaohongshu* is viewed as the most popular online female community in China. Many mothers use it for sharing and learning parenting experiences. The platform also provided verified accounts for medical professionals. Relatives and friends whose children are in similar age were also important contacts to consult PCV13 information (N=11). Some parents reported they used a search engine (Baidu.com) to check PCV13 information (N=7). Four Shanghai-based parents (P2, P7, P11, and P13) gained PCV13 information from the online health education lessons from the Shanghai Municipal Center for Disease Control and Prevention WeChat account (Shanghai CDC). They mentioned that the clinic staff instructed them to finish the course and gain a

training certificate before the vaccination appointment. Other sources mentioned included vaccine information printed on the vaccination certificates (P5, P9, P14, P15), *Douyin* (P1, P10, P12, P17), *Zhihu* (P5), *Dingxiang Mama* Wechat account (P12, a maternal care account developed by *Dingxiang Doctor*, a dedicated medical information platform in China), *Weibo* (P1, a *Twitter*-like social media platform), and a pediatric vaccine information platform *Xiaodoumiao* (P7).

The combination of sources was very heterogeneous and personalized during the information seeking process. No consistent patterns were found. Some parents might have a primary source and use the others as a reference. Others will follow a specific order. Examples are addressed below:

*I primarily use Xiaohongshu. The second source type would be recommendations from friends who have had babies. They might suggest which vaccines are best to get. The third one is the community health care center. When they called for vaccination appointment booking, I asked the staff to provide information about the vaccine. (P2)*

*I first used the CDC channel to learn about pediatric vaccines. I then started following some WeChat public accounts, especially those focusing on maternal and childcare topics. Some well-known pediatricians also run a WeChat public account, sharing content about vaccines. Additionally, I might search for information on platforms like Xiaohongshu. Besides, some parents will also share the vaccine their babies had taken in the maternal WeChat groups. These are the channels I rely on. (P11)*

Parents indicated that multiple channel checking would provide them with different perspectives. For example, parents were interested in other parents' tips sharing

in *Xiaohongshu*. If consulting with friends, they mainly checked whether the counterparts had vaccinated their children with PCV13. From the healthcare-related sources, parents reported checking what the doctors say about the benefits of PCV13 vaccines. However, none of the interviewees reported using official media sources for vaccine information checking. Two parents (P7, P12) shared a similar view on not using the official media as they did not perceive the official media mainly provide daily news rather than their needed information for the routine pediatric vaccines.

#### **4.2.2 Theme II – Drivers of vaccine information seeking**

Two primary drivers for PCV13 information seeking were identified from the data –1) unclear and insufficient information given by the vaccination clinics and 2) the desire to know what to expect during the vaccination appointment and the post-vaccination child care.

Many parents complained of unclear or insufficient information given by the clinic workers (N=11). According to parents' description, a typical appointment process includes online appointment booking, on-site information confirmation, paying the vaccination fee (only for optional Category II vaccines), the child receiving vaccination, and half-hour observation time to prevent the potential ADE after the vaccination. Therefore, there were rare chances during this process for vaccine consultation. Parents considered it was due to the enormous daily workload of vaccination, as described by informant P4:

*They (clinic workers) usually mention the vaccine the baby must take in the next appointment. There are too many people at the vaccination center. They don't have much*

*time to give each family a detailed introduction about what the vaccine is for. You feel like you have to rely on yourself to manage it, do your research, and figure out what to do. (P4)*

As the clinic would inform in advance what vaccines the child would take in the next appointment, many parents utilized the waiting period before the next vaccine appointment for information seeking.

On the other hand, some informants expressed that their motivation for vaccine information seeking was only the preparedness for the coming vaccination appointment. Their expressed their primary intention of information seeking was not to inform their decision making, but to get more prepared for the potential post-vaccination adverse effects and tips for proper child care, as shared by the P15 interviewee.

*They (friends) told me some children might have a fever after receiving PCV13. It might be just a little, perhaps a bit of a fever on the evening of the same day, and then most of the children recover the next day, or maybe a slight low-grade fever in the afternoon of the third day. I would take it as a reference to prepare. (P15)*

#### **4.2.3 Theme III – Trust in different information sources**

In this part, parents were asked to evaluate the trustworthiness of their information sources. The adjectives in Chinese ‘Kaopu’ (reliable), ‘Quanwei’ (authoritative), and Zhuanye (having expertise) were used frequently to describe their preferred healthcare-related sources, indicating parents’ positive trust in the sources. The healthcare-related sources included doctors in their personal network, hospitals or CDC official WeChat accounts or websites, medial professionals’ social media accounts.

Parents also shared the reason of their trust in healthcare-related sources, which is mainly a trust in their expertise:

*We cannot make a judgment based on our subjective inference. It requires a certain level of medical knowledge to comprehend. When the doctors said it's safe to get vaccinated, go ahead and get it. I think it's better to listen to the advice of medical professionals rather than make judgments on your own. (P1)*

Higher credibility was also given to ‘Guanfang’ (official) channels. Parents highlighted their recognition of information from the government and official media. People who possessed knowledge in vaccine-relevant fields were also perceived as trusted sources. One parent (P8) consulted his cousin for vaccine information as the cousin held a doctoral degree in bioengineering. Finally, trust was also given to the majority’s opinion. P10 informants mentioned she would trust ‘what most people said about the vaccine’ during her information seeking:

*I will search for many answers and compare the ones with higher probabilities. After that, I will believe in them. (P10)*

Regarding the distrustful sources, two parents mentioned the immunization clinics. One (P8) perceived potential commercial incentives the clinic workers might gain by promoting the optional vaccines. The other one (P1) considered ‘they lack pediatric knowledge’ for the reason of distrustfulness.

Regarding the web-based information, the results were mixed and diverse from the parents’ responses. Some parents were skeptical to all online information, as described by the P2 informant:

*I never fully believed the online content or other parents' sharing. I always have a double-check with vaccine clinics. (P2)*

The second type is the generally lower trust in social media platforms. P14 mentioned she never checked *Xiaohongshu* as she doubted the genuineness of the information posted:

*I never checked Xiaohongshu as I didn't know whether the information was true, and it was time-consuming to look it up. I feel many people in Xiaohongshu want to attract attention. (P14)*

However, many other informants showed varied trust levels toward different accounts on social media platforms. A typical sharing is as follows from P5:

*Zhihu has a very diverse user base. Some individuals may be certified as outstanding answer providers, and in some cases, some of these answer providers are doctors. I would fully accept their contributed content. (P5)*

Therefore, many parents included at least one trusted medical source to inform their decision-making. Several interviewees reported they had checked parents' sharing, as well as the influential pediatrician's articles in *Xiaohongshu*. Others consulted friends' feedback on PCV13, but eventually they would check with medical professionals from their network, as shared by P7:

*If most of my friends have vaccinated their children, and I also know about the vaccine from other popular science sources, I would be inclined to get it. I would also seek more information and decide by asking the doctor during the next appointment. (P7)*



#### **4.2.4 Theme IV –Knowledge and attitudes toward PCV13**

Many parents vaguely remember PCV13 knowledge, especially the vaccine benefits and schedule. Most parents could not remember the vaccination schedule of PCV13 as they simply followed the instructions of the clinic system. Many only emphasized that PCV13 could prevent pneumonia but ‘never heard of’ or ‘do not remember’ its benefit of reducing otitis media and meningitis. Two identical impressions of PCV13 were ‘expensive’ and ‘post-vaccination fever.’

Many informants expressed acceptance of PCV13 vaccines as their perceived benefit to children’s health regarding the vaccine’s efficacy in ‘pneumonia protection,’ ‘ease the severity if caught pneumonia,’ ‘cost-effective to avoid hospital admission,’ and ‘critical for enhancing the immune system when children were young.’

Among the four fathers we interviewed, two reported hesitancies towards PCV13. P8 expressed an apparent refusal of the PCV13 vaccination as he believed optional vaccines were unnecessary to take. P1 held neutral attitudes toward PCV13 and indicated he would consult his pediatrician relative’s opinion before making the final decision.

#### **4.2.5 Theme V – Vaccination decision making**

Based on the parents’ sharing, we divided them into three categories regarding their informed level of PCV13 for the vaccination decision-making: (1) being fully informed, (2) being partially informed, and (3) remaining uninformed.

The P7 informant demonstrated her comprehensive knowledge of PCV13. She was the only parent to list three PCV13 vaccine brands in China, while others only referred to domestic and imported PCV13. She checked three information sources - the

*Xiaodoumiao* app for evidence-based vaccine information, *Xiaohongshu* for other parents' attitudes and suggestions on PCV13, and *Zhihu* for the comparison of different vaccine brands regarding the manufacturing process and the post-vaccination adverse effects.

Most of the parents were partially informed. They only focused on some of the vaccine information for their decision-making. Safety and adverse effects were frequently mentioned (N=9), which were also the most discussed topics on social media discourse. Eight parents reported that efficacy was a keyword they used to seek vaccine information. Another fact was the vaccine launch time. A longer launch time was essential to raise parents' vaccine acceptance (N=5).

Two parents remained highly uninformed when making vaccination decisions. Their decision-making relied on simple beliefs. P19 parent reported being too busy to check the vaccine information. He showed strong trust in vaccine benefits, healthcare institutions, and government policy, which guided him to sign the agreement of vaccination:

*We are very busy with work and usually have to take time off to take our children for vaccinations. None of us are medical professionals. I fully trust the hospital. Whatever the hospital advises us to get vaccinated for children, we just proceed. I believe in vaccines' efficacy. (P19)*

Similarly, the P11 parent vaccinated almost all optional vaccines for her child. She said the decision was made before she knew the vaccine's details. No significant difference was identified in the demographic and socio-economic characteristics between

the informants and other participants regarding their age, education, employment status, and the residential cities.

The majority's decision was identified as another influential fact separated from being informed about the vaccine information. Mothers especially showed their interest in other parents' choices and decisions. They would ask around among their friends or raise questions on social media, pooling opinions from other parents who had experience with PCV13 vaccination, as described by P4:

*I'll first talk to these friends, who are mostly moms, and see if their babies have been vaccinated. Most of them mentioned being vaccinated, so I think there shouldn't be any problem. (P4)*

Though the male informants were underrepresented, the decision-making patterns differed by gender. Male informants seemed to apply a more straightforward decision-making style and relied on fewer sources. Male informants (P1, P8, P18) mainly consulted people with expertise from their close network. P19 reported being too busy to learn about PCV13 information but relied on trust to make a short-cut decision.

## 5. Discussion

The study aims to examine the relationship between parents' trust in information sources and their knowledge, attitudes, and practices regarding PCV13 vaccination for children in China. To do this, the study combines quantitative survey and qualitative interviews, and it includes three focuses: 1) levels of trust in different vaccine information sources, 2) the demographic and socio-economic factors associated with the level of trust in different information sources, 3) the association between the level of trust in different information sources and parents' KAP regarding children's PCV13 vaccination. There are some novel highlights of this study. It is the first study in China to explore the association between trust in information sources and parents' KAP regarding children's PCV13 vaccination. It provides a new insight for public health workers, who might consider strategically utilizing this evidence to effectively disseminate the vaccine information through the most trusted sources for vaccine uptake increase. Secondly, it provided more detailed information on source descriptions in the survey based on account types rather than general media types (e.g., TV, newspaper, websites), which was more relevant to what parents used for vaccine information seeking in real-world scenarios.

The results of the quantitative analysis suggest a general higher trust in healthcare institution sources and official media sources and a lower trust in participants' personal networks and online communities, which was in line with the findings from the qualitative interview. The higher trust in healthcare institution sources among parents for pediatric vaccine information was in line with previous studies (Du et al., 2021; T.-L. Liu et al., 2023). The proportion of parents using each source did not show the exact

consistency by the trust level ranking. The phenomenon was more evident in the qualitative data as many interviewees remained highly engaged with social media platforms (e.g., *Xiaohongshu*) and other fellow parents for vaccine-related information despite expressing low trust in both sources. This paradox was consistent with the COVID-19 study in the UAE that the sources with higher usage frequencies were not viewed as the more trustworthy (Figueiras et al., 2021). A potential explanation would be the convenience of accessing the information. Using social media platforms to check vaccine information was considered time-saving and efficient, as posts from individual and verified medical sources could be checked at the same time. It might also relate to the over-representativeness of female participants, as mothers tended to obtain more information from social media platforms and personal networks than their male counterparts (Figueiras et al., 2021).

Both quantitative data and qualitative interviews identified high uncertainty of parents' PCV13 knowledge. The survey data showed over half of the participants were unsure about the vaccination schedule, PCV13's efficacy in protecting children from meningitis, otitis media, and other infections, and the adverse effects of vaccination. In the qualitative study, parents' PCV13 informed levels varied. Only one parent could tell very comprehensive information about PCV13. When recalling the information, most parents had a vague memory about the vaccine information. It might be partially due to the time past after the scheduled vaccination. The highest uncertainty on the vaccination schedule in the survey could be explained from the qualitative findings of the usage of digital tools to remind parents about the vaccine schedule at the due time. I particularly

noticed two parents who remained highly uninformed when taking their children for PCV13 vaccination. Both of them expressed strong beliefs in vaccine benefits, trust in healthcare institutions, and trust in the government's policy. Due to the sample number limitation, we could not identify strong evidence of shared demographic characters or personal experiences. Future studies may explore how trust plays a role among uninformed parents in making vaccination decisions.

The results also presented low rates of 'wrong' response in each knowledge narrative, which indicated a high probability that very few of our study participants were misinformed about PCV13. 23% of parents agreed that they were hesitant or somewhat hesitant about having their children vaccinated PCV13. The proportion was closer to the findings in a study in Shanghai in which about 24.5% of parents had no intention to vaccinate their children with PCV13 (Ni et al., 2023). When comparing the vaccination rate results with the population-based study in the Shanghai Songjiang district, our study participants' reported higher vaccination rate (64.5%) than the PCV13 first dose coverage in Shanghai (54.7%, 2020)(Tian et al., 2023). Considering the proportion of higher education and annual household income level of our study participants, the higher vaccination rate was our expectation. Survey results of male participants' lower knowledge scores and higher likelihood of reported vaccination uptake could be partially explained by their decision-making pattern unveiled by the interview data. However, since our male informants were under sample, future studies could investigate the gender-specific patterns in parents' vaccination decision-making.

Moreover, age, gender, and education were significantly associated with trust in specific information sources from our survey data. In this study, age was associated with lower trust in personal network sources. Previous studies only confirmed age's association with different information sources using habit (Figueiras et al., 2021). Women placing higher trust in social media and people with higher education attainment trusting official media and close social networks more were similar to previous studies (Figueiras et al., 2021; Rowley et al., 2017). People with higher education attainment were found to have higher trust in family and friends' sources, which was also identified from the UAE study. A possible explanation would be that these people might have a higher likelihood of having close contact with people who have medical backgrounds. Therefore, they might rely more on their personal network source for consultation, which was identified in the sharing from two of our informants (P1, P8). This group of people was also found to have higher trust in online community sources, which might be explained by the correlation between education and health literacy in previous evidence (Van Der Heide et al., 2013). People with higher education backgrounds tend to be more competent in navigating credible and reliable information from online communities.

More importantly, the study results showed that trust in healthcare institution sources was related to better PCV13 knowledge, less vaccine hesitancy, and more positive vaccine uptake practices. Trust in other information source clusters did not show similar consistency in the association with the primary outcomes. Previous studies only demonstrated higher knowledge scores when study participants reported their exposure to

information from the Ministry of Health, physicians, and pediatricians (Maykrantz et al., 2021; Tabacchi et al., 2017). The findings aligned with another study in the United States, which reported that trust in medical institution sources was related to lower vaccine hesitancy (Latkin et al., 2021). To our surprise, trust in official media sources was negatively associated with vaccine uptake. Parents in the interviews reported high trust but a low frequency of using official media to check routine pediatric vaccines. They perceived official media sources providing daily news but not a proper platform to check routine pediatric vaccines. Therefore, parents who reported high trust in official media could not get sufficient information about PCV13 vaccines from the source. Their less informed status might reduce the likelihood of the vaccination act.

Besides, a significant association was found between the trust of online community sources and vaccine uptake practices. The finding could positively demonstrate health content regulation in mitigating the risk of misinformation and enhancing health behaviors. These popular online social platforms all applied health content regulations. For instance, doctors running accounts on *WeChat*, *Xiaohongshu*, *Weibo*, and *Zhihu* had to provide identification and proof of professional certificate for verification. Therefore, parents addressed different trust levels based on the types of accounts on these platforms. They reported a higher trust in verified healthcare accounts. The phenomenon was not unique in China. The UAE study author believed the participation feature of social media could influence people's trust and transform their health behavior (Figueiras et al., 2021). Another possible explanation could be related to the majority's influence that the interviewees shared. Some parents reported their



decision-making relied on other people's actions. This might also suggest why trust in online community sources had no association with PCV13 knowledge and attitudes but the vaccine uptake results.

What is more, the qualitative interviews provided more details about parents' information-seeking drivers, multi-sources information-seeking strategies, and their decision-making of vaccination. One of the primary drivers for PCV13 information seeking was the unclear and insufficient information given by the vaccination clinics. A previous study found that immunization providers' recommendations and knowledge were a strong predictor of children's optional vaccination uptake (Chang et al., 2019). However, such vaccine information provision was highly related to the community's immunization worker density (Chang et al., 2019). Informants in our studies shared similar perspectives from the demand side. They perceived a high workload of clinic workers and no dedicated time during the vaccination process for vaccine information communication. Besides, parents reported multiple sources checking when seeking vaccine-related information. One previous study in Switzerland found vaccine hesitancy parents often consulted different sources, which were varied in format and content (Ebi et al., 2022). We did not find a similar phenomenon among our study participants. Many expressed a clear purpose for using various sources and addressed different levels of trust based on their perceived trustworthiness of sources. Parents would include one or more trusted sources, usually healthcare-related, to inform their vaccination decision. The present study has several limitations. The cross-sectional nature of the web-based survey cannot establish causal inference. Recruitment of the participants from the

*Weidiao* platform's database was opportunistic and self-voluntary, which could bias the results of our findings and affect the generalization of the evidence. The survey information was self-reported and might be subject to information bias. As for the qualitative part, the interviewees were unevenly distributed in their socio-demographic characteristics. Second, the study researcher had no other observers or counterparts to cross-check the coding and the transcript translation. The analysis might be subject to bias due to the researcher's perspectives. Finally, the study was conducted right after the World Health Organization declared the end of the COVID-19 pandemic, which might affect the general trust evaluation and parents' awareness of the vaccine topics periodically.

## **6. Conclusion**

In summary, though information-seeking strategies were largely individualized, using trusted sources or relying on trust to convince their decision was a shared pattern, even if parents were not fully informed of PCV13. This study reflected healthcare institution sources won the highest trust from our study participants. Other sources' trust was subject to age, gender, education, and annual household income levels. Healthcare institution sources trust could significantly influence parents' PCV13 knowledge, reduce vaccine hesitancy, and increase the likelihood of vaccine uptake, even after adjusting the effect from demographic and socio-economic factors. The significant influence of online communities on driving the vaccination uptake could be further utilized for future vaccine awareness-raising campaigns. This study also unveiled parents' information-seeking motivations, which shed light on the insufficient information provision throughout the routine pediatric vaccination process. Public health policymakers could refer to the evidence and consider effective and people-centered vaccine information provision.

## Appendix A

### Survey Questionnaire

Demographic Information
1. Gender: [1] Female [2] Male
2. Age: [1] 18-24; [2] 25-34; [3] 35-45; [4] >45
3. Your education attainment: [1] secondary school and below; [2] High school and technical secondary school; [3] Junior college; [4] Bachelor degree; [5] Postgraduate and above.
4. Estimated household income in the past 12 months: [1] <20,000; [2] 20,000 to 49,999; [3] 50,000 to 99,999; [4] 100,000 to 300,000; [5] >300,000
5. Single child family: [1] Yes; [2] No
Information sources
6. Which sources have you been exposed to for the PCV13 information? (multiple selection) [1] CDC; [2] Vaccine clinics; [3] Hospitals; [4] Medical media; [5] Official media; [6] Family/Friends; [7] Maternal apps; [8] Online forum (Tieba, WeChat Group); [9] Social media (Xiaohongshu, Weibo etc.); [10] Never heard of PCV13 before.
7. Rate your trust levels in the sources listed (same as Q6) by Five-Point Likert scale: [1] distrust at all; [2] somewhat distrust; [3] neutral; [4] somewhat trust; [5] fully trust
PCV13 Knowledge
Rate true/wrong for the six narratives about PCV13 using Five-Point Likert scale: [1] wrong; [2] maybe wrong; [3] I am not sure; [4] maybe correct; [5] correct.
8-1. PCV13 is a Category II vaccine which is self-paid by parents.
8-2. PCV13 is not a mandatory vaccine.
8-3. To be fully vaccinated, children need to finish the 3+1 vaccination schedule.
8-4. PCV13 can reduce the likelihood of getting pneumonia.
8-5. PCV13 can reduce the likelihood of getting otitis media, sepsis, and meningitis.
8-6. It is normal to experience redness and pain in the injection area after PCV13 vaccination.
Attitudes towards PCV13
Rate agree/disagree for the narratives about PCV13 vaccination using Five-Point Likert scale:
9. In all, I am hesitant to vaccinate my child with PCV13. [1] disagree, [2] somewhat disagree, [3] neutral, [4] somewhat agree, [5] agree
PCV13 vaccination plan
10. Has your youngest child been vaccinated with PCV13? [1] Yes; [2] No. (Answer 'Yes' will end the survey)
11. What is your plan for your children's PCV13 vaccination? [1] No vaccination plan; [2] Not for now, but I will seek further information; [3] Plan to, but I have not made an appointment; [4] I have booked the vaccination appointment.

## Appendix B

### Semi-structured interview guide

Category	PCV13 vaccinated	Not yet vaccinated PCV13
<b>Attitudes</b>	<ul style="list-style-type: none"> <li>• What do you think about the vaccines?</li> <li>• What would you think about the optional vaccines?</li> </ul>	<ul style="list-style-type: none"> <li>• What do you think about the vaccines?</li> <li>• What would you think about the optional pediatric vaccines?</li> </ul>
<b>Knowledge</b>	<ul style="list-style-type: none"> <li>• As you've vaccinated your children with PCV vaccines, what do you know about PCV vaccines?               <ul style="list-style-type: none"> <li>○ Probes: about the vaccine category, price range, efficacy, schedules</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Have you ever heard of PCV vaccines before this survey? What do you know about it? (If they know little about it, go to the trust of source part)</li> </ul>
<b>Information sources</b>	<ul style="list-style-type: none"> <li>• Could you remember where did this information first come from?               <ul style="list-style-type: none"> <li>○ Information from the clinics: What did the clinic tell you about the PCV/PPV vaccines? Do you find it enough for you to make a vaccination decision? Did you use other sources to check the information?</li> <li>○ If exposed to other sources: do you find it enough/trustworthy for you to make a vaccination decision?</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Could you remember where did this information come from?               <ul style="list-style-type: none"> <li>○ Information from the clinics: What did the clinic tell you about the PCV/PPV vaccines? Did you use other sources to check the information?</li> </ul> </li> </ul>
<b>Trust of sources</b>	<ul style="list-style-type: none"> <li>• How did you conduct information search about PCV13?</li> <li>• What sources/channels of vaccine information do you think are the most trustworthy? Why?</li> <li>• Probe: Close family member's sharing, or an article quoting vaccine experts from mainstream media</li> </ul>	<ul style="list-style-type: none"> <li>• How will you conduct information search about PCV13 if you want to know more about the vaccine?</li> <li>• What would be your personal evaluation of different sources? Why do you think they are trustworthy/not trustworthy?</li> </ul>

<b>Decision making</b>	<ul style="list-style-type: none"> <li>• What made you choose to get your children vaccinated with PCV/PPV?</li> </ul>	<ul style="list-style-type: none"> <li>• What made you choose not to get your children vaccinated with PCV/PPV?</li> </ul>
<b>Demographic</b>	<ul style="list-style-type: none"> <li>• Age, employment status (Full time/part-time/unemployed), education attainment, city, children's age</li> </ul>	<ul style="list-style-type: none"> <li>• Age, employment status (Full time/part-time/unemployed), education attainment, city, children's age</li> </ul>

## Appendix C

Participants' knowledge, attitudes, and practices regarding children's PCV13 vaccination. (N=1304)

<b>Knowledge</b>			
<b>Subjects</b>	<b>Outcome</b>	<b>n(%)</b>	
PCV13 is a Category II vaccine which is self-paid by parents.	Correct	674	51.69%
	Uncertain	587	45.02%
	Wrong	43	3.3%
PCV13 is not a mandatory vaccine.	Correct	582	44.63%
	Uncertain	605	46.40%
	Wrong	117	8.97%
To be fully vaccinated, children need to finish the '3+1' schedule.	Correct	450	34.51%
	Uncertain	801	61.43%
	Wrong	53	4.06%
PCV13 can reduce the likelihood of getting pneumonia.	Correct	853	65.41%
	Uncertain	443	33.97%
	Wrong	8	0.61%
PCV13 can reduce the likelihood of getting otitis media, sepsis, and meningitis.	Correct	565	43.33%
	Uncertain	687	52.68%
	Wrong	52	3.99%
It is expected to experience redness and pain after vaccinating PCV13.	Correct	610	46.78%
	Uncertain	664	50.92%
	Wrong	30	2.3%
<b>Attitudes</b>			
Overall, I am hesitant to vaccinate my child with PCV13.	Agree	86	6.6%
	Somewhat agree	214	16.41%
	Neutral	400	30.67%
	Somewhat disagree	287	22.01%
	Disagree	317	24.31%
<b>Practices</b>			
What is your youngest child's PCV13 vaccination status?	Vaccinated	841	64.49%
	Have made vaccination appointment	17	1.3%
	Plan to, but I haven't booked an appointment	268	20.55%
	Wait and see	167	12.81%
	No intention	11	0.84%
<b>Correlation results of predictor variables</b>			
	Healthcare institutions	Official Media	Personal network
Healthcare institutions			
Official media	0.547***		
Personal network	0.330***	0.198***	
Online community	0.405***	0.207***	0.411***

**Correlation results of outcome variables**

	Knowledge	Vaccine hesitancy
Knowledge		
Vaccine hesitancy	-0.124***	
Vaccination plan	0.098***	-0.378***



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