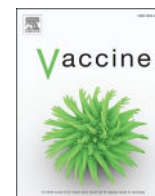


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# Attitudes and behaviors of maternal Tdap vaccination in Panama, Peru, and Colombia: An international cross-sectional study

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## ABSTRACT

**Introduction:** Despite a recommendation by PAHO for Tdap vaccination in pregnant women since 2019, uptake remains suboptimal across Latin America. This study evaluated the knowledge and attitudes of women towards maternal Tdap vaccination in Colombia, Peru, and Panama to identify the critical behavioral and social drivers of Tdap vaccine uptake during pregnancy.

**Methods:** A cross-sectional online survey was undertaken between December 8, 2022, and January 11, 2023, targeting women in Colombia, Peru, or Panama with a child 12 months or under. We collected data on respondents' demographics, social and behavioral determinants of vaccine acceptance, determinants of vaccine uptake (using the validated 5As taxonomy), and previous vaccination experience.

**Results:** In the 938 respondents who completed the survey (Panama, n = 325; Peru, n = 305; Colombia, n = 308), 73–80 % had received the influenza vaccine, whereas only 30–39 % had received a Tdap vaccine. Significant correlates of Tdap vaccine uptake common to all three countries included a health professional recommendation, knowledge of the vaccine and location of vaccination, perceived vulnerability to pertussis infection, perceived importance of immunization, and receipt of a reminder. In specific countries, nonvaccinated women were more likely to cite issues with ease of access (Panama, Colombia), affordability (opportunity costs; Peru, Colombia), and understanding the rationale for vaccination in pregnancy (Panama, Colombia).

**Conclusion:** To increase maternal Tdap vaccine uptake, health professionals should be encouraged to recommend vaccination consistently, and pregnant women should receive reminders explaining why and where to be vaccinated.

## 1. Introduction

Pertussis (whooping cough) is a respiratory disease that can sometimes be severe or even fatal, especially in infants under 12 months of age [1]. Vaccination provides the best protection, but for infants who cannot yet be vaccinated, pertussis antibodies through passive immunization during pregnancy are protective [2].

Since 2004, the Pan American Health Organization (PAHO) Technical Advisory Group (TAG) on vaccine-preventable diseases has recommended influenza vaccination for pregnant women. In 2019, acellular pertussis-containing vaccines (tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine [Tdap]) were also recommended [3]. As of 2019, 34 countries in the Americas recommend vaccinating pregnant women against influenza, and 17 countries

recommend using Tdap for pregnant women [4]. Despite these recommendations, maternal vaccination coverage varies significantly across Latin American countries [3,5], with one study reporting a weighted regional maternal immunization coverage of 75 % for influenza and 42 % for Tdap in 2018 [6]. Several systematic reviews on the epidemiology of pertussis in Latin America have also found wide disparities in disease burden and vaccine coverage between countries [7,8].

While several studies have examined the mothers' acceptance of Tdap vaccination during pregnancy [9–11] and more broadly about maternal immunization [3], there is limited research on attitudes and behaviors towards Tdap vaccine within a Latin American context, which is a vital gap to address when considering the 1 in 4 children are currently unvaccinated against Pertussis in Latin America [12].

The COVID-19 pandemic has negatively impacted the delivery and

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uptake of routine vaccination worldwide [13,14]. However, suboptimal vaccine coverage in Latin America was evident before the pandemic began [9,12,15,16]. Barriers to vaccine uptake may variously manifest at the individual (intra- and inter-personal), community, social, programmatic, and structural levels [17–19].

Here, we evaluated socio-psychological factors that may influence maternal vaccine decision-making in pregnant women and other barriers to vaccine uptake that women may experience following the 5As taxonomy (access, affordability, awareness, acceptance, activation) [17]. This study, conducted in three Latin American countries with national recommendations for maternal Tdap vaccination (Colombia, Peru, and Panama), aimed to provide meaningful and actionable insights to inform national strategies to improve maternal Tdap immunization rates.

## 2. Methods

### 2.1. Population and procedures

An online survey was created and administered anonymously using the Qualtrics survey platform, with respondents recruited through the health market research company CloudResearch. The company maintains a panel of voluntary market research respondents who receive points to exchange for cash, gift cards, charitable donations, magazine subscriptions, or similar incentives for participation.

Respondents to the survey were based in either Columbia, Peru, or Panama, all of which were chosen based on the funder's priority needs (Sanofi). To meet the inclusion criteria, respondents had to self-identify as 18 years old, read and understand Spanish, live in Colombia, Peru, or Panama, have a child aged 12 months or younger, and provide consent. The survey was conducted between December 8, 2022, and January 11, 2023. Respondents' unique IP addresses prevented duplicate entries. Sample size calculations indicated a minimum of 300 completed surveys were required for a 95 % confidence interval and 3 % margin of error [15]. The completion rate for this survey was 35.5 % (938/2646), with 1708 responses excluded for being either ineligible or incomplete and 938 completed responses included for analysis.

This study was approved by the UNSW Human Research Ethics Committee (#220657). The Participant Information Statement was made available for download, and the survey was taken as eligible respondents provided informed consent.

### 2.2. Survey instruments and measures

To identify perceived barriers – and enablers – to maternal Tdap vaccine acceptance and uptake, we designed a questionnaire consisting of 19 items from published qualitative and quantitative maternal and adult immunization studies. We identified and included questions based on critical potential socio-psychological determinants of maternal and adult vaccination acceptance [3,20,21]. We also included the validated 11 items from the 5As taxonomy for vaccine uptake determinants, including access, affordability (financial and opportunity costs), awareness, and activation [17,22]. We also collected data on demographic factors such as religion, age, number of children, country of residence, education, marital status, and vaccination status. Questions were mainly closed-ended with simple categorical questions for demographics, yes or no questions, and a 5-point Likert scale from Strongly agree to disagree for attitude and belief questions. The survey was written in English and translated into Spanish (accounting for minor country-based language differences). Before the rollout, a pilot survey (20 participants) was conducted by CloudResearch to confirm the target audience would be able to answer all the questions accurately and produce quality data. Based on feedback from CloudResearch, any issues or confusing/challenging questions were adjusted before rollout.

### 2.3. Statistical analysis

Data was collated in Microsoft Excel and imported to SPSS (IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY, USA) for further analysis. Descriptive statistics, including frequency percentages and means, were used to present the survey results. We used the Chi Square Test or Fischer's Exact Test to test for associations between categorical variables and the one-way ANOVA analysis for continuous variables. P values of < 0.05 were considered statistically significant. Diagnostics confirmed model assumptions were met.

## 3. Results

A total of 938 respondents were enrolled in the study (Panama, n = 325; Peru, n = 305; Colombia, n = 308), with an average age of 30 years (range:18–52, SD:6.67) and an average number of children in the household of 1.84 (0–8, SD:1.029).

Of the 938 respondents, 86 % stated that they had received a vaccination during the last pregnancy, 77 % had received an influenza vaccine, and only 33 % received a Tdap vaccine (Table 1).

### 3.1. Determinants of Tdap uptake during pregnancy

The respondents held a predominantly favorable attitude towards vaccination, as the majority expressed openness to receiving vaccinations, demonstrated an understanding of the reasons behind vaccination, and acknowledged the importance of getting vaccinated against whooping cough during pregnancy. There were some misunderstandings on the impact of pertussis, with 26.8 % (251/938) of respondents not agreeing that their child would be vulnerable to whooping cough if they were not vaccinated. See Fig. 1 for the significant determinants of vaccination in Panama, Peru, and Colombia.

### 3.2. Correlates of Tdap vaccine uptake

With exploratory analyses for each country, we examined possible associations between Tdap vaccination status, demographics, and various potential social and behavioral determinants of adult and maternal vaccine acceptance and determinants of vaccine uptake following the 5As taxonomy. See Supplementary File 1 for a full breakdown of the results.

The only socio-demographic factors associated with vaccination were education level ( $p = 0.023$ ) and marital status ( $p = 0.041$ ) in Colombia.

Significant correlates of Tdap vaccine uptake, seen in all three countries, included a health professional recommendation, knowledge of the vaccine and location of vaccination, perceived vulnerability to pertussis infection, perceived importance of immunization, and receipt of a reminder. Over 80 % of respondents said they had received a recommendation from a health professional for vaccination generally during their last pregnancy, primarily a doctor or nurse, to get vaccinated against whooping cough during their current pregnancy (Panama 81 %; Peru 83 %; Colombia 85 %), and this was strongly associated with Tdap vaccination ( $p < 0.01$  for all countries), despite the relatively low immunization rates. A recommendation from a health professional in a previous pregnancy was also associated with vaccination in all countries ( $p < 0.001$  for all countries). Receipt of a reminder was a significant correlate of vaccination in all countries ( $p < 0.001$  for all countries). Certain socio-psychological factors were also consistently found to correlate with vaccination across the three countries, including knowledge of eligibility for vaccination ( $p < 0.05$  for all countries) and of immunization location ( $p < 0.05$  for all countries), perceived vulnerability to infection ( $p < 0.01$  for all countries) and perceived importance of vaccination ( $p < 0.01$  for all countries).

In certain countries, nonvaccinated women were significantly more likely to cite issues with ease of access (Panama, Colombia),

**Table 1**  
Demographic features of the studied respondents by country (n and %).

Characteristic	Panama % (n/325)	Peru % (n/ 305)	Colombia % (n/308)
<b>Religion</b>			
Catholic	63.1 (205)	81 (247)	73.4 (226)
Protestant	8.3 (27)	3.3 (10)	3.9 (12)
No affiliation	12.9 (42)	7.9 (24)	14.6 (45)
Christian	9.8 (32)	4.3 (13)	4.9 (15)
Islamic	0.9 (3)	0.3 (1)	0.3 (1)
Traditional (indigenous)	1.5 (5)	1 (3)	0.6 (2)
Other	3.4 (11)	2.3 (7)	2.3 (7)
<b>Education</b>			
No formal education	4.3 (14)	3.6 (11)	2.6 (8)
Less than high school	4.3 (14)	3.6 (11)	2.9 (9)
High school degree	7.1 (23)	11.8 (36)	21.8 (67)
Bachelor's degree or equivalent	24.3 (79)	17 (52)	17.9 (55)
Business or technical certificate or diploma	7.7 (25)	10.5 (32)	43.8 (135)
College degree	40.3 (131)	41.6 (127)	11 (34)
Postgraduate/higher studies	12 (39)	11.8 (36)	0
<b>Marital Status</b>			
Single (never married)	21.5 (70)	27.9 (85)	21.8 (67)
Married or in a relationship	69.2 (225)	67.9 (207)	71.8 (221)
Widow	0.9 (3)	0	0
Divorced	2.8 (9)	1(3)	1.9 (6)
Separated	4.6 (15)	2.3 (7)	3.9 (12)
Refuse to answer	0.9 (3)	1 (3)	0.6 (2)
<b>During the last pregnancy, did you receive any vaccination?</b>			
Yes	85.8 (279)	84.6 (258)	88.6 (273)
No	10.8 (35)	12.1 (37)	9.1 (28)
Unsure	3.4 (11)	3.3 (10)	2.3 (7)
<b>It is recommended to vaccinate during pregnancy.</b>			
Yes	80.9 (263)	82.6 (252)	84.7 (261)
No	10.8 (35)	11.5 (35)	9.1 (18)
Don't remember	8.3 (27)	5.9 (18)	6.2 (19)
<b>Source of recommendation</b>			
Doctor/Nurse, Other	72.9 (237)	73.8 (225)	77.6 (239)
Midwives	3.4 (11)	1 (3)	2.3 (7)
Pharmacist	2.5 (8)	2.6 (8)	4.2 (13)
Family or Friends	12.9 (42)	16.1 (49)	16.6 (51)
Other	0.3 (1)	2 (6)	-
<b>Vaccine received.</b>			
Influenza	80 (260)	73.4 (224)	76.3 (235)
Tdap	30.5 (99)	30.8 (94)	39 (120)
Neither	2.5(8)	3.6 (11)	6.2 (19)
<b>Location of vaccinations</b>			
Doctor's office	20.9 (68)	9.2 (28)	25.6 (79)
Vaccination Center of the Ministry of Health	46.5 (151)	50.5 (154)	32.1 (99)
Pharmacy	-	0.7 (2)	0.3 (1)
Hospital	14.2 (46)	18.4 (56)	18.8 (58)
Prenatal clinic	3.7 (12)	5.2 (16)	11.0 (34)
Other	0.6 (2)	0.7 (2)	0.6 (2)
<b>During your last pregnancy, did you receive a reminder from a health professional to get vaccinated against Whooping Cough?</b>			
No	24.9 (81)	27.5 (84)	22.1 (68)
Yes	62.2 (202)	61.6 (188)	67.2 (207)
Don't remember	12.9 (42)	10.8 (33)	10.7 (33)

affordability in terms of opportunity costs (Peru, Colombia), and understanding the rationale for vaccination against pertussis in pregnancy (Panama, Colombia).

#### 4. Discussion

This study aimed to provide actionable insights to inform a national strategy to increase maternal Tdap immunization rates in three American countries. Variations in vaccination coverage may relate to a range of social and behavioral factors, cultural norms, or system barriers, including access, costs, and lack of provider recommendation [7,23]. In the current survey of pregnant or recently pregnant people, only 30.5 % of respondents in Panama, 30.8 % in Peru, and 39 % in Colombia reported receiving the Tdap vaccine. These numbers are concerning as recommendations for Tdap in pregnancy began in 2012 for each country [24], and both Tdap and influenza vaccines are currently listed on the vaccination schedule for pregnant women in Colombia [25], Peru [26], and Panama [27] according to WHO reporting. Our results are also far lower than coverage estimates reported by WHO in 2021 of approximately 72.71 % in Panama and 50.3 % in Colombia, yet is more than double the previous estimate of 12.4 % in Peru [5].

Despite the low uptake of the maternal Tdap vaccine, respondents in the current study report similarly high levels of influenza vaccination to the 75 % average in Latin America in 2018 [6], with 80 % of respondents reporting influenza vaccination in Panama, 73.4 % in Peru, and 77.6 % in Colombia. This result implies that there are untapped opportunities for implementing concurrent vaccinations to enhance acceptance of the Tdap vaccine. Previous evidence has demonstrated that this approach effectively boosts vaccine uptake in adolescent and adult populations [8,28]. Research by Alvarez et al. (2017)[29] in the Americas and Fleming et al. in El Salvador (2018)[30] both describe the effectiveness of integrating maternal immunization with other health services and multiple vaccine delivery to improve the costs, access, coverage, and vaccine acceptance during pregnancy. Beyond this, there are many benefits to integrating maternal immunization with other health services, especially considering in 29 LAC countries, around 87 % of pregnant women received four antenatal care visits [30]. This could provide four separate opportunities to educate pregnant women in raising awareness and acceptance of Tdap vaccination through tailored behavior change communication campaigns and providing the vaccines themselves.

It is vital to acknowledge the significant role of healthcare providers in increasing maternal vaccine acceptance, and this has been highlighted repeatedly in the literature, with pediatricians, doctors, and nurses being the primary and most trusted source of vaccine-specific information and recommendations [31–33]. Conversely, healthcare providers influence vaccine delay [34,35]. Furthermore, vaccine hesitancy among healthcare providers has been shown to influence vaccination recommendations to others [36].

Our study observed statistically significant findings of HCP recommendations increasing maternal vaccine acceptance, with 78.2 % of respondents in Panama, 85.6 % in Peru, and 84.8 % in Colombia receiving a recommendation from a healthcare professional to be vaccinated against pertussis. This is similar to the study, which reported that 81.3 % of HCPs in Peru routinely recommended Tdap to pregnant women [37]. Of concern are the high rates of HCP recommendations alongside a low uptake of Tdap observed. Further research should explore this disconnect in more depth to understand the communication strategies being applied by providers and the quality of the consultation about immunization with women (before and during pregnancy). The key to improving vaccine uptake may be that we need to not focus on the 'what' (information) but also help providers to understand who they are talking to (in terms of attitudes, values & position on vaccination) and modulate how they speak to patients (to increase receptivity, decrease reactivity in the person). Lastly, it is critical to understand why an average of 21.8 % of maternal patient providers are not giving a

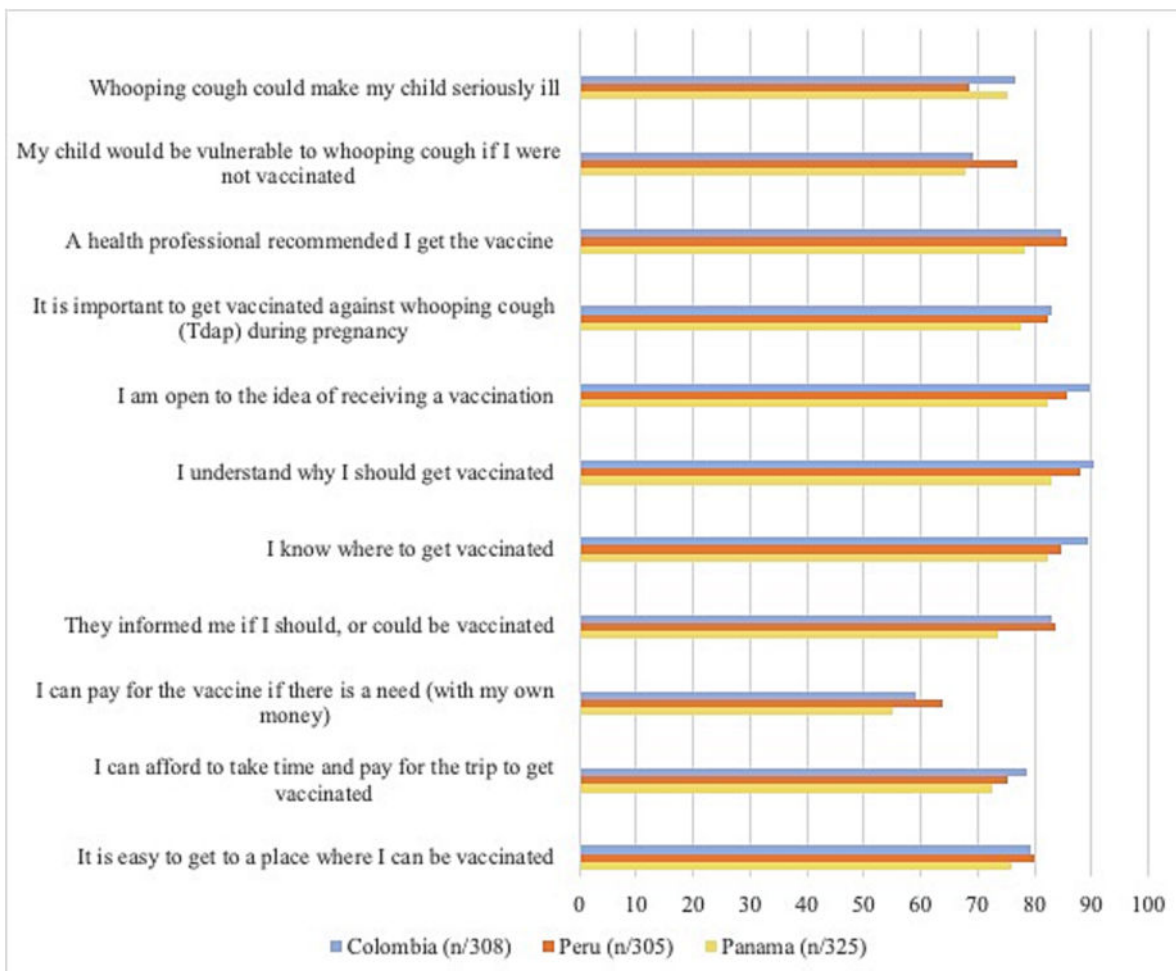


Fig. 1. Determinants of vaccination in Colombia, Peru, and Panama (Percentage of participants who agree/strongly agree).

recommendation.

Another factor strongly associated with not receiving the Tdap vaccine across all the countries (despite respondents receiving a recommendation) was not receiving a reminder, with 64 % of participants having received a reminder from a health professional to get vaccinated against whooping cough (597/938). Research has supported the notion that people are less receptive to information when in a reactive or defensive state than in a receptive frame of mind [38]. To maximize the opportunity for discussions with immunization providers, we propose to 'prime' or prepare pregnant women or parents for conversations about vaccination by sending them a reminder. A study by Byrne et al. (2018) suggests that using well-established recall systems for infant rotavirus vaccination in the UK could explain the higher coverage compared to maternal pertussis vaccination and mitigate missed opportunities and challenges for maternal vaccinations [39]. Further, patient reminder or recall systems are currently one of the most studied, affordable, and prominent intervention strategies to increase vaccination uptake in children and adults [40]. These have been mainly shown to be effective in low to middle-income countries, and the timing and frequency also played a role [41]. Reminders for the patient and healthcare provider in identifying eligible patients is an evidence-based approach to maximize convenience and promote maternal vaccine acceptance [42].

Because of these findings, we strongly recommend a reminder system be set in place specifically for pregnant patients in Latin American countries, including multiple reminders sent throughout their pregnancy with a personalized message aimed at awareness.

Beyond the impacts of healthcare provider recommendations and reminders on respondents' Tdap vaccination status, analysis of

respondents' responses to the 5As taxonomy captured important determinants in respondents' decision to be immunized against pertussis while pregnant. Despite cost being a significant barrier in other studies, it is perhaps unsurprising that being able to afford the vaccine was not associated with Tdap vaccination status in any country analyzed, as it is free for all pregnant women in Peru [37] and Panama [43], and depends on salary and insurance coverage in Colombia. This study's primary barrier was vaccine acceptance, precisely openness, importance, vulnerability, and severity. Overall, those who were unvaccinated against Tdap were more likely not to understand why they should get vaccinated, not to be open to receiving a vaccination, not to find it essential to get vaccinated against whooping cough during pregnancy, and held incorrect beliefs that their child would [1] not be vulnerable to whooping cough and [2] would not get seriously ill from whooping cough. These results highlight the lack of understanding about Tdap vaccine benefits and the risks of vaccine-preventable diseases, and therefore, are less likely to be a priority during pregnancy, which provides important information gaps that need to be addressed in future interventions.

Barriers like these are not unique to Tdap or low-income countries, as significant findings in multiple other studies have highlighted the strong influence that vaccine-specific factors have on final vaccination uptake. For example, a study by Kilich et al. (2020) found that both negative vaccine safety perceptions served as a strong deterrent to influenza vaccine. Conversely, perceptions of vaccine utility, specifically safety for the pregnant mother and perceiving the vaccine as safe in general, were all positive influences on influenza vaccine uptake [44]. Based on the results from this study, we recommend targeted communication to raise

acceptance and awareness of the Tdap vaccine in pregnant women to address the common barriers across each country.

## 5. Limitations

Our study has several limitations. Firstly, as recruitment was explicitly targeted to three Latin American countries, the attitudes and knowledge limit the findings generalizability to other countries despite having many similarities across the results. Secondly, as our survey included self-reports on vaccine status during pregnancy, which for some participants, may have been up to 12 months prior to completing the survey, there may be possible recall bias. This should be limited due to the question not requiring a response and with the inclusion of a 'unsure' option.

Further, although we used a validated tool, we acknowledge the previously identified limitations of the 5A model not being tested for maternal vaccinations or low-income countries [3], however at the time of data collection this is the best model for the purpose of this survey. Racial and ethnic diversity data was not collected; and considering the high rates of indigenous populations in these countries, future research should explore the impact of this on vaccination decisions in order to effectively target public health efforts. Further, similar to other survey studies conducted online, there is a risk of sampling bias, as women who did not have access to technology, the internet, lived remotely, or those who lack computer literacy would be unable to complete the survey.

Finally, the experiences and survey were aimed specifically to the Tdap vaccine and results may not be transferable to attitudes towards other vaccinations. Despite these limitations, the study provides important insights into the behaviors and attitudes of pregnant women and the factors relating to vaccination against whooping cough.

## 6. Conclusion

Vaccination during pregnancy is vital to not only protect the mother but the infant who cannot be vaccinated and remains vulnerable to pertussis. Understanding maternal determinants of Tdap vaccine acceptance during pregnancy is critical in addressing vaccine hesitancy. This study provides important insights into the attitudes and perceptions of mothers in Peru, Panama, and Colombia regarding the Tdap vaccine, and highlights the significant influence of healthcare providers' recommendations and reminders, vaccination behaviors and beliefs, and sociodemographic factors. This study highlights opportunities where support is needed to enhance uptake and where public health strategies and communications can be targeted to address the aspects of vaccine hesitancy in Latin America, where the burden of vaccine-preventable disease is high.

## 7. Declarations

### 7.1. Ethics approval

This study was approved by the UNSW Human Research Ethics Committee (#220657). The Participant Information Statement was made available for download, and the survey was taken as eligible respondents provided informed consent.

## Funding

Hs has received funding from Irimi to support

## Credit authorship contribution statement

**Pippa McDermid:** Formal analysis, Writing – original draft, Writing – review & editing. **Katrina Blazek:** Formal analysis, Writing – review & editing. **Nathan Mougins:** Conceptualization, Writing – review & editing. **Angus Thomson:** Conceptualization, Writing – review & editing.

**Holly Seale:** Conceptualization, Project administration, Supervision, Writing – review & editing.

## Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Holly Seale reports financial support was provided by Irimi. Holly Seale reports a relationship with Moderna Inc that includes: funding grants and travel reimbursement. Nathan Mougins reports a relationship with Irimi that includes: board membership and consulting or advisory. Angus Thomson reports a relationship with Irimi that includes: board membership and employment. Nathan Mougins, Angus Thomson reports a relationship with Sanofi that includes: funding grants. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

Data will be made available on request.

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We want to thank the participants for their time.

## Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.vaccine.2024.01.106>.

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