Vaccine 64 (2025) 127709

Contents lists available at ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

Caregivers' attitudes toward school-based vaccination programs: A comparison of COVID-19, HPV, influenza, and dengue vaccines in Brazil

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ARTICLE INFO

Keywords:
Children
Adolescents
School vaccination programs
Brazil
HPV, dengue
Influenza
COVID-19

ABSTRACT

Background: There is limited data on adult opinions toward school-based vaccination programs, which can supplement clinic-based strategies in the Brazilian public health system. Since 2016, vaccination rates among Brazilian children and adolescents have shown worrisome declines, remaining well below full coverage, including for more recently introduced COVID-19 vaccines. School vaccination programs are not commonly implemented or monitored in Brazil.

Methods: A face-to-face household survey of Brazilians aged 18+ was conducted from July 29 to August 3, 2023. This cross-sectional study used multivariate and ordinal logistic regressions to assess caregiver support for school vaccination programs against COVID-19, HPV, influenza, and dengue.

Findings: Most caregivers stated they would support vaccinating their child at school. However, more guardians were unwilling to have their child or adolescent participate in COVID-19 school vaccination (21.11, 95 % CI, 18.3 %, 23.9 %, $p < 0.001$) compared to dengue (13.60, 95 % CI, 11.2 %, 16.0 %, $p < 0.001$), HPV (13.95, 95 % CI, 11.5 %, 16.4 %, $p < 0.001$), and influenza (12.80, 95 % CI, 10.4 %, 15.1 %, $p < 0.001$). All else equal, factors predicting opinions opposed to vaccinating at school included being a caregiver of only children younger than six and those who self-identify as Evangelical. Except for dengue, women are equally likely to support school vaccination programs as men.

Interpretation: At least one in five Brazilian caregivers of school-aged children is hesitant about participating in COVID-19 school vaccine programs, whereas one in 10 is hesitant about influenza, HPV, and dengue vaccines.

1. Introduction

Vaccination coverage among children and adolescents has declined in recent years across various regions of the world, including Brazil. According to UNICEF and the WHO, for example, only 27 % of adolescent girls globally have received at least one dose of the HPV vaccine, which protects against cervical cancer, in 2023. HPV vaccine coverage remains well below the 90 % target to eliminate cervical cancer as a public health problem, reaching 56 % of adolescent girls in high-income countries and only 23 % in low- and middle-income countries [1]. In Brazil, Ministry of Health (MoH) 2022 estimates suggest that 57.4 % of adolescent girls received two doses [2].

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https://doi.org/10.1016/j.vaccine.2025.127709
Received 7 August 2024; Received in revised form 18 August 2025; Accepted 1 September 2025
Available online 9 September 2025

Table 1
Brazil: immunization doses, eligibility, availability and coverage rates in SUS for Influenza, HPV, COVID-19, and dengue vaccines, 2023.

	Influenza	HPV	COVID-19	Dengue
Number of Recommended Doses	Six months to Eight years old [32]: Two doses for first immunization; annual dose Nine to 18 years old: One annual dose	Nine to 14 years old [33]: Two doses 15 to 18 years old: Three doses	Six months to four years old [34]: Three monovalent doses Five to 11 years old: Two monovalent doses 12 to 18 years old: Three monovalent doses	Two doses
Age Groups Eligible	Six months and older in priority groups	Nine to 14 years old, and people with special medical conditions	Six months and older	Four years and older
Year Vaccine granted Emergency Use and/or incorporated in PNI	1999	2014	Emergency Use: 2021 PNI: 2024 (after the survey)	December 2023 (after the survey) [35]
Coverage, Brazil (2022) [10,30]	More than six months to 9 years (58.48 %) [32]	Nine to 14 years (1st dose: 75.9 % females; 52.30 % males) Nine to 14 years (2nd dose: 57.4 % females; 36.6 % males) [21]	Six months to two years (2nd dose: 13.80 % and 3rd dose: 6.30 %) 3–4 years (2nd dose: 22.8 % and 3rd dose: 6.5 %) 5–11 years (2nd dose: 55.8 % and 3rd dose: 12.6 %) 12–17 years (2nd dose:82.7 % and 3rd dose:33.7 %) [34]	··
School Level during Vaccination Eligibility	Early childhood education; Primary education; Secondary education	Primary education; Secondary education	Early childhood education; Primary education; Secondary education	Primary education; Secondary education

·· Dengvaxia was approved by Anvisa, Brazil's regulatory authority, in 2015. As of July 2024, the vaccine was only authorized in individuals who had a previous dengue infection and was not incorporated into the PNI or used in mass in Brazil except in the state of Parana [36]. Qdenga was approved by Anvisa in December 2023, nearly six months after the July/August survey.
Source: Brazil. Ministry of Health [37,38].

In Brazil, reversals of historically high vaccination coverage rates were also detected in the last decade by the National Immunization Program (*Programa Nacional de Imunizações* – PNI), which provides free vaccination to all residents in Brazil as part of the Brazilian Unified Health System (*Sistema Único de Saúde* - SUS) [3]. For example, the rate of first dose of DTP vaccine coverage declined from 91 % in 2013 to 64.3 % in 2016 [3]. Furthermore, the decline in coverage was especially marked for vaccines against diseases that required more than one dose. Only 53.7 % of four-year-olds had the second dose of the DTP vaccine to protect them against diphtheria, tetanus, and pertussis in 2019. During the COVID-19 pandemic, vaccination coverage was further reduced by the interruption in routine and non-essential health services and the decline in on-site health consultations [4]. In 2021, 63 % of infants less than one year of age had received a DTP vaccine, and 57.7 % of four-year-olds had received the second DTP dose [3].

Moreover, these trends were also affected by former President Bolsonaro's policies, which questioned the urgency and delayed the procurement and rollout of COVID-19 vaccination in children and adolescents throughout 2021 and 2022 [5]. On February 23, 2021, ANVISA granted the first full authorization with a two-dose regimen of BNT162b2 (Comirnaty, Pfizer-BioNTech) for individuals 16 years or older. ANVISA authorized BNT162b2 (Comirnaty, Pfizer-BioNTech) for adolescents aged 12–17 in June 2021 and for children aged 5–11 in December of the same year [6]. On the 20th of June, the Coronavac vaccine received ANVISA approval for emergency use in the six to seventeen age group [7]. Notably, ANVISA stressed that there was insufficient data to authorize this vaccine for children aged three and four. Sinovac's CoronaVac vaccine was licensed for children three years and older in July 2022. Vaccination was approved for children from six months to two years old with two doses of mRNA1273 (Spikevax, Moderna) in December 2022. However, prior and after the approval of COVID-19 vaccines for children in Brazil, then-President Jair Bolsonaro [5] and his allies voiced concerns about side effects, and organized public hearings allowing medical experts opposing vaccination for children to air their views alongside proponents [8].

Following the inauguration of Luiz Inacio 'Lula' da Silva, the Ministry of Health included a three-dose regimen against COVID-19 for children six months to four years of age and a two-dose regimen for children five to 11 years of age in the National COVID-19 Vaccination Operational Plan (PNO) in January 2023. State and local governments also enacted sustained efforts to reverse declining vaccination coverage. However, improvements in vaccination coverage for children remain limited for many vaccines, including those that protect against COVID-19 [9]. In 2025, the Ministry of Health estimated that for infants 6 months old to two years of age, three-dose vaccination coverage was 12.5 % [11–13]. For children aged 3 to 4 years, 16.24 % had received three doses, and for children aged 5 to 11 years, coverage was 24.5 %.

School vaccination programs have gained attention as one of the most effective strategies to increase immunization coverage for school-aged children and adolescents [14]. Data on school vaccination programs collected by the WHO show that an increasing number of countries declare that routine doses of vaccines on the national immunization schedule are regularly delivered to children at school [15]. Notably, 14 countries in Latin America reported running these programs in 2022. However, Brazil, Colombia, the Dominican Republic, Nicaragua, and Uruguay reported to the WHO that they did not run school vaccination programs.

Published evidence has emphasized that parental support is crucial for school vaccination programs to be effective [16]. To identify whether caregiver adherence to school vaccination is conditional on vaccine type, we surveyed adults who are the guardians of children in the household to assess support for school vaccination programs in Brazil. Specifically, guardians were asked about their willingness to support school vaccination for four infectious diseases: influenza, HPV, COVID-19, and dengue. To the extent that school vaccination programs existed before or during the study, they were sporadic and limited to specific municipalities.

Table 2
summary statistics for caregivers of children and adolescents aged 17 and younger.

	Unweighted Sample (%)	Weighted Sample (%)
Region		
Central-West	8.0	9.1
North	11.7	11.0
Northeast	24.4	25.0
South	15.8	15.9
Southeast	40.1	39.0
Gender		
Male	45.3	46.4
Female	54.7	53.6
Age Group		
18 to 24 years	9.7	9.2
25 to 34 years	32.4	32.2
35 to 44 years	34.7	35.3
45 to 59 years	20.7	20.5
60 years and older	2.6	2.8
Education		
Up to Primary School	28.6	33.4
At least some High School	51.3	46.4
College Education	20.1	20.2
Household Income (M.S. = Minimum Salaries)		
Up to 2 M.S.	47.1	39.7
From 2 to 5 M.S.	34.3	39.5
Over 5 M.S.	18.6	20.8
Skin Color/Race		
Black/Brown	71.0	70.7
White	25.9	26.1
Asian/Indigenous	3.1	3.1
Religion		
Catholic	47.8	49.5
Non-Denominational	15.7	14.5
Protestant/Evangelical	33.2	32.5
Other	3.4	3.5
School Vaccination Program Eligibility		
Caregiver of Only Infants and Young Children (Age 0–5)	22.6	21.2
Caregiver of Only School-Age Eligible Children (Age 6+)	57.0	57.1
Caregiver of both Young and School-Age Eligible Children	20.4	21.3
% Caregivers who will not authorize child participation in a School Vaccination Program		
Influenza	12.8	12.8
HPV	13.3	14.0
COVID-19	19.9	21.1
Dengue	13.6	13.6
	Unweighted Sample (Mean)	Weighted Sample (Mean)
Caregiver Age	42.9	37.6
Number of Children	2.3	2.2
Overall School Vaccine Hesitancy	0.7	0.7
Total	779	779

2. Methods

2.1. Study population and data collection

The face-to-face household survey was conducted in a nationally representative sample of Brazilians 18 years or older between July 29 and August 3, 2023. The selected households were chosen using the 2010 census sectors from the Brazilian Institute of Geography and Statistics (IBGE) [17]. The survey design was based on a three-stage cluster sampling design. In the first stage, a random sample of municipalities was selected considering the population living in the five regions of Brazil: North, Northeast, Southeast, South, and Central-West. In the second stage, a random sample of census sectors was selected within these regions considering population. In the third stage, a sample of residents was interviewed, considering quotas for gender, age group, level of education and household income. The survey sample resembles the overall Brazilian population, except for a higher share of individuals reporting receiving lower household income (less than two minimum salaries) and a lower proportion with some primary schooling (see Table 1 in Supplementary Materials). Skin color and religious affiliation were self-reported by respondents. The survey questionnaire is detailed in Portuguese and English in the Supplementary Materials.

In this study, we analyzed the answers of those respondents in the survey who are caregivers of children 17 years or younger ($n = 779$). Primary schooling begins at age six in Brazil. Among guardians in the survey, 78.8 % ($n = 604$) have children between six and 17 who are thus eligible to receive vaccines in school programs.

Caregivers were asked if they would allow (or not allow) their children to get vaccinated if there was a school vaccination campaign to protect against four infectious diseases. The influenza vaccine has been provided since 1999 by the National Immunization Program (NIP). The target population typically consists of children five years of age and younger and the elderly population over 60. However, during the 2009 H1N1 pandemic, adolescents were the target group for influenza vaccination. The HPV vaccine has only been provided to a more restricted age group (nine to 14 years old) since 2014. COVID-19 vaccines were gradually introduced to children in specific age groups in 2021 and were only authorized for emergency use in 2023. The dengue vaccine was approved in December 2023 (after the survey) and offered to children aged 10 to 14 in SUS. Our research design had two purposes. First, we examine whether the federal government's interventions to discourage COVID-19 vaccination affected attitudes toward school vaccination against this disease, compared to routine vaccines that had a more extended history of administration by the NIP. We selected three vaccines available in SUS: two of which were available before the COVID-19 pandemic (influenza and HPV), and COVID-19 vaccines that were still only licensed on an emergency basis in 2023. Second, we investigated whether a caregiver's attitudes toward authorization of school vaccination are contingent on vaccines already authorized in Brazil's public health system (SUS) by regulatory authorities. To do so, we asked caregivers about their willingness to allow the children under their responsibility to be vaccinated against dengue even though a vaccine had not yet been approved and was not yet available in SUS.

A substantial majority of caregivers (94.3 %) were willing to respond to the four questions regarding school vaccination campaigns. However, for each vaccine, a relatively small number of caregivers (1.75 % for influenza, 2.94 % for HPV, 1.21 % for COVID-19, and 2.4 % for dengue) did not know or did not wish to answer whether they would allow their children to be vaccinated in school-based campaigns. Due to the small number of missing data, these responses were maintained as missing and are therefore excluded from the analysis.

2.2. Statistical analysis

Logistic regressions were estimated to obtain caregivers' predicted probabilities of allowing their children to get vaccinated in school

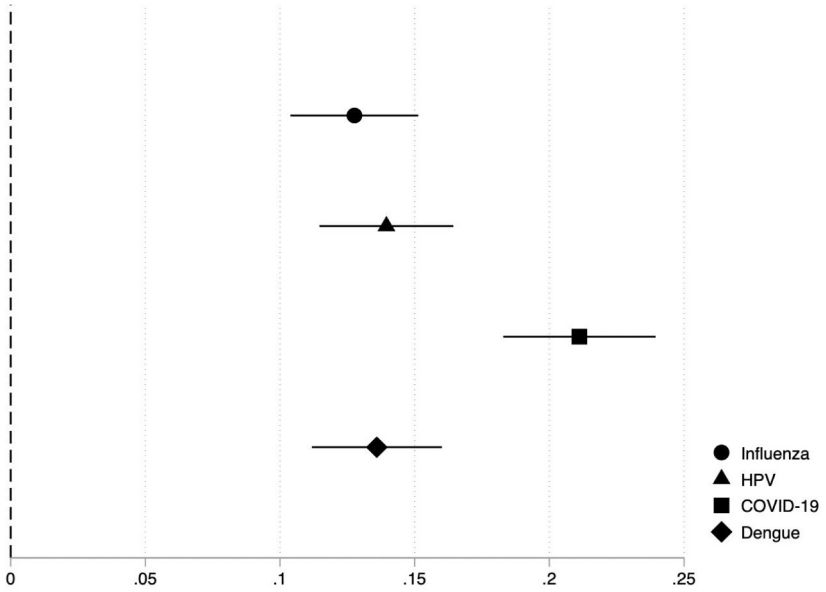

Fig. 1. Predicted Probabilities of Caregivers' Unwillingness to Participate in School Vaccination for the Influenza, HPV, COVID-19, and Dengue Vaccines, 2023[1].
Notes: Predicted probabilities are calculated based on the estimates reported in Table 3.

settings. The response variable was caregiver unwillingness to permit children to receive one of four vaccines (influenza, HPV, dengue, and COVID-19) at school. In these models, the explanatory variables were self-declared skin color (white, black/brown, and Asian/Indigenous descent), Brazilian macro-regions (North, Northeast, Southeast, South, and Central-West), age (18 years or older), education level (up to primary, at least some high school, at least some college education), religious affiliation (non-denominational, Catholic, Evangelical/Protestant or other religious groups), number of children in the household, household income (0 to 2 minimum salaries, more than two to five minimum salaries and more than five minimum salaries), whether the caregiver's children are only six years or older (eligible for school vaccination programs) and whether the caregiver's children are only five years or younger (not yet eligible for school vaccination programs). Caregivers with both younger and older children in the household are the reference category.

Several response categories were grouped for most explanatory variables. We followed Brazilian census questionnaires to ask respondents to self-declare their skin color and/or racial identification. The same census question was employed in this survey [18]. We also grouped religious affiliation, considering academic and census practices [19]. The grouping of education categories aims to identify whether there are differences in caregivers who have attained basic, secondary, and tertiary education [20].

A small percentage of caregivers did not wish to declare their skin color ($n = 15$, 1.9 %) or religion ($n = 9$, 1.16 %). For the analyses below, we assigned the median value for missing values for these characteristics. No missing responses for the other explanatory variables were reported in this study. Sampling weights are included. Using a G-computation approach, we employ the marginal odds ratio (MOR) to evaluate logit coefficients, retaining an odds ratio interpretation [21].

To examine the intensity of caregiver attitudes opposing school vaccination, an ordinal variable was generated based on the summation of the number of vaccines caregivers stated they were unwilling to authorize their children to receive in educational facilities. The minimum score was 0, indicating that the parents were willing for their children to receive the four vaccines at school. The maximum score of four represents cases where parents stated that they were unwilling for their child to receive all four vaccines (influenza, HPV, dengue, and COVID-19 vaccines) at school. A multivariate ordinal logistic regression was estimated to verify which parental traits were associated with higher reluctance to support vaccination at school.

As a robustness exercise, the analysis was repeated, including parents who did not know or did not respond to school vaccination queries, in the group of caregivers expressing opposition to school vaccination. The statistical analysis was conducted using Stata 18.0 and R 4.3.1.

2.3. Ethics statement

This study protocol was reviewed and approved by the Ethics Committee at Instituto Pensi (Process N° 6,124,542). All participants verbally consented to the research and signed consent forms were recorded. The questionnaire is presented in the Supplementary Materials.

3. Results

Vaccines within SUS were available for children and adolescents for influenza, HPV, and COVID-19 in 2023. A dengue vaccine was made available through SUS in 2024 after the survey. Table 1 summarizes information about these four vaccines, including the recommended doses, age group eligibility, the year in which the Ministry of Health (MoH) included the vaccine in its calendar, and the level of coverage for eligible children and adolescents at the end of 2023. Notably, in 2023, the 95 % coverage target stipulated by the Brazilian MoH was not attained by any of the three vaccines (influenza, HPV, or COVID-19) available at the time. Among these vaccines, the lowest coverage was observed for COVID-19 vaccines, with the lowest rates observed for infants and children less than five years of age [20].

The survey included 779 caregivers (mean [SD] age, 38 [10] years); 354 men [46.4 %]; 203 white [26.1 %], 553 [70.7 %] Black/Brown, and 23 [3.1 %] Asian or Indigenous). Of the total, 312 [39.0 %] reside in the Southeast region, 188 [25.0 %] in the Northeast, 123 [15.9 %] in the South, 90 [11.0 %] in the North, and 66 [9.1 %] in the Center-West. There were 221 [33.4 %] respondents who had some or completed primary schooling, 398 [46.4 %] with at least some secondary education and 160 [20.2 %] with at least some college education. At the time of the survey, the monthly minimum salary was R$1303, and 364 [39.7 %] of caregivers reported receiving less than two minimum salaries, while 266 [39.5 %] received between two to five minimum salaries and 149 [20.8 %] received more than five (income greater than R$ 6600). On average, caregivers were responsible for two children. Table 1 in the

Table 3
Logit with Odds Ratio of Parental Opposition to School Vaccination.

	Influenza		HPV		COVID-19		Dengue	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Region								
Southeast (*ref.*)	1	(.)	1	(.)	1	(.)	1	(.)
Northeast	1.237	(0.376)	0.885	(0.259)	1.142	(0.284)	1.281	(0.391)
Central-West	1.206	(0.511)	1.351	(0.507)	1.297	(0.437)	1.400	(0.536)
North	1.025	(0.426)	0.519	(0.232)	0.608	(0.226)	0.663	(0.312)
South	1.088	(0.368)	0.735	(0.251)	0.984	(0.280)	1.264	(0.412)
Education Level								
At least some Primary (*ref.*)	1	(.)	1	(.)	1	(.)	1	(.)
At least some High School	1.174	(0.335)	0.865	(0.252)	1.469	(0.359)	1.124	(0.318)
At least some College	0.706	(0.283)	0.579	(0.226)	1.151	(0.375)	0.967	(0.361)
Skin Color/Race								
White	0.998	(0.266)	0.778	(0.209)	1.098	(0.245)	1.083	(0.278)
Black/Brown (*ref.*)	1	(.)	1	(.)	1	(.)	1	(.)
Asian/Indigenous	0.843	(0.567)	1.106	(0.671)	1.236	(0.616)	0.996	(0.575)
Age Group								
18–24 years	0.736	(0.368)	0.649	(0.303)	0.727	(0.282)	0.471	(0.268)
25–34 years	0.959	(0.268)	0.851	(0.244)	0.960	(0.232)	0.990	(0.279)
35–44 years (*ref.*)	1	(.)	1	(.)	1	(.)	1	(.)
45–59 years	1.402	(0.435)	0.638	(0.220)	1.029	(0.280)	1.025	(0.326)
60+	0.489	(0.537)	0.345	(0.384)	0.328	(0.366)	0.412	(0.484)
Religion								
Non-denominational	1.388	(0.488)	1.556	(0.520)	0.705	(0.217)	1.381	(0.498)
Catholic (*ref.*)	1	(.)	1	(.)	1	(.)	1	(.)
Evangelical	1.813**	(0.466)	1.578*	(0.403)	1.830***	(0.378)	2.096***	(0.535)
Other Religion	2.914*	(1.658)	1.240	(0.832)	1.477	(0.845)	2.476	(1.525)
Household Income (M.S. = Minimum Salaries)								
0 to 2 Minimum Salaries (MS) (*ref.*)	1	(.)	1	(.)	1	(.)	1	(.)
>2 to 5 MS	0.953	(0.269)	1.238	(0.332)	0.975	(0.227)	0.949	(0.256)
>5 MS	0.915	(0.294)	0.911	(0.292)	0.914	(0.247)	0.838	(0.287)
Gender								
Male	0.791	(0.186)	1.100	(0.256)	0.838	(0.164)	0.568**	(0.140)
Female (*ref.*)	1	(.)	1	(.)	1	(.)	1	(.)
Caregivers of younger children (< 6 y.o.)								
No children 0–5 (*ref.*)	1	(.)	1	(.)	1	(.)	1	(.)
Parent of 0–5	1.843**	(0.535)	2.079***	(0.587)	2.846***	(0.700)	1.959**	(0.560)
Caregivers of older children (6+ y.o.)								
No children 6+ (*ref.*)	1	(.)	1	(.)	1	(.)	1	(.)
Parent of 6+	1.523	(0.585)	1.258	(0.450)	1.385	(0.433)	1.919	(0.767)
Number of Children	0.923	(0.0985)	0.928	(0.104)	0.891	(0.0845)	0.965	(0.106)
Observations	766		757		769		760	

Note [1]:* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. [2] OR = Odds Ratio, SE = Standard Error.

Supplementary Materials presents the summary data of the sample population and how they compare to the target population. Table 2 reports the proportion or means with and without sampling weights for the subsample of parents with children aged 17 and younger, which is the study population.

Most caregivers stated they would support vaccinating their child at school. However, multivariate logistic regressions indicate that a higher proportion of parents are unwilling to have their children participate in COVID-19 school vaccination (21.11, 95 % CI, 18.3 %, 23.9 %, $p < 0.001$) compared to dengue (13.60, 95 % CI, 11.2 %, 16.0 %, $p < 0.001$), HPV (13.95, 95 % CI, 11.0 %, 16.0 %, $p < 0.001$), and influenza (12.8, 95 % CI, 10.4 %, 15.1 %, $p < 0.001$). Fig. 1 confirms that the difference in the percentage of guardians stating they would be unwilling to allow their children to participate in school vaccination programs for influenza, HPV, and dengue is not statistically significant. In contrast, the percentage of caregivers who stated they would not allow their children to participate in a school vaccination program for COVID-19 is much higher than for these other three vaccines.

Of the 779 caregivers with children 17 or under in the survey, 175 [21.2 %] were only raising children aged five and younger, 438 [57.1 %] were only raising children aged six and up in the household, and 166 [21.3 %] reported having children 0–5 and older than 6 in their families. Table 3, reporting the results of the multivariate logistic regressions for each vaccine type, confirms that the reluctance to support vaccinating at school increases in households where caregivers only have children younger than six in the household. Caregivers of younger children (< 6 y.o.) were more likely to express an unwillingness to grant permission for their children to participate in school vaccination against COVID-19 (OR 2.85 95 % CI 1.76–4.61, $p < 0.001$), HPV (OR 2.08, 95 % CI 1.20, 3.62, $p = 0.010$), dengue (OR 1.96, 95 % CI 1.12–3.43, $p = 0.020$) and influenza (OR 1.84, 95 % CI 1.04–3.26, $p = 0.035$).

To illustrate the magnitude of the increased reluctance to support

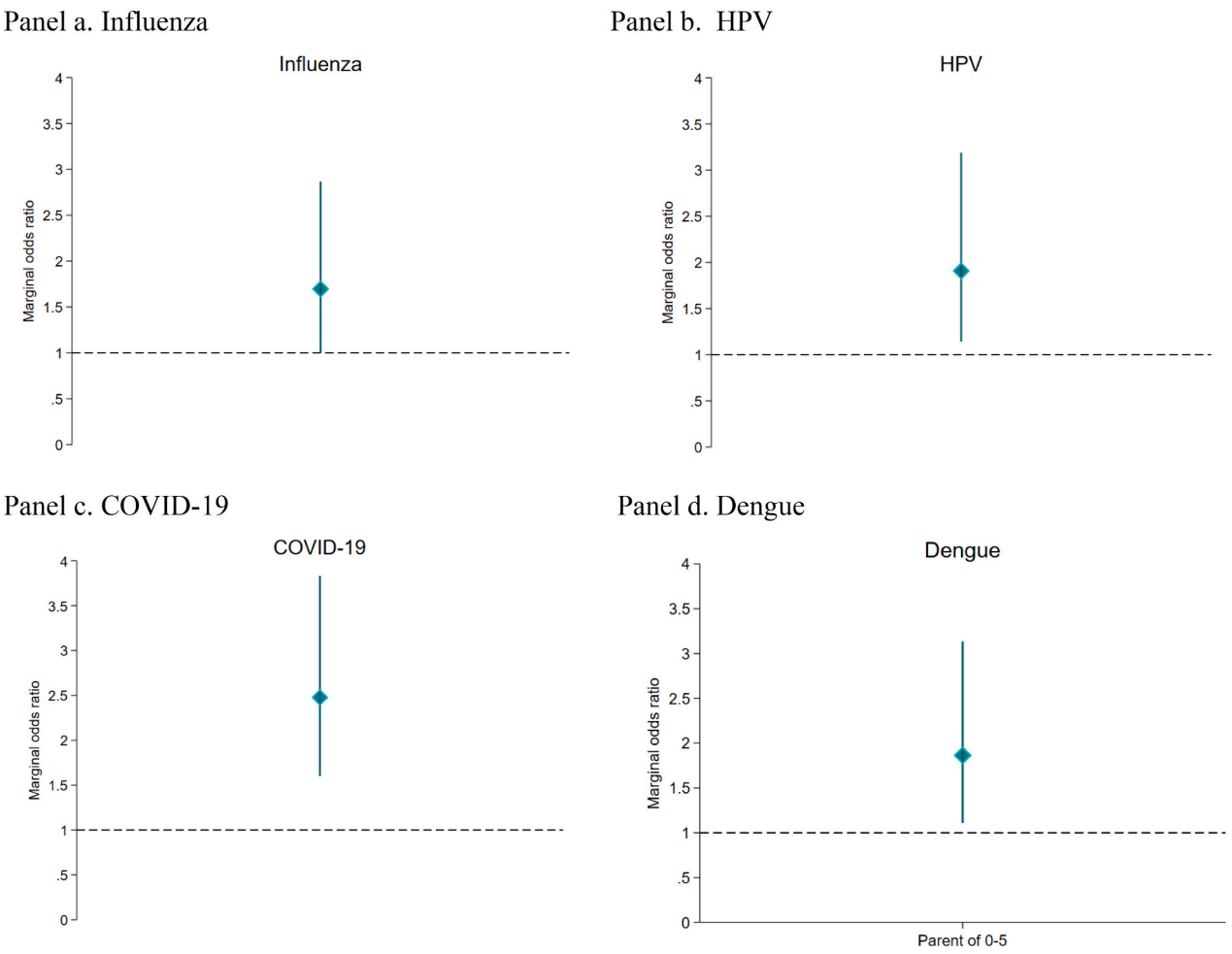

Fig. 2. Marginal Odds Ratios (MOR) for Caregivers with children under six. (Dependent variable: Unwillingness to participate in School Vaccination program for each respective vaccine).
Notes: Marginal odds ratios and the 95 % confidence intervals are calculated based on the coefficient estimates reported in Table 3.

school vaccination in caregivers who only have children aged zero to five, we calculated the Marginal Odds Ratio (MOR) of being a parent of younger children. Fig. 2 reports the MOR for each vaccine. Guardians who are only caregivers of younger children expressed an unwillingness to vaccinate their children at school against influenza (MOR 1.69, 95 % CI 1.00–2.87, $p = 0.048$), HPV (MOR 1.91, 95 % CI 1.14–3.19, $p = 0.014$), COVID-19 (MOR 2.48, 95 % CI 1.60–3.83, $p = 0.000$) and dengue (MOR 1.86, 95 % CI 1.11–3.14, $p = 0.019$).

Nearly half of the caregivers ($n = 358$, 49.2 %) identify as Catholic. The second most common religious affiliation is Evangelical/Protestant ($n = 245$, 32.5 %). In addition to these two religious faiths, 116 (14.9 %) parents identify as non-denominational, and 25 (3.4 %) follow another religion, including the Jewish and Afro-Brazilian faiths. Fig. 3 reports the MOR using Catholic caregivers as the baseline category [22]. Evangelical caregivers expressed an unwillingness to vaccinate their children at school against influenza (MOR 1.79, 95 % CI 1.09–2.95, $p = 0.021$), HPV (MOR 1.56, 95 % CI 0.96–2.54, $p = 0.075$), COVID-19 (MOR 1.77, 95 % CI 1.20–2.60, $p = 0.004$) and dengue (MOR 2.05, 95 % CI 1.26–3.34, p = 0.004).

Research studies have generally identified that Brazilian female caregivers are more likely to support infant, child, and adolescent vaccination [13]. However, to the best of our knowledge, this is the first study that evaluates whether caregivers trust vaccination to occur at school. For influenza, HPV, and COVID-19, female and male caregivers were equally likely to support school vaccine programs, all else being equal. In the case of dengue, however, male caregivers were more willing to have their child or adolescent vaccinated at school (OR 0.58, 95 % CI 0.36–0.91, $p = 0.019$) (see Fig. 4 for marginal odds ratios). In other words, the odds for women caregivers are about 76 % higher than the odds for men.

Using a measure of overall caregiver attitudes toward the administration of vaccines at school based on these four vaccines, there are 7.5 % ($n = 59$) of guardians who are unwilling to allow their children's participation in a school vaccination program. There are 4.2 % ($n = 32$) and 3.8 % ($n = 30$) who expressed unwillingness to authorize school vaccination for two and three vaccines, respectively. Furthermore, there are 10.6 % ($n = 82$) who are only opposed to school vaccination for one vaccine, and 74.0 % ($n = 576$) who support that their child receive all four vaccines at school. This data suggests that there are vaccine-specific factors that influence parental reluctance to participate in school vaccination, reinforcing earlier findings. At the same time, there is also a smaller number of parents with a more intense opposition to school-based vaccination programs.

Table 4 reports the results from a multivariate ordinal logistic regression using the intensity of opposition to school vaccination (ranging from 0 to 4) among caregivers. The odds of being increasingly opposed to school vaccination programs increase by 2.09 (95 % CI 1.350–3.257, $p = 0.001$) for caregivers having only younger children at home (less than six years of age), holding all the other parent and household characteristics constant. The odds of being unwilling to permit children to be vaccinated at school are 1.75 (95 % CI 1.200–2.560, $p = 0.004$) greater for guardians who identify themselves

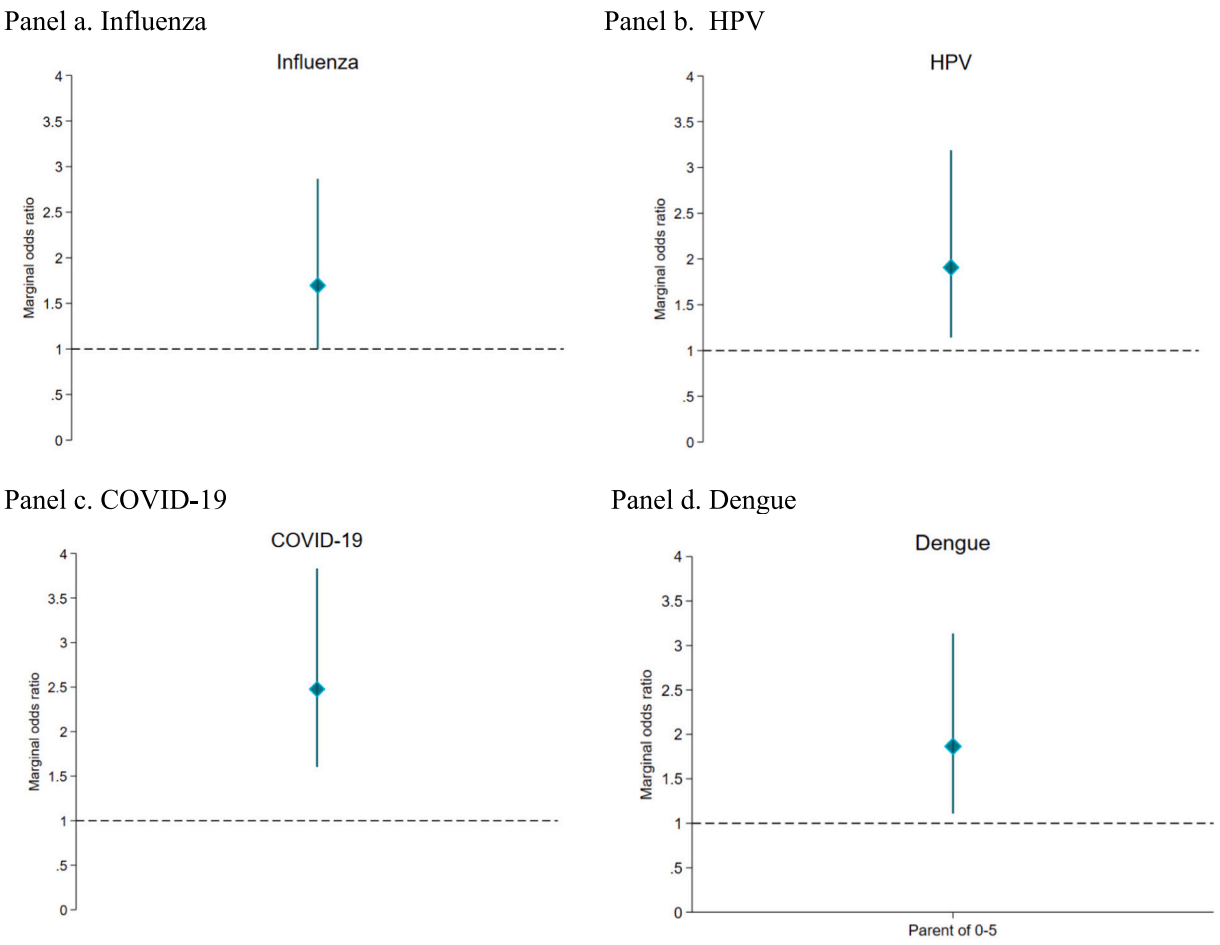

Fig. 3. Marginal odds ratios (MOR) for influenza, HPV, COVID-19 and dengue: caregivers identifying as evangelical, non-denominational and other religious affiliation (Reference Category: Catholic) (Dependent variable: Unwillingness to participate in School Vaccination program for each vaccine).
Notes: Marginal odds ratios and the 95 % confidence intervals are calculated based on the coefficient estimates reported in Table 3.

as of the Evangelical faith. There are no statistically significant differences for caregivers living in specific regions of the country, nor for given income or education levels.

4. Discussion

School vaccination programs remove obstacles in immunization programs that rely on primary care delivery, such as reducing the costs to access vaccines and primary care and the opportunity costs for parents who must travel to health providers during regular work hours [23,24]. Moreover, school vaccination programs have also been recognized as effective in blocking transmission during outbreaks [23,24]. Through these programs, governments and public health authorities have sought to provide additional immunization opportunities to initiate or complete infant and early childhood vaccination and ensure that vaccines targeted only for older children and adolescents, such as HPV, reach this population.

Adolescents, who typically fall outside the scope of traditional childhood vaccination programs, are recognized as a challenging demographic group to reach through conventional immunization strategies [25,26]. School-based vaccination programs, particularly in the context of HPV vaccination, have been identified as an important opportunity to increase protection of teenagers [12,13]. HPV vaccination campaigns organized in schools in Colombia and Nigeria suggest that significant challenges remain to ensuring these programs achieve higher vaccination coverage. In both settings, researchers found that HPV vaccine introduction should be tailored to address community concerns with clear messaging, appropriate delivery, and targeted advocacy.

Thus far, studies examining the effectiveness of school vaccination programs have been concentrated in developed countries, where school attendance rates are higher among children and teenagers, which, in turn, favors the successful implementation of school vaccination programs [27]. In these settings, vaccination stakeholders, such as school personnel, adolescents, and parents, have expressed satisfaction with school vaccination. Nevertheless, research in these settings underscores that caregiver concern with vaccine safety remains a significant barrier to adherence to school-based vaccination. Accordingly, efforts have been directed at ensuring parents have sufficient information about vaccines and their long-term safety in school settings.

To the best of our knowledge, this is the first study to focus specifically on what factors are associated with a caregiver's attitudes regarding authorization for their children to be vaccinated at school in a developing country that counts on a well-developed public health system. The survey applied the questions on school vaccination to those adults in the households who confirmed they were responsible for raising children. Thus, it captures the attitudes toward school vaccination of guardians who may not be a child's biological parents in Brazil. In Brazil, an estimated 26 million children are enrolled in primary education, and 7.6 million adolescents are enrolled in secondary education, according to data from 2023 [28]. Thus, school vaccination programs have the potential to guarantee that vaccination programs reach a significant portion of children.

In 2025, after this study was completed, the MoH and the Ministry of Education of the Lula Administration announced a new initiative to

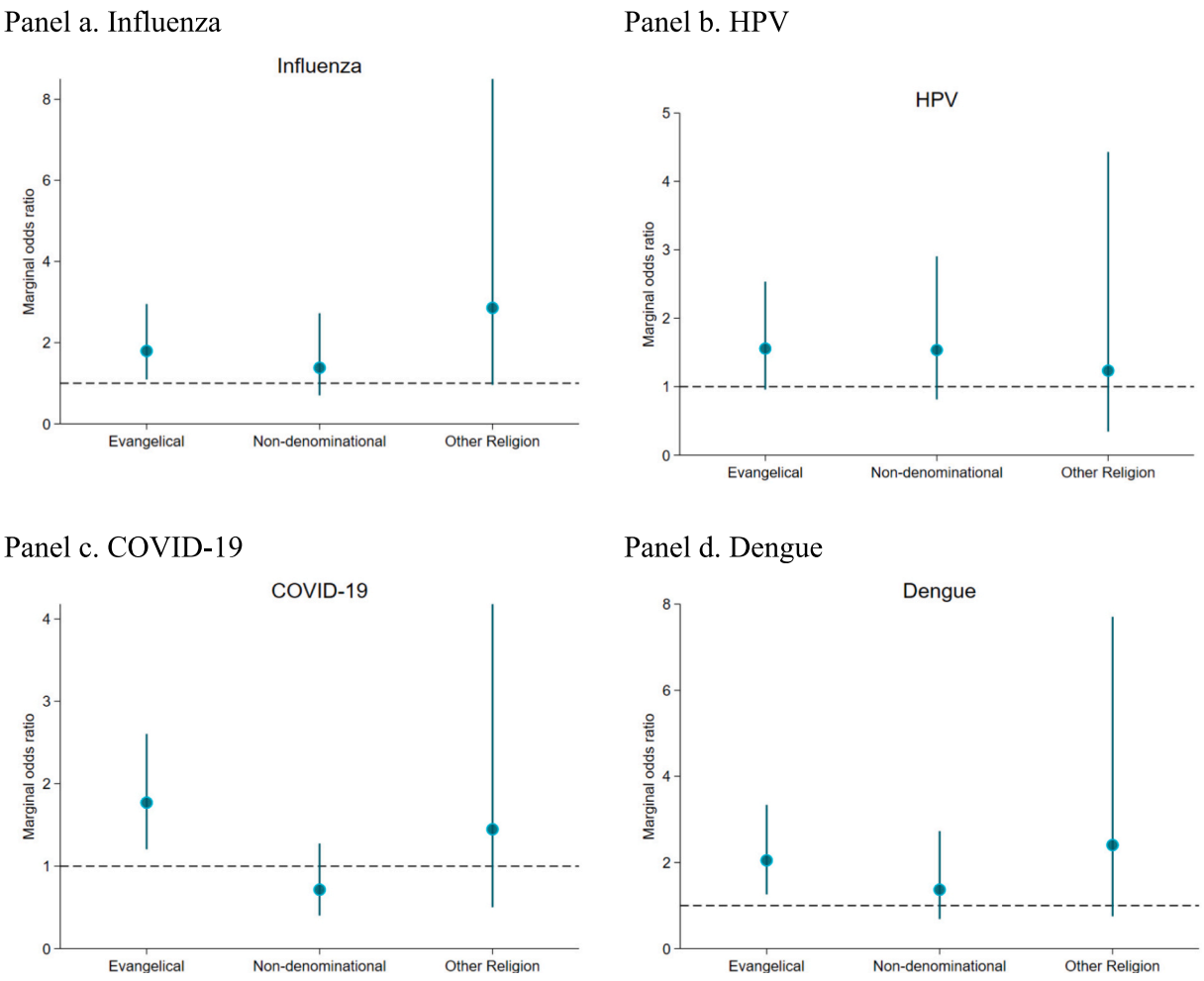

Fig. 4. Marginal odds ratios (MOR) for Influenza, HPV, COVID-19 and Dengue: Self-identified female caregivers (Dependent variable: Unwillingness to participate in School Vaccination program).
Notes: Marginal odds ratios and the 95 % confidence intervals are calculated based on the coefficient estimates reported in Table 3.

implement nationwide school vaccination programs targeted at specific vaccines, including dengue, HPV, yellow fever, DPT, and MMR vaccines [29]. At the time of the survey, the National Health Surveillance Agency (ANVISA) had not yet approved a dengue vaccine, nor was it widely available in SUS or employed in municipal school vaccination programs. Since no significant differences were observed in the percentage of caregivers unwilling to authorize their children to receive a dengue vaccine compared to influenza and HPV, the results provide evidence that a caregiver's opposition to school vaccination is not conditional on whether the vaccine was incorporated into the PNI or the duration since its inclusion.

Our results confirm that caregivers are more apprehensive about supporting children and adolescents receiving COVID-19 vaccines at school than influenza, HPV, and dengue. This apprehensiveness is best understood in the context of Brazil's pandemic. COVID-19 vaccines were gradually authorized for the five youngest age groups, with age significant differences in age group eligibility depending on vaccine type [30]. In 2021 and 2022, the president and the Bolsonaro administration's MOH downplayed the risk of COVID-19 disease for children, questioned the safety of vaccines, emphasizing side effects, and opposed mandatory vaccination of adolescents and children in violation of the Child and Adolescent Statute (ECA – Law No. 8.069/1990) [5]. Following the approval by ANVISA of COVID-19 vaccines for children aged 5 to 11, former President Bolsonaro criticized the regulatory agency, and the MOH organized a public consultation and hearings where scientists opposed to COVID-19 vaccination could share evidence on the risks for children in December 2021 [30]. When the MOH authorized vaccines in January 2022 for this age group, the government insisted that written parental consent be obtained by public health clinics, even though written permission is not required for other vaccines provided to children by the PNI.

The survey results confirm that stronger religious affiliation with Evangelical religions predicted more negative attitudes toward each vaccine, confirming research that has documented a positive correlation between religion and reluctance to vaccinate children in school-based programs. In England, a novel study on the coverage of school-delivered vaccines among adolescents used school-level variables to examine associations between vaccine coverage and school type or faith affiliation. The study showed that Muslim and Jewish schools had significantly lower coverage than schools of no religious character for HPV [31].

5. Limitations

This study used a representative sample based on face-to-face survey interview data and has provided valuable data for understanding attitudes toward school vaccination programs. There are some important limitations to this study. First, the survey asked caregivers about their willingness to participate in school vaccination programs. The findings reported in this study should not be interpreted as implying that guardians are necessarily hesitant about vaccination in general. For instance, guardians might prefer to vaccinate their children at a

Table 4
Ordinal Logit with odds ratio of parental opposition to school vaccination.

	Coefficient	SE
Region		
Southeast (*ref.*)	1	(.)
Northeast	1.162	(0.267)
Center-West	1.393	(0.416)
North	0.754	(0.252)
South	0.980	(0.253)
Education Level		
At least some Primary (*ref.*)	1	(.)
At least some High School	1.050	(0.234)
At least some College	0.797	(0.229)
Skin Color/Race		
White	1.066	(0.213)
Black/Brown (*ref.*)	1	(.)
Asian/Indigenous	0.987	(0.523)
Age Group		
18–24 years	0.773	(0.263)
25–34 years	0.910	(0.202)
35–44 years (*ref.*)	1	(.)
45–59 years	0.945	(0.234)
60+	0.185	(0.209)
Religion		
Non-denominational	1.246	(0.317)
Catholic (*ref.*)	1	(.)
Evangelical	1.755**	(0.336)
Other Religion	1.332	(0.803)
Household Income (M.S. = Minimum Salaries)		
0 to 2 MS (*ref.*)	1	(.)
>2 to 5 MS	1.027	(0.220)
>5 MS	1.016	(0.245)
Gender		
Male	0.901	(0.163)
Female (*ref.*)	1	(.)
Caregivers of younger children (< 6 y.o.)		
No children 0–5 (*ref.*)	1	(.)
Parent of 0–5	2.167***	(0.494)
Caregivers of older children (6+ y.o.)		
No children 6+ (*ref.*)	1	(.)
Parent of 6+	1.514	(0.426)
Number of Children	0.907	(0.0791)
cut1	5.285***	(2.219)
cut2	10.42***	(4.424)
cut3	15.24***	(6.531)
cut4	24.22***	(10.74)
Observations	779	

Note [1]:* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. [2] OR = Odds Ratio, SE = Standard Error.

neighborhood health clinic or in other types of vaccination campaigns. Future research should seek to understand whether vaccination attitudes is contingent on where it is offered (e.g., health clinics, schools, and mass vaccination campaigns). Second, it should be noted that the lack of data does not permit us to further understand if caregivers' attitudes toward school-based vaccination programs is impacted by whether children would be receiving an initial or a booster dose.

Third, data on the gender of the children in the household was not collected in the survey. Future research on support for school-based vaccination for HPV, for example, may wish to explore whether the findings reported in this study can be generalized when separately examining adherence to vaccination for female and male adolescents. Fourth, a percentage of caregivers did not know or chose not to answer questions regarding school-based vaccination campaigns. Since the percentage of missing responses was relatively small, the numbers were insufficient to yield any meaningful identification of which socio-demographic traits were associated with caregivers' reluctance to respond to questions on school vaccination. Future research should seek to better understand why some guardians are more reluctant to answer questions regarding attitudes toward school vaccination.

Finally, there are additional roles that schools can play to strengthen vaccination coverage that were not explored in the survey. For example, under Brazilian law, schools must request vaccination records during enrollment each calendar year. The periodic request for vaccination records by schools is a preexisting policy that could be more effectively utilized by health authorities in Brazil to identify gaps in coverage, and it should also be studied in further depth.

Contribution

LGB and TCM participated in the conceptualization of the study, funding acquisition and project administration. LGB, NPM, ISC, RC, DVP and TCM designed the study, participated in the data curation and validation, analyzed the data, conceived and conducted the sensitivity analyses, and prepared the first manuscript draft. JCM and MV participated in the study conception, statistical analysis and interpretation of results. All authors provided relevant input for manuscript writing and review and have read and approved the final manuscript.

CRediT authorship contribution statement

Lorena G. Barberia: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Isabel Costa Rosa Seelaender:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Data curation. **Rebeca de J. Carvalho:** Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Investigation, Formal analysis, Data curation. **Jose Cassio de Moraes:** Writing – review & editing, Writing – original draft, Supervision, Formal analysis, Conceptualization. **Natália de Paula Moreira:** Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Investigation, Formal analysis, Data curation. **Marcel de Toledo Vieira:** Writing – review & editing, Validation, Supervision, Software, Methodology, Investigation, Formal analysis. **Dara Aparecida Vilela Pinto:** Writing – review & editing, Validation, Software, Investigation, Formal analysis, Data curation. **Tatiane C. Moraes de Sousa:** Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Investigation, Formal analysis, Conceptualization.

Consent for publication

The authors consent to publication.

Funding

The survey and research project were made possible by grant support from the José Luiz Egydio Setúbal Foundation.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Isabel Costa Rosa Seelaender, Rebeca de J. Carvalho, and Dara Aparecida Vilela Pinto report financial support was provided by José Luiz Egydio Setúbal Foundation. 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.

Acknowledgments

The authors acknowledge the government of the Republic of Brazil for making the data publicly available, which made this analysis possible, and the financial support of José Luiz Egydio Setúbal Foundation for underwriting the survey collection and analysis, and grant support (2021/08772-9 and 2022/10997-1) from the São Paulo Research Foundation (FAPESP). The comments and suggestions made by Dr. Silvia Costa, Dr. Sofia Gastellu and participants of the José Luiz Egydio Setúbal Foundation's5º Fórum de Políticas Públicas da Saúde na Infância are gratefully acknowledged.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2025.127709.

Data availability

Data will be made available on request.

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