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Vaccine hesitancy in the school community and among health personnel: a cross-sectional study

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Abstract

Vaccine hesitancy is a complex phenomenon influenced by factors such as complacency, convenience, confidence, context, and communication, which must be analyzed in their distinct and interrelated intersections. The school environment, given its strong influence on students, families, and local social networks, can be recognized as an important channel for knowledge dissemination and a favorable setting for debates focused on health promotion and the prevention of vaccine-preventable diseases.

Objective To analyze vaccine hesitancy among education and health personnel, identifying associated sociodemographic and contextual factors.

Methods This is a cross-sectional study conducted between August 2023 and April 2024, carried out from an online questionnaire whose respondents involving people from the school community (school managers and teachers) and public health units in Minas Gerais, Brazil.

Results Statistically significant differences were observed regarding education level, marital status, age group, municipality size, perception of government and institutional influence, occupation, and family income. Higher scores – indicating greater agreement with favorable attitudes toward vaccination – were found among participants with postgraduate education, without a partner, of younger age, those who agreed that government decisions influence vaccination, who were health personnel and who had higher income, whereas teachers and those with intermediate education levels showed a greater tendency toward vaccine hesitancy.

Conclusion This study reinforces the need for specific strategies targeting the school environment, both to strengthen educators' confidence and to promote joint actions between the health and education sectors. Interventions that expand training for managers and teachers on vaccines, combined with transparent and contextualized public communication policies – empowering them as multipliers of reliable information – may help to alleviate doubts and increase vaccination adherence.

Keywords Vaccine hesitancy, Vaccines, Schools, Immunization, Vaccination

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Introduction

Vaccine hesitancy is defined by the *Strategic Advisory Group of Experts on Immunization* (SAGE), a strategic advisory group on immunization of the World Health Organization (WHO), as the delay in acceptance or refusal of available vaccines [1]. Subsequently, this definition was replaced, being defined, since 2022, as a motivational state of conflict or opposition to vaccination, considering the intention and willingness to vaccinate [2]. This definition is based on the methodology that considers behavioral and social aspects that are determinants of vaccination adherence and, due to the difficulty in establishing it, the WHO encourages research that considers behavioral and social factors in addition to demographic and economic aspects [2].

This phenomenon has become an increasing challenge for keeping high and homogeneous vaccination coverage, even in countries with well-established immunization policies such as Brazil, where vaccination efforts are coordinated by the National Immunization Program (Programa Nacional de Imunizações, PNI) [3]. Although the PNI achieved coverage rates above 90% in previous decades, a decline in these indicators has been observed since 2016, a trend further aggravated by the COVID-19 pandemic [4, 5].

Vaccine hesitancy is complex and context-specific, varying across time, location, and vaccine type [6]. It is influenced by factors such as complacency, convenience, confidence, context, and communication [1, 7]; these elements must be analyzed in light of their complex and distinct interrelations [1, 4–6].

In the international context, vaccine hesitancy has been recognized by the WHO as one of the top ten global health threats since 2019 [8]. To better understand the factors influencing such decisions, the *Vaccine Hesitancy Determinants Matrix* was developed. This framework systematizes the main determinants of vaccine acceptance, delay, or refusal into three categories: (1) contextual determinants, such as cultural, social, political, and media-related factors; (2) individual and group determinants, including personal beliefs, risk perception, life experiences, and peer influence; and (3) vaccine or vaccination-specific determinants, such as confidence in vaccine efficacy and safety, accessibility (convenience), and the logistical complexity of vaccine administration [1]. Convenience cannot be understood only as access to the vaccine, it must also consider access to information about immunobiologicals and the vaccination process.

In Brazil, the success of the PNI has historically ensured high vaccine uptake. However, this progress presents inherent challenges to its continued advancement, as the control of diseases through high vaccination coverage affects individuals' perceptions of the risks and benefits

of immunization [9]. In this context, recent declines in vaccination coverage have been observed [4, 5].

Health personnel have significant potential to influence vaccine uptake among individuals who access social and health services, as they represent a particularly important group for investigating factors associated with vaccination processes and vaccine confidence [5, 7, 10]. During the health emergency caused by COVID-19, personnel within the Unified Health System (*Sistema Único de Saúde*, SUS) who operated on the frontlines and kept direct contact with the population played a decisive role in vaccination processes, an essential task they had already fulfilled before the pandemic [11, 12]. On the other hand, the relationship between the dissemination of *fake news* about vaccines and the WHO 3 C model is considered a possible cause for vaccine hesitancy (FRUGOLI, 2021). Brazil experienced a real disarray during the COVID-19 pandemic, in which high-level government officials gave rise to a wave of uncoordinated and untrue information about vaccines, calling into question the credibility of the National Immunization Program and confidence in the safety and efficacy of vaccines [13].

Many authors have also indicated that vaccine hesitancy affects education personnel in several countries. A study conducted in China found that 37.1% of university professors reported hesitancy toward COVID-19 vaccines, which was associated with low confidence in vaccines, limited engagement with vaccine-related news, and the presence of comorbidities [14].

A study examining children born between 2017 and 2018 reported vaccine hesitancy rates ranging from 1.0% to 1.6% across different municipalities in the state of Minas Gerais [15]. Although most national studies have focused on parents and caregivers, recent research indicates that one-third of basic education teachers did not receive the influenza vaccine in 2020—mainly due to concerns about adverse reactions and beliefs that the vaccine poses significant risks [16].

Schools can be recognized as important hubs for disseminating knowledge and places for discussion on health promotion and disease prevention. In this regard, several authors emphasize the crucial role of education personnel in spreading accurate information about health and vaccination, thus contributing to the development of a safer and healthier society [17].

Given the influence that the school community exerts over students, families, and local social networks, it is important to acknowledge vaccine hesitancy within this group. Therefore, this study aimed to analyze vaccine hesitancy among members of the school community (administrators, principals, and teachers) and health personnel, to identify associated sociodemographic and contextual factors, and to propose potential future interventions.

Methods

Study design

This cross-sectional study was conducted between August 2023 and April 2024, involving participants affiliated with the school community (administrators and teachers) and public health units in the state of Minas Gerais, Brazil.

Minas Gerais is the second most populous state in the country, with over 20 million inhabitants, and is characterized by marked socioeconomic and geographic diversity. The state is administratively organized into 28 regional health units (Unidades Regionais de Saúde, URS), which were considered for sample planning. In the context of the State of Minas Gerais, the 28 Regional Health Units (URS) are administrative structures of the State Health Department (Secretaria de Estado de Saúde) that coordinate health policies and actions across geographic regions of the state. They serve as decentralized governance and coordination bodies, helping to implement health programs, support municipalities, and organize health services within their territories. However, they are not directly responsible for administering vaccinations at the point of service. Immunization activities are primarily delivered through primary health care services, which are responsible for providing vaccines to the population as part of routine and campaign-based immunization programs.

The sample size calculation was based on a finite population, with a 95% confidence level and a 5% margin of error. This procedure ensured the representativeness of the sample in relation to the target population, allowing for valid and reliable inferences regarding the state of Minas Gerais. These methodological features contribute to the robustness and relevance to the analysis, so that the findings offer important contributions both to the regional context and to broader discussions about the Brazilian reality.

A structured questionnaire (attached Supplementary Material) was made available through an online platform, containing questions related to the participants sociodemographic profiles and a thematic module designed to assess vaccine hesitancy. The participants included administrators and educators from state public schools that teach in the final years of elementary education and high school, as well as health personnel working in public health units across the different RHU of Minas Gerais.

The original database contained 1,546 records. To ensure unbiased responses, duplicate entries were initially removed. Subsequently, observations with missing data for key variables of interest were then excluded. After these procedures, the final analytical sample comprised 1,132 participants.

Variables

The structured questionnaire collected information on participant’s age, sex, educational level, marital status, race/skin color, occupation, income, place of residence, and perceptions related to vaccination. The variable “municipal size” was constructed based on population estimates from the Brazilian Institute of Geography and Statistics (IBGE, 2024), classifying municipalities as small (up to 20,000 inhabitants), medium (20,001–100,000 inhabitants), or large (more than 100,000 inhabitants). The thematic module assessing perceptions about vaccination comprised 14 items, adapted from validated instruments (Table 1).

Each item was measured on a five-level scale (1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, and 5 = Strongly agree). For items L1 and L5–L11, reverse coding was applied to standardize the direction of the interpretation, ensuring that higher values consistently reflected greater vaccine confidence. Thus, the raw score for each individual, calculated as the sum of responses across the 14 items, ranged from 14 to 70 points, with higher scores indicating greater levels of vaccine confidence among members of the school community and health personnel (Roberts et al., 2015).

Table 1 Items comprising the vaccine hesitancy scale used in the study. Brazil, 2025

L1	Patients report that media news about an alleged relationship between vaccines and chronic diseases (e.g., autism and multiple sclerosis) creates uncertainty or doubt regarding vaccine safety.
L2	It is important to maintain population vaccination coverage to prevent the emergence of new epidemics.
L3	Educating parents about vaccines is an important strategy for achieving adequate vaccination coverage.
L4	Physicians and nurses play a key role in educating parents or caregivers about the importance of adolescent vaccination.
L5	It is no longer necessary to vaccinate adolescents because these diseases are very rare nowadays.
L6	It is safer to contract the disease than to be vaccinated against it.
L7	Vaccines contain substances that are known to be harmful to adolescent health.
L8	Diseases began to disappear due to improvements in hygiene and sanitation, even before vaccines were introduced.
L9	The Government does not have the right to obligate adolescent vaccination; parents should make that decision.
L10	There is insufficient scientific evidence that immunization prevents infectious diseases.
L11	Pharmaceutical companies promote childhood vaccination for profit, even though they know it is harmful to health.
L12	I would vaccinate an adolescent according to the recommendations of the National Immunization Program.
L13	I would advise a patient to vaccinate their child according to the recommendations of the National Immunization Program.
L14	I recommend that adolescents receive the meningococcal ACWY vaccine.

Exploratory factor analysis

To investigate the latent structure of the 14 items related to vaccine hesitancy, we conducted an exploratory factor analysis (EFA) based on the inter-item correlation matrix [18]. Sample adequacy was assessed using the Kaiser–Meyer–Olkin index (KMO) and Bartlett’s test of sphericity.

We evaluated internal consistency using Cronbach’s alpha [19]. The number of factors to be extracted was determined according to the Kaiser criterion (eigenvalues > 1). Factor extraction was carried out using the principal components method, followed by oblique rotation, which showed a clearer and more interpretable solution by minimizing item complexity.

Construction of the vaccine hesitancy score

After factor extraction, factor scores were calculated for each individual. To ensure that the factor score maintained the same scale as the raw item score (having an identical mean and standard deviation), a linear transformation was applied, rescaling the weighted score while preserving the statistical properties of the original item sum.

This rescaled score was used to create a continuous variable representing vaccine hesitancy for each participant, which was incorporated into the study database for further analyses. Higher scores indicated greater vaccine confidence.

Statistical analysis

Descriptive analyses were presented as mean and standard deviation of the vaccine hesitancy score. To examine associations between the vaccine hesitancy score and categorical variables of interest (such as sex, age group, and educational level), parametric mean comparison tests were applied: the Student’s *t*-test for variables with two categories and analysis of variance (ANOVA) for variables with three or more categories [20, 21].

The suitability of these tests was verified by assessing the assumptions of normality (Shapiro–Wilk test) and homogeneity of variances (Levene’s test) [22, 23]. In cases of heteroscedasticity, robust alternatives were applied, such as Welch’s *t*-test and Welch’s ANOVA [24].

When ANOVA indicated statistically significant group differences, post hoc tests (Tukey or Games–Howell, depending on variance equality) were conducted to identify specific group pairs showing differences [25, 26]. The significance level was set at 5% ($p < 0.05$). All analyses were performed in R (version 4.5.1) [27].

Ethical aspects

This research was approved by the Research Ethics Committee of the Federal University of Minas Gerais (Certificate of Ethical Review Presentation number

69731923.1.0000.5149/2024), and adhered to all ethical principles established in Resolution No. 466/2012 of the National Health Council of Brazil. Volunteers who agreed to participate in the study signed an informed consent form before completing the questionnaire. Even so, the database was organized in a way that ensured participants’ confidentiality by not identifying them.

Results

The percentage distribution of responses for each item – where the categories “strongly disagree” and “disagree” were grouped, “strongly agree” and “agree” were combined, and the “neither agree nor disagree” category was presented separately – provides a concise overview of participants’ patterns of agreement and disagreement (Fig. 1). High levels of agreement were observed for items emphasizing the benefits of vaccination and the role of health personnel, such as the importance of maintaining vaccination coverage to prevent epidemics (L2), the need to educate parents about vaccines (L3), the contribution of physicians and nurses in this process (L4), and the recommendation to vaccinate according to the National Immunization Program (L12–L14), all showing agreement rates above 89%. Conversely, there was strong rejection of statements based on myths or misinformation, such as believing it is safer to contract the disease than to be vaccinated (L6), claiming that adolescent vaccination is no longer necessary (L5), or suggesting that vaccines contain proven harmful substances (L7), which each received over 85% disagreement. Items related to the influence of the media (L1), parental autonomy regarding mandatory vaccination (L9), and historical interpretations about the role of hygiene and sanitation in disease decline (L8) displayed more evenly distributed responses between agreement and disagreement, along with higher proportions of neutrality, reflecting the complexity of the phenomenon of vaccine hesitancy.

The correlogram presented in Fig. 2, constructed using Pearson’s linear correlation, highlights patterns of association among the assessed items. Items favorable to vaccination (L12, L13, and L14) showed strong positive correlations with one another ($r=0.63–0.80$). Similarly, items associated with vaccine hesitancy – including L5, L6, L7, L10, and L11 – were also moderately to strongly correlated ($r=0.44–0.60$). Items based on scientific evidence (L2, L3, and L4) displayed positive correlations among themselves ($r=0.48–0.73$) and negative correlations with hesitancy-related items, particularly L5–L11 (r ranging from -0.22 to -0.45), indicating a clear opposition between pro-vaccination attitudes and misinformed beliefs.

To investigate the latent structure of the 14 items related to vaccine hesitancy, an exploratory factor analysis was conducted. Sample adequacy was considered

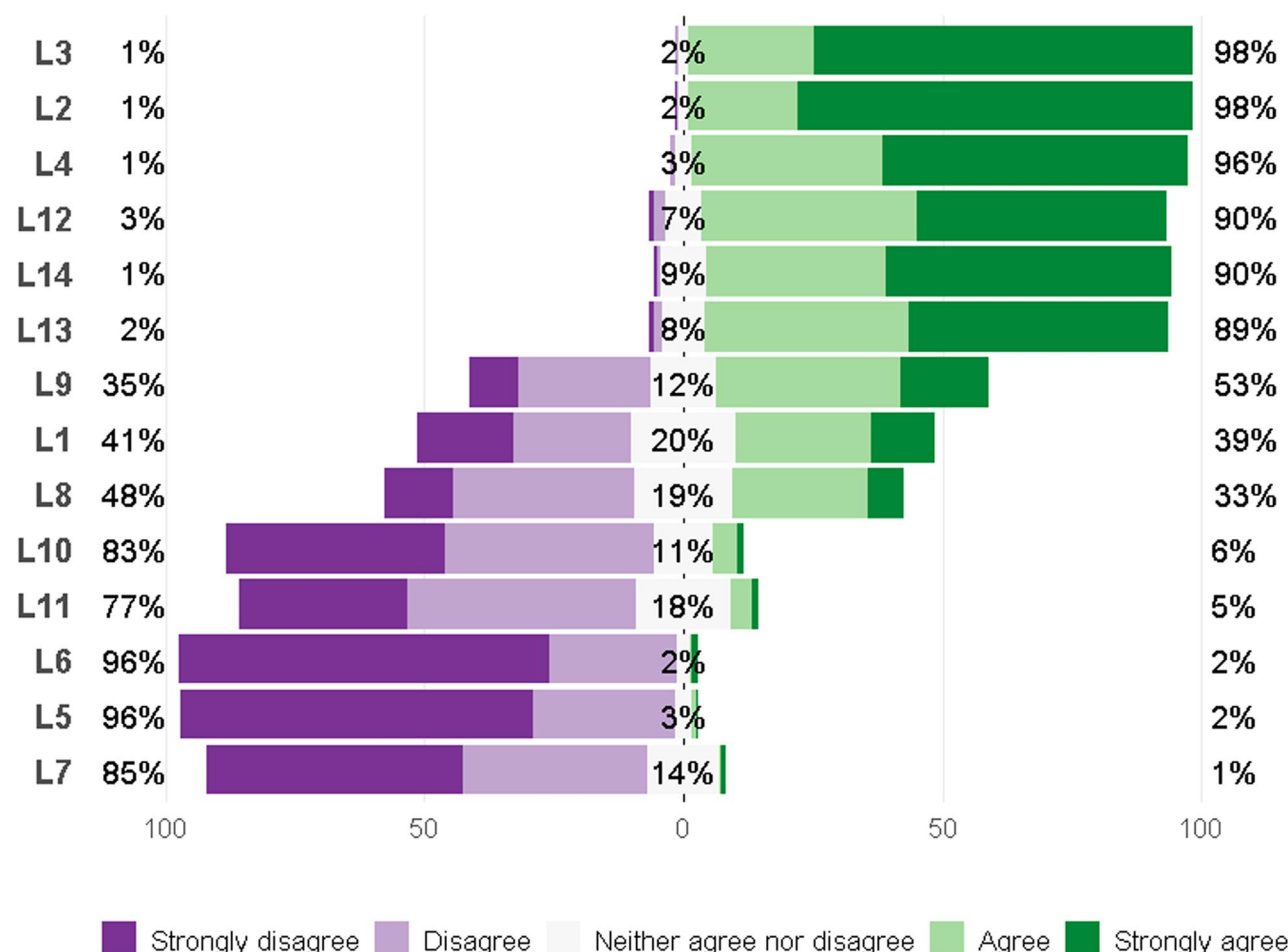


Fig. 1 Relative distribution of responses according to the items of the vaccine hesitancy scale ($n = 1.132$). Minas Gerais, Brazil, 2025

excellent, as indicated by the KMO test (Kaiser–Meyer–Olkin = 0.89), while the Bartlett’s test of sphericity ($\chi^2 = 6.472$, $p < 0.001$) confirmed the presence of significant inter-item correlations, supporting the use of factor analysis. Internal consistency was also high, with a Cronbach’s alpha of 0.82, indicating excellent reliability.

Based on the Kaiser criterion, the analysis indicated the extraction of three factors, which together explained 58% of the total item variance — a value considered adequate in psychometric research and ensuring a consistent representation of the evaluated latent structure.

Table 2 presents the factor loadings, corrected item-total correlations and Cronbach’s alpha values if each item were removed.

Factor I (Risk Perception) grouped items expressing doubts, fears, or misconceptions regarding vaccine safety and efficacy, as well as questions about the necessity of vaccination (L1, L5, and L11). Factor II (Attitudes toward Vaccination) comprised items reflecting the value of vaccination as a public health strategy and the educational role of health personnel (L3 and L5). Individuals who

disagreed with item L9 — and therefore supported state autonomy in vaccination policies — contributed more to Factor (I) Conversely, those who agreed with this same item and believed in parental autonomy in vaccination decisions contributed more to Factor (II) Finally, Factor III (Recommendation) included items representing the intention to vaccinate or an explicit recommendation for vaccination (L12 and L14). Item L9 exhibited high heterogeneity, while the correlogram (Figs. 1 and 2) illustrated clusters of items with stronger interrelations.

Corrected item-total correlations ranged from 0.18 to 0.73. Most items showed fair to good values (> 0.40), indicating that they consistently contributed to measuring the same construct. When individual items were removed, Cronbach’s alpha remained relatively stable (ranging from 0.79 to 0.84), suggesting that the exclusion of any item did not significantly alter the reliability of the scale.

A comparison of mean scores for adolescent attitudes toward vaccination, according to sociodemographic characteristics and participants perceptions, revealed

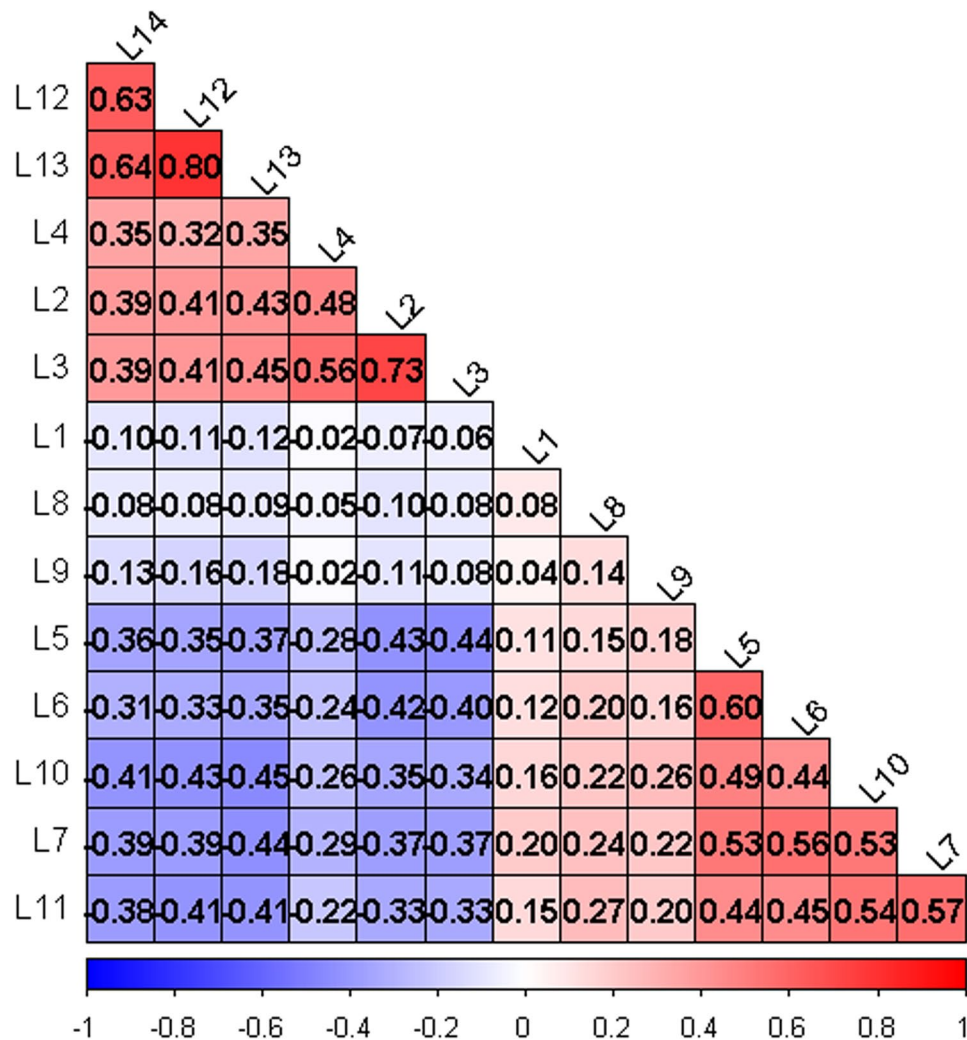


Fig. 2 Correlogram of the items of the vaccine hesitancy scale ($n = 1,132$). Brazil, 2025

statistically significant differences in education, marital status, age group, perception of government/institutional influence, occupation, family income, and municipality size ($p < 0.05$) (Table 3). Higher scores – indicating stronger agreement with favorable attitudes toward vaccination – were observed among participants with postgraduate degrees, those without a partner, younger individuals (18–44 years), and those who agreed that government decisions influence immunization. Such patterns were also found among health personnel, participants with higher incomes, and individuals from both large and small municipalities. In contrast, participants with higher education (without postgraduate degrees), teachers, individuals from medium-sized municipalities, and those neutral regarding institutional influence on vaccination scored lower. No significant differences were found for race or gender.

Discussion

The results of this study indicate that attitudes toward vaccination among the school community in Minas Gerais vary significantly and are strongly associated with sociodemographic and contextual characteristics. Overall, higher confidence in vaccines was observed among health personnel and individuals with higher education and income levels, whereas teachers and those with intermediate education levels showed a greater tendency toward vaccine hesitancy.

In Brazil, individuals with a family income above ten minimum wages per month and higher levels of education exhibit the highest rates of vaccine acceptance, exceeding 80% [28]. These findings are supported by other studies, which indicate that higher education levels are associated with greater vaccine uptake [29]. This association has also been observed in international contexts.

Table 2 Factor loadings of the 14 items of the vaccine hesitancy Scale, with corrected item–total correlations and cronbach's alpha values if the item were removed. Minas Gerais, Brazil, 2025

Item	Factor Loading			Corrected item-total correlations	Cronbach's alpha values if the item were removed
	I	II	III		
L1 - Patients report that media news about an alleged relationship between vaccines and chronic diseases (e.g., autism and multiple sclerosis) creates uncertainty or doubt regarding vaccine safety.	0.34			0.18	0.84
L2 - It is important to maintain population vaccination coverage to prevent the emergence of new epidemics.		0.76		0.66	0.8
L3 - Educating parents about vaccines is an important strategy for achieving adequate vaccination coverage.		0.81		0.67	0.8
L4 - Physicians and nurses play a key role in educating parents or caregivers about the importance of adolescent vaccination.		0.75		0.48	0.81
L5 - It is no longer necessary to vaccinate adolescents because these diseases are very rare nowadays.	0.61	0.31		0.66	0.8
L6 - It is safer to contract the disease than to be vaccinated against it.	0.68			0.64	0.8
L7 - Vaccines contain substances that are known to be harmful to adolescent health.	0.7			0.71	0.79
L8 - Diseases began to disappear due to improvements in hygiene and sanitation, even before vaccines were introduced.	0.65			0.24	0.83
L9 - The Government does not have the right to obligate adolescent vaccination; parents should make that decision.	0.45	−0.33		0.25	0.83
L10 - There is insufficient scientific evidence that immunization prevents infectious diseases.	0.61			0.67	0.79
L11 - Pharmaceutical companies promote childhood vaccination for profit, even though they know it is harmful to health.	0.66			0.65	0.79
L12 - I would vaccinate an adolescent according to the recommendations of the National Immunization Program.			0.9	0.7	0.8
L13 - I would advise a patient to vaccinate their child according to the recommendations of the National Immunization Program.			0.87	0.73	0.79
L14 - I recommend that adolescents receive the meningococcal ACWY vaccine.			0.79	0.64	0.8

Factor loadings with absolute values lower than 0.30 were omitted

In South Korea, a study including over half a million participants found that higher education and income levels were positively correlated with SARS-CoV-2 vaccine uptake [30]. Nonetheless, the persistence of hesitancy even among highly educated individuals suggests that the issue extends beyond informational barriers, involving trust in institutions and the influence of conflicting social discourses.

Another important finding was the greater tendency of health personnel to hold favorable attitudes toward vaccination. This aligns with studies reporting moderate to high adherence among health personnel, often exceeding that of the general population. In China, for example, 77.0% of health personnel reported accepting COVID-19 vaccines, compared to 56.2% among non-health personnel [31]. A global meta-analysis of health personnel also documented high vaccination coverage, showing heterogeneity by professional category, with physicians showing the highest adherence compared to nurses. Additionally, a history of SARS-CoV-2 infection was associated with lower adherence in this group [32]. Nonetheless, paradoxically, vaccine hesitancy can persist even among health professionals [33–35]. In a study of 598 health

workers, lower confidence in vaccines, diminished perception of vaccine importance, greater concern about adverse effects, and doubts regarding colleagues' acceptance were all associated with increased hesitancy [34].

Health personnel play a key role in addressing vaccine hesitancy, acting as a trusted source of information for the population [36]. Personnel who are well-informed, experienced, and confident in vaccine safety and efficacy are more likely to recommend vaccination to their patients [35]. Therefore, targeted educational strategies, institutional support, and transparent communication channels are essential to maintain the trust and engagement of this group.

Among school community professionals, particularly teachers, the lowest average scores on vaccine hesitancy were noted, indicating greater vaccine hesitancy. In a study with teachers, only 4.5% reported receiving the influenza vaccine during the 2018/2019 season. The main barrier was lack of confidence in vaccine efficacy (56.9%), followed by fear of adverse effects (30.6%). In contrast, higher influenza vaccine uptake was associated with greater knowledge about the disease, recommendations from family physicians, the belief that vaccination should

Table 3 Means and standard deviations of vaccine hesitancy scores according to sociodemographic variables and participants' perceptions ($n = 1,132$). Minas Gerais, Brazil, 2025

Variable	Category	n (%)	Score (Standard Deviation)	Test Statistic (p -value)	Multiple Comparisons*
Education	High school	88 (7.8%)	58.53 (2.22)	$F = 24.71$ (< 0.001)	A
	Post-graduation	30 (2.7%)	59.98 (1.65)		B
	Undergraduate	1014 (89.6%)	57.84 (3.03)		C
Marital status	With a partner	731 (64.6%)	57.70 (3.06)	$T = -3.99$ (< 0.001)	A
	Without a partner	401 (35.4%)	58.41 (2.75)		B
Age group	18 to 29 years	169 (14.9%)	58.62 (2.57)	$F = 18.70$ (< 0.001)	A
	30 to 44 years	527 (46.6%)	58.34 (2.73)		A
	45 to 59 years	387 (34.2%)	57.29 (3.21)		B
	60 to 75 years	49 (4.3%)	56.64 (3.44)		B
The position of governments and health institutions influences immunization decisions.	Agree	835 (73.8%)	58.40 (2.72)	$F = 47.8$ (< 0.001)	A
	Neither agree nor disagree	154 (13.6%)	55.68 (3.31)		B
	Disagree	143 (12.6%)	57.75 (2.84)		C
Occupation	Administration	318 (28.1%)	58.53 (2.58)	$F = 110.81$ (< 0.001)	A
	Teachers	521 (46.0%)	56.77 (3.24)		B
	Health personnel	293 (25.9%)	59.40 (1.81)		C
Race	Asian/Prefer Not to Answer	24 (2.1%)	56.54 (3.09)	$F = 2.04$ (0.104)	A
	White	686 (60.6%)	57.95 (3.03)		A
	Pardo	361 (31.9%)	58.06 (2.83)		A
	Black	61 (5.4%)	57.80 (2.99)		A
Household income	≤ 1 Minimum Wage or No Income	34 (3.0%)	56.87 (2.71)	$F = 13.18$ (< 0.001)	A
	1–6 MW	822 (72.6%)	57.87 (2.99)		A
	More than 6 MW	191 (16.9%)	58.88 (2.42)		B
	Prefer Not to Answer	85 (7.5%)	57.00 (3.41)		A
Sex	Female	980 (86.6%)	57.92 (2.96)	$T = -0.71$ (0.42)	A
	Male or other gender	152 (13.4%)	58.13 (3.05)		A
Municipality size	Small	683 (60.3%)	58.09 (2.80)	$F = 6.64$ (0.002)	A
	Medium	374 (33.0%)	57.53 (3.20)		B
	Large	75 (6.6%)	58.77 (3.02)		A

*Identical letters indicate comparisons with no significant difference

be mandatory for teachers, and having a vaccinated family member [37]. In a comparative analysis of high school teachers and outpatient physicians, it was found that, despite overall high vaccination coverage ($> 85\%$), 63.5% of participants cited concerns about vaccine safety as the primary reason for hesitancy [38].

In a cross-sectional survey of 5,095 participants, the authors used the Vaccine Hesitancy Scale (VHS) to assess aspects such as confidence in vaccines and perceived risk. The results indicated that teachers generally exhibited high confidence in vaccines, with hesitancy more related to perceived risks than to doubts about vaccine efficacy. Additionally, greater knowledge about vaccines and a history of never having postponed or refused vaccination were associated with higher confidence levels. Nevertheless, teachers expressed uncertainty regarding their role in school immunization programs, highlighting opportunities to strengthen collaboration between public health and education [39].

The school community plays a crucial role in vaccine hesitancy. The fact that teachers score lower on hesitancy scales suggests that, while they are able to disseminate information and promote vaccination practices, they may lack adequate support or training or be exposed to conflicting information that fuels doubts. Teachers can serve as valuable allies in disseminating accurate vaccination information [40]. Plutzer and Warner (2021) [40] report that, although only 42% of teachers discuss the benefits of immunization in the classroom, the majority do not consider themselves skeptical of vaccines, highlighting the underutilized potential of this group as agents of vaccine promotion. Complementing this perspective, Wareham (2025) [41] argues that teachers not only can but also should promote vaccination, incorporating not only scientific evidence on efficacy and safety but also moral considerations and the understanding of immunization as an educational civic duty.

This study also showed a higher propensity for vaccination among individuals who perceive that the stance of governments and health institutions influences their vaccination decisions. The literature indicates that institutional trust – including trust in government, health institutions, and science – is one of the main determinants of vaccine acceptance [42, 43]. Trust is a key driver of vaccine acceptance worldwide [42], and confidence in governments, health systems, and scientific evidence decisively influences the uptake of Covid-19 vaccines [43]. Additional studies further support that greater trust in federal monitoring of vaccine safety and in the healthcare system is associated with higher vaccination intentions across different countries [44]. Transparent and effective communication, coupled with community engagement, are strategies shown to increase vaccination uptake [45]. At this point, it is necessary to highlight the tragic situation experienced by Brazil during the COVID-19 pandemic, a time when mismatched and, for now, false information has been widely disseminated by high-ranking heads of the federal government, reducing confidence that vaccines are safe and effective [13].

In this context, the federal Bolsa Família Program requires beneficiaries with children under 7 years of age and pregnant women to attend health services for nutritional monitoring, vaccinations, and prenatal care. However, the decline in vaccination coverage has highlighted the need for enhanced monitoring and follow-up within the program [46].

Therefore, addressing vaccine hesitancy requires a multifaceted approach. For health personnel, it is essential to implement ongoing training programs that address not only the technical aspects of vaccination but also communication strategies to tackle doubts and resistance. For the school community, investing in targeted training for teachers can transform them into effective promoters of vaccination [47]. In this regard, the Ministries of Health and Education have collaborated to reinvigorate vaccination through the “School Vaccination Strategy 2025” (Estratégia de Vacinação na Escola, 2025), which outlines several training initiatives on vaccination and vaccine safety aimed at teachers, with the goal of raising awareness, combating vaccine hesitancy, and strengthening trust in the National Immunization Program within schools. However, the document still lacks specific proposals for the development and implementation of these initiatives [48]. Vaccine hesitancy, being complex and multifactorial, can only be overcome through coordinated actions among health personnel, educators, policymakers, and society.

Finally, this research has some limitations. The study relied on an online questionnaire, which may have

restricted participation to individuals with greater digital access and interest in the topic, and may also have introduced self-report bias. Nonetheless, the instrument’s high internal consistency and the robustness of the statistical analysis support the validity of the findings. Despite these limitations, the results reinforce the need for targeted strategies within the school environment – both to strengthen educators’ confidence and to promote collaborative actions between the health and education sectors.

Interventions that expand vaccine training for managers and teachers, combined with transparent and contextualized public communication policies, can help address doubts and increase adherence to immunization. Given the strategic role of schools in shaping social values and practices, understanding vaccination barriers within this group is essential for strengthening vaccination coverage in Minas Gerais and across Brazil. Future research should qualitatively investigate the reasons underlying teacher hesitancy and assess educational interventions that foster engagement with the school community as active partners in immunization campaigns.

As main findings, although vaccine hesitancy does not have determined predictors in all situations, this study reinforces the influence of some of the factors already known to influence vaccination adherence, including education level, marital status, age group, family income, occupation, and governmental/institutional influence. And it presents, as one of the insights of this study, the fact that the size of the municipality is also significant to determine greater or lesser adherence to vaccination.

Some gaps remain as a possibility for future studies. Although the methodology used in this study was carefully prepared, the results may have been influenced by respondent bias, i.e., people who have some interest in the subject were more likely to answer the questionnaire. In addition, some aspects related to social and behavioral behavior, contained in the most recent definition of vaccine hesitancy, were not evaluated.

Abbreviations

IBGE	Instituto Brasileiro de Geografia e Estatística (Brazilian Institute of Geography and Statistics)
PNI	Programa Nacional de Imunizações (National Immunization Program)
RHU	Regional Health Units
WHO	World Health Organization
SAGE	Strategic Advisory Group of Experts on Immunization
SUS	Sistema Único de Saúde (Unified Health System)

Supplementary Information

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Supplementary Material 1.

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Authors' contributions

FPM, study conception and design, data collection and analysis, writing of the main text, final review; TPRS, data collection and analysis, writing of the main text, final review; CSV, writing of the main text, data interpretation; FCSLF, writing of the main text, submission process; GAV, statistical analysis, preparation of Figs 1 and 2. All authors reviewed the manuscript and contributed significant suggestions.

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Data availability

The database for this study is the result of the project "Strategies for Increasing Vaccination Coverage in the State of Minas Gerais, Brazil" and is held by the corresponding author, leader of the Observatory of Research and Studies in Vaccination.

Declarations

Ethics approval and consent to participate

This research was approved by the Research Ethics Committee of the Federal University of Minas Gerais (Certificate of Ethical Review Presentation number 69731923.1.0000.5149/2024), and adhered to all ethical principles established in Resolution No. 466/2012 of the National Health Council of Brazil and in accordance with the ethical principles of the Declaration of Helsinki. Volunteers who agreed to participate in the study signed an informed consent form before completing the questionnaire. Even so, the database was organized in a way that ensured participants' confidentiality by not identifying them.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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