Original Article/Research

"Vaccine hesitancy and acceptance in Latvia and Lithuania after the COVID-19 pandemic"

Liubove Murauskiene [a],*, Daiga Behmane [b], Ausra Berzanskyte [a]

[a] Department of Public Health, Faculty of Medicine, Vilnius University, M. K. Čiurlionio g. 21, Vilnius LT-03101, Lithuania
[b] Faculty of Public Health and Social Welfare, Riga Stradins University, Rīga LV-1007, Latvia

ARTICLE INFO

SCIENTIFIC ABSTRACT

Objectives: This study investigates vaccine hesitancy and acceptance in Latvia and Lithuania following the COVID-19 pandemic, contextualising current attitudes within historical and institutional frameworks, quantifying public preferences for vaccine features and policy measures, and identifying predictors of vaccine acceptance to inform future public health strategies.
Methods: A cross-sectional survey using the VaxPref database was conducted with demographically balanced samples from Latvia ($n = 1109$) and Lithuania ($n = 1010$). A discrete choice experiment elicited preferences for vaccine characteristics and public health policies. Latent class analysis explored heterogeneity in vaccine acceptance, incorporating sociodemographic and attitudinal predictors such as trust in public health authorities and prior vaccination behaviour.
Results: Three classes emerged: Provaxers, Refusers, and Hesitants. Nearly half of respondents in both countries were Refusers, a marked increase from earlier surveys.Refusers were indifferent to vaccine attributes and strongly averse to vaccination, while Provaxers and Hesitants preferred higher vaccine effectiveness and Westernmanufactured vaccines. Trust public health authorities and prior COVID-19 vaccination were the strongest predictors of acceptance. Policy-related variables, such as social restrictions and mandates, had statistically significant but minor associations, with both countries preferring the absence of constraints. Gender and religious affiliation influenced hesitancy in a country-specific manner.
Conclusions: Vaccine attitudes in Latvia and Lithuania are shaped more by trust public health authorities and prior behaviours than by traditional sociodemographic factors. The high proportion of systematic Refusers poses a significant challenge for pandemic preparedness, highlighting the need for targeted trust-building initiatives and contextspecific policies to improve vaccine uptake.
Public interest summary: Our study looked at why many people in Latvia and Lithuania are hesitant or refuse to get vaccinated, even after the COVID-19 pandemic. We found that nearly half of adults in both countries are strongly against vaccines, and this reluctance is not driven by age, education, or income. Instead, the main reasons are a lack of trust in public health authorities and past experiences with vaccination. While some people prefer vaccines that are more effective or made in Western countries, regulations such as societal limitations or mandates little affected their choices. To increase vaccine uptake in the future, context-specific approaches and trust-building are essential.

Introduction

Vaccination is universally acknowledged as one of the most efficacious and economically viable public health interventions in history. It has significantly alleviated the burden of infectious diseases and enhanced global life expectancy [1]. Following a decline in vaccination rates in recent decades, the COVID-19 pandemic challenged assumptions about high vaccine acceptance and revealed the persistent and evolving nature of vaccine hesitancy. Even in situations when vaccines were both accessible and free of charge, portions of the population either postponed or refused vaccination, jeopardising public health objectives and compromising the efficacy of collective immunity initiatives [2–4].

For many, vaccination represented not only personal health issues but also signified perspectives on institutional power, societal duty, and human autonomy [5,6]. Individuals evaluated attributes such as effectiveness, adverse effects, and duration of protection with overarching societal considerations, including policy requirements and the perceived legitimacy of public health measures [2,7]. Vaccine views ranged from enthusiastic acceptance to caution and refusal, influenced by psychological, cultural, and structural factors, with the COVID-19 epidemic underscoring the impact of misinformation, political polarisation, and identity on behaviour [7–9]. In the Baltic states, these dynamics were intensified by distinct historical and sociopolitical contexts, leading to significant disparities in vaccine uptake. Surveys and national data indicate that, despite extensive biomedical information, hesitancy remained due to emotional, moral, and social apprehensions [10–12].

This study analyses vaccine hesitancy and acceptance in Latvia and Lithuania within the post-COVID-19 pandemic context. We utilise data from the VaxPref database, a cross-sectional international database containing individual-level data on vaccine preferences, revealed vaccination behaviours, attitudinal and demographic information [2,7, 13]. Our analysis contributes to the literature in several ways. First, we provide a comprehensive overview of vaccination policies and hesitancy patterns in both countries over the past century, contextualising contemporary attitudes within their unique institutional trajectories. Second, we examine how individuals in these post-transition economies negotiate trade-offs between vaccination characteristics (e.g., safety, effectiveness, duration of protection) and potential societal constraints (e.g., mandates or restrictions on liberties during pandemics) in the event of a future pandemic. This approach enables us to quantify preferences for different vaccine attributes, with important implications for pandemic preparedness policy. Third, we explore heterogeneity in vaccination preferences across the two countries, exploiting a rich set of individual covariates to identify key predictors of vaccine acceptance and inform targeted public health interventions.

History of vaccination policies and hesitancy

During the early twentieth century, immunisation programmes in Latvia and Lithuania remained limited in both scope and reach. The Soviet period marked a profound transformation, as both nations integrated vaccination into newly centralised healthcare systems that substantially expanded delivery capacity. The Soviet public health model, grounded in strict state control and an ethos of collective responsibility, pursued comprehensive population coverage through large-scale, state-organised preventive measures, including mandatory vaccination [14]. Immunisation against diphtheria, pertussis, tetanus (DTP), polio, tuberculosis, measles, and rubella became an established component of routine medical care, implemented under institutional oversight and medical authority, leaving minimal space for individual discretion.

This model began to evolve during the dissolution of the Soviet Union, as extensive social and political changes commenced to alter public perceptions on health and vaccination. Vaccine hesitancy in the post-Soviet era can be attributed to the distinctive culture of Soviet society, marked by widespread distrust of the government, healthcare system, medical practitioners, and media, coupled with a preference for alternative remedies and a repressed inclination for autonomy in personal choices [15].

Following independence in the early 1990s, Lithuania and Latvia implemented major health sector reforms, decentralising governance and restructuring immunisation delivery through modernised public health and primary care systems. While these reforms created contemporary immunisation programmes, they also revealed coordination, trust, and equity challenges in a context of public scepticism toward state health interventions. Childhood vaccination coverage has largely stabilised, with DTP and measles-containing vaccine (MCV) uptake exceeding 90 % in both countries between 2000 and 2023. However, MCV coverage in Lithuania declined from 96 % in 2014 to 86 % in 2023,

whereas Latvia maintained higher levels . Adult vaccination remains weak; influenza coverage among older adults in Latvia reached only 8 % in 2021, compared to the EU average of 51 % [4].

This accumulated vulnerability became particularly evident during the COVID-19 pandemic, when vaccine distribution exposed the enduring consequences of fragmented governance, inconsistent communication, and public scepticism —factors that undermined compliance and overall vaccination uptake [9,16,17].

Vaccination policies and hesitancy during COVID-19

The COVID-19 pandemic stress-tested national health system responsiveness in Latvia and Lithuania through the implementation of extensive public health measures (Table 1). Both countries introduced lockdowns, mask mandates, school closures, and travel restrictions, broadly aligned with EU guidance but varying in timing and stringency. They also launched governmental COVID-19 contact-tracing applications (Apturi COVID in Latvia; KoronaStopLT in Lithuania) and implemented the EU Digital COVID-19 Certificate via national online portals [18].

National vaccination campaigns began in late December 2020 following EU approval of mRNA vaccines, which formed the backbone of primary and booster programmes. Lithuania adopted a phased approach prioritising healthcare workers, older adults, and high-risk groups, underpinned by centralised logistics, municipal involvement, and strong primary care engagement. In contrast, Latvia faced early logistical and communication challenges, contributing to slower uptake, driven by underfunded primary care, unclear messaging, and uncertainty regarding eligibility.

Fig. 1 presents vaccination coverage from 2020 to 2022 alongside key national policy milestones, including introduction and withdrawal of the COVID-19 vaccination passport in Lithuania, Latvia's proposed but ultimately abandoned mandate, and the launch of booster campaigns.

By late 2021, overall coverage converged across both countries, and primary and booster uptake plateaued by early 2022. As of December 2022, cumulative completion of the primary COVID-19 vaccination series remained below the EU average: 68.3 % in Lithuania and 69.0 % in Latvia versus 73.0 % in the EU overall [19].

The overall picture underscores persistent barriers to achieving consistent vaccination coverage in both countries. It also raises important questions about the relationship of proposed and implemented social mandates and incentivising measures on vaccination uptake. Assessing sociodemographic and attitudinal factors in relation to vaccination preferences is crucial, notwithstanding the scarcity of robust information in Lithuania and Latvia. Such analysis helps to identify emerging predictors for vaccine acceptance and inform context-specific interventions, so enhancing the effectiveness and equity of pandemic responses. Thus, our research question is "What is the relationship between sociodemographic and attitudinal characteristics and individual vaccination preferences in two neighboring post-Soviet Baltic countries, and what implications can this have for future pandemic preparedness policies?"

Materials and methods

Discrete choice experiment

To investigate individuals' preferences for vaccine acceptance in the event of a future pandemic and explore preference heterogeneity, we conducted a Discrete Choice Experiment (DCE). The DCE methodology involves presenting respondents with hypothetical decision scenarios that mirror real-world choice situations, requiring them to indicate their most preferred alternative.

Attribute identification and level specification followed established methodological guidelines from the DCE literature [20], employing a

Table 1
Key COVID-19 Response Measures in Lithuania and Latvia (March 2020 – December 2022).

Date	Measure	Lithuania	Latvia
February, 2020	State of emergency declared	✓	
2020-02-28	First confirmed COVID-19 case	✓	
2020-03-02	First confirmed COVID-19 case		✓
March, 2020	State of emergency declared		✓
	Internal border controls reinstated	✓	✓
	First quarantine enforced	✓	
June, 2020	State of emergency lifted		✓
	First quarantine lifted	✓	
November, 2020	Second quarantine reintroduced	✓	
	State of emergency reintroduced		✓
December, 2020	Vaccination rollout begins	✓	✓
April, 2021	Second quarantine lifted		✓
May, 2021	Introduction of COVID-19 Vaccination Passport with full validity on 2021-09-13	✓	
June, 2021	Second quarantine lifted	✓	
July, 2021	Emergency state reintroduced	✓	
September, 2021	100 bonus for 75+ with full vaccination (till December, 2021) or with the booster (till April, 2022)	✓	
October, 2021	Emergency state reintroduced		✓
	Compulsory vaccination for workers in healthcare, long-term social care, social rehabilitation institutions, and education as well as for customer-facing/high-risk workers based on the employer' assessment		✓
January, 2022	State of emergency lifted		✓
	The Parliament rejected amendments to the law introducing compulsory vaccination for health and social workers	✓	
February, 2022	COVID-19 vaccination passport abolished	✓	
May, 2022	State of emergency lifted	✓	

Notes: The start and end times of the lockdown are indicated by light orange and green, respectively.
Sources: Derived from legislation disseminated by official national sources
(https://e-seimas.lrs.lt and https://www.mk.gov.lv).

comprehensive mixed-methods framework [7,13]. Table 2 lists the attributes and levels used in the discrete choice experiment, Seven key attributes were incorporated to characterize vaccination programs, covering both vaccine-specific properties and associated public health policy measures. For detailed information about attribute identification and selection see Antonini et al. [7] and Antonini et al. [13].

Experimental design

The experimental design consisted of an unlabelled choice experiment with two vaccination program alternatives and a confirmation question allowing respondents to validate their selection or opt out

entirely. We used a D-optimal design using NGENE software (Choice-Metrics, 2018) focusing on main effects with informed priors to construct 36 choice scenarios across 3 blocks of 12 tasks each, reducing cognitive burden. Choice tasks were randomly sequenced within blocks to mitigate ordering effects [21].

Recruitment and sample

Data collection involved recruiting demographically balanced samples from Latvia ($n = 1109$) and Lithuania ($n = 1010$) via online panel providers managed by the market research firm DemetraOpinioni, maintaining proportional representation across demographic
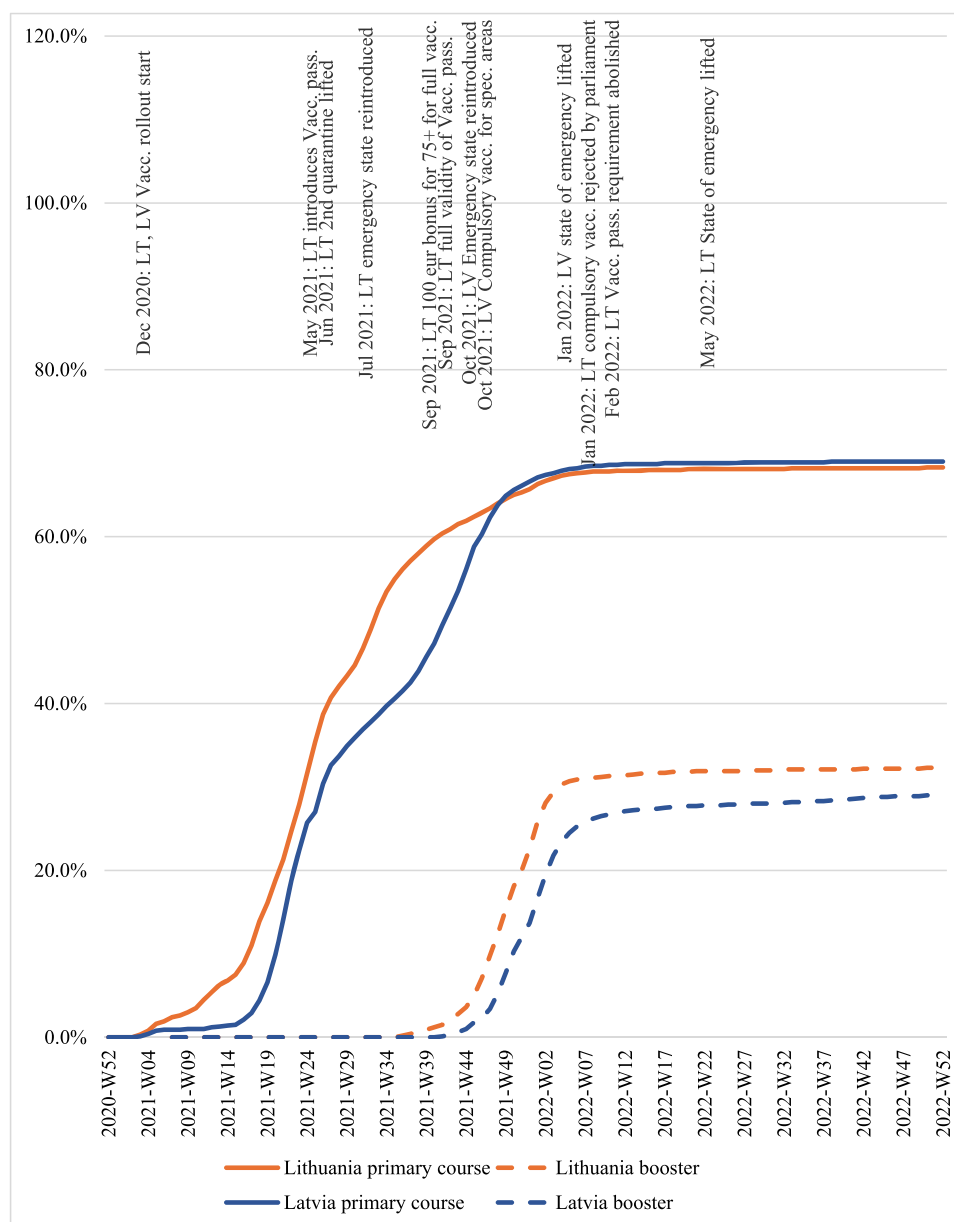
Fig. 1. COVID-19 Vaccination Uptake and Policy Milestones in Lithuania and Latvia (2020–2023).
Notes: Vacc. - vaccination, pass. - passport, spec. - special. Source for the data on vaccination rates - vaccinetracker.ecdc.europa.eu.

characteristics including age cohorts, gender, and regional distribution. Data collection occurred during distinct timeframes: Latvian respondents were surveyed between October 10, 2022 and March 6, 2023, whilst Lithuanian participants completed surveys between June 8, 2023 and August 12, 2023. Quota specifications aligned with official census data from both Latvia and Lithuania (Table A1 in the Appendix). For additional information on quality checks and fraudulent responses see Antonini et al. [7].

This study received ethical approval from the Human Care and Ethics Committee of the University of Newcastle (Approval No. H-2021–0363).

Econometric analysis

We analyzed choice data using a random utility maximization framework [22], which posits that respondents select the alternative providing maximum utility.

We initiated the analysis by estimating conditional logit models to assess attribute association with utility within each country (Appendix).

Subsequently, we examined the feasibility of combining observations across both countries using the Swait and Louviere pooling test. Results indicated significant differences between pooled cross-country models and country-specific estimations. The likelihood ratio test for preference equivalence whilst allowing scale variation across countries yielded LRT = 202.48, df = 19, p-value < 0.001, leading us to reject cross-country pooling.

Our research focus centers on investigating preference heterogeneity in vaccination choices across the two Baltic countries. Given that conditional logit models presuppose uniform preferences across respondents, we implemented latent class (LC) modelling to accommodate preference variation. LC models partition respondents into distinct segments, with homogeneous preference structures assumed within each segment [23]. Class proportions indicate the percentage of individuals allocated to respective classes. Determining optimal class numbers involves balancing model performance metrics (AIC and BIC criteria), parameter efficiency, and interpretive clarity [23]. LC models were chosen over alternative heterogeneity approaches (such as mixed

Table 2
Attributes and levels included in the discrete choice experiment.

Attribute	Definition	Levels
Vaccine features		
Vaccine effectiveness	Preventing laboratory-confirmed severe illness (i.e., deaths, hospitalizations) among people without evidence of previous infection	40 out of 100 (40 %), 60 out of 100 (60 %), 70 out of 100 (70 %), 90 out of 100 (90 %),
Risk of severe-side effects	Probability of getting severe side-effects that require urgent hospitalization after the vaccination (e.g., thrombosis/ blood clots, heart attack)	1 out of 100,000, 5 out of 100,000, 12 out of 100,000, 20 out of 100,000,
Duration of protection	Length of time before a new vaccination is required to boost the initial immune protection	3, 6, 12, 24 months
Time between the first clinical trial and market approval	Length of time between the first clinical trial of the vaccine(s) to market approval	6, 12, 24 months
The origin of the manufacturer	Location in which the vaccine manufacturing company has its headquarters	China, European Union, United Kingdom, USA, Russia
Social restrictions features		
Stringency of social restrictions	Stringency of the social activities ban (how restricted are social activities)	No social activities allowed, Some social activities allowed, All social activities allowed
Vaccine mandate	Vaccine mandate to return to usual work activities (formal or informal)	Return to formal or informal work activities <u>not allowed</u> without the vaccine, Return to formal or informal work activities <u>allowed</u> without the vaccine

Table 3
Characteristics of sample respondents and t-tests on the equality of proportions and means.

Age group	Latvia (n=1109) Freq.	Percent	Lithuania (n=1010) Freq.	Percent	t-test of proportions (Latvia – Lithuania)
18-29	225	20.3	159	15.7	4.5***
30-44	264	23.8	250	24.8	-1.0
45-54	178	16.1	174	17.2	-1.1
55-64	272	24.5	216	21.4	3.1**
over 65	170	15.3	211	20. 9	-5.6***
Total	1109	100	1010	100	
Female	603	54.4	546	54.1	0.3
Male/Other	506	45.6	464	45.9	
Total	1109	100	1010	100	
Bachelor	383	34.5	683	67.6	-33.1***
No Bachelor	726	65.5	327	32.4	
Total	1109	100	1010	100	
High income+	192	17.3	72	7.1	10.2***
Low and middle-income	917	82.7	938	92.9	
Total	1109	100	1010	100	
Religious±	365	32.9	299	29.6	3.3*
Not religious	644	67.0	711	70.4	
Total	1009	100	1010	100	
Fully vaccinated Covid-19 (≥ 2 doses)	795	71.7	764	75.6	-3.9**
Not vaccinated (≤ 1 dose)	314	28.3	246	24.4	
Total	1109	100	1010	100	

Attitudinal variables	Mean	St. dev.	Mean	St. dev.	t-test of means (Latvia – Lithuania)
Trust public health authorities	3.35	1.61	3.80	1.67	-0.45***
Total	1109		1010		
Vax scale	3.98	1.05	3.88	1.12	0.1**
Total	1109		1010		

Notes: The table presents descriptive statistics for sample respondents in Latvia and Lithuania, reporting frequencies, proportions, and *t*-tests for sociodemographic and attitudinal variables across both countries. Coefficients reflect mean or proportion group differences (e.g., age, gender, education, income, etc., and attitudinal scores) between Latvian and Lithuanian samples. T-tests positive values indicate higher means or proportions in Latvia; negative values show higher means or proportions in Lithuania. Missing values: +131 respondents in the Latvian sample and 163 respondents in the Lithuanian sample preferred not to report their income. We assigned these respondents to the non-high-income group to retain them in the analysis. ± In the Lithuanian sample 68 respondents preferred not to answer the question about their religious status. Following the strategy adopted for the income categories, we assigned these respondents to the non-religious group to retain them in the analysis.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

multinomial logit) based on comparative model performance and methodological precedent in the literature. One challenge in comparing preferences between countries and latent classes is that differences in coefficient magnitudes may reflect variation in either underlying preferences or response scale usage [24]. We tackled this by computing Marginal Rates of Substitution (MRS), with severe side effect risk as our reference attribute. This is a scale-free measure that captures how much additional risk—out of 100,000 people—respondents would be willing to accept or improvements in attribute levels compared to their baseline.

Results

To analyse the coefficients in the following tables and figures, focus on their direction and magnitude. Positive coefficients signify an increased probability or elevated value of the outcome linked to the specified variable or group, whereas negative coefficients imply a diminished probability or value. In latent class models, coefficients indicate the influence of sociodemographic or attitudinal characteristics on the likelihood of membership in a specific class compared to a reference group, typically the Hesitant class. Statistical significance is ascertained by associated p-values and standard errors.

Descriptive statistics

Descriptive statistics (Table 3) indicated sociodemographic and attitudinal differences between the Latvian ($n = 1109$) and Lithuanian ($n = 1010$) survey samples.

To begin with, the age distribution exhibited slight variations, with individuals aged 18–29 constituting a greater percentage of the Latvian sample (20.3 %) compared to the Lithuanian sample (15.7 %).

Conversely, the proportion of older adults (65+) was higher in Lithuania (20.9 %) than in Latvia (15.3 %). Gender ratios remained consistent across both samples, with women accounting for slightly more than half of the respondents. Disparities in education and wealth were pronounced: 67.6 % of Lithuanians possessed at least a bachelor's degree—over double the 34.5 % observed in Latvia—while a significantly higher proportion of Latvians (17.3 %) classified themselves as high-income, in contrast to merely 7.1 % in Lithuania. In regard to religion, self-identified religious affiliation was marginally more prevalent in Latvia (reported as 36.2 %, though this may be erroneous) compared to Lithuania (31.7 %), underscoring nuanced yet significant differences in the socioeconomic and demographic characteristics of the two both countries.

Additionally, regarding vaccination against COVID-19 status (at least two doses at the time of data collection), 75.6 % of Lithuanian respondents indicated they were vaccinated, in contrast to 71.7 % in Latvia.

Attitudinal variables, such as trust public health authorities (TPHA) and Vax scale scores, were assessed based on respondents' agreement with the statement "I trust the public health authorities for the management of the pandemic," along with twelve supplementary items examining scepticism regarding vaccine efficacy, apprehensions about future consequences, concerns over commercial exploitation, and preference for natural immunity. Calculated averages indicated that Lithuanian respondents exhibited markedly greater trust public health authorities, with a mean TPHA score of 3.80, in contrast to Latvian respondents' mean of 3.35, a difference that was statistically significant ($p < 0.01$, *t*-test). Simultaneously, Latvian respondents had somewhat elevated anti-vaccination inclinations on the Vax scale, achieving an average score of 3.98 compared to 3.88 among Lithuanian participants, suggesting greater vaccine scepticism and hesitance in Latvia relative to Lithuania.

Latent class analysis

Class definitions

We identified the optimal number of classes based on statistical criteria (i.e., CAIC) and interpretability. Three classes were identified for both countries, with remarkably consistent patterns observed across Latvia and Lithuania:

- The Pro-Vaccine Class (Pro-vax) exhibited strong vaccination preferences, characterized by negative willingness to accept risk from opting out (Latvia: −2.679, Lithuania: −2.085).
- The Vaccine Refusers Class (Refusers) demonstrated the opposite pattern with very high positive willingness to accept risk from opting out (Latvia: 6.259, Lithuania: 6.514), reflecting a systematic preference for avoiding vaccination.
- The Vaccine Hesitant Class (Hesitant) occupied a middle ground with moderate positive willingness to accept risk from opting out (Latvia:

1.628, Lithuania: 2.619) but remained responsive to vaccine characteristics.

A key distinction between the identified latent classes lies in the magnitude and direction of their willingness to accept risk from opting out of vaccination. Fig. 2 shows the distribution of latent class membership by the opt-out attribute for Latvia and Lithuania, illustrating how respondent subgroups are assigned by the model. Refusers reported the strongest positive coefficients for accepting opt-out risk, while Pro-vax reported negative coefficients, and Hesitant showed moderately positive coefficients. This pattern indicates that Pro-vax actively seek vaccination to avoid risk, Refusers are willing to accept higher risk by avoiding vaccination, and Hesitant maintain some risk tolerance but can be persuaded by favorable vaccine characteristics.

Class probability distribution

The probability distribution of respondents across these classes revealed concerning patterns, with the largest share of respondents in both countries having the highest probability of falling into the Refusers category. As shown in Fig. 2, Refusers comprised the largest segment (Latvia: 49.6 %, Lithuania: 44.1 %), followed by Pro-vax (Latvia: 32.1 %, Lithuania: 37.6 %) and Hesitant representing the smallest group (Latvia: 18.3 %, Lithuania: 18.2 %). This distribution indicates that nearly half of the sample in both countries demonstrates consistent vaccine refusal preferences, while about one-third exhibits strong pro-vaccine attitudes and less than one-fifth maintains a hesitant but potentially persuadable stance toward vaccination.

Attribute preferences across classes

Class membership probabilities are determined by individual characteristics. We selected sociodemographic and attitudinal variables pertinent to vaccination decision-making based on literature synthesis. Sociodemographic variables encompassed age (binary indicator for individuals over 55 years), gender, educational achievement, income level (exceeding 200 % of median household income in respective countries), religious self-identification (binary indicator for respondents reporting to belong to a religious group). We aimed to look into the influence of
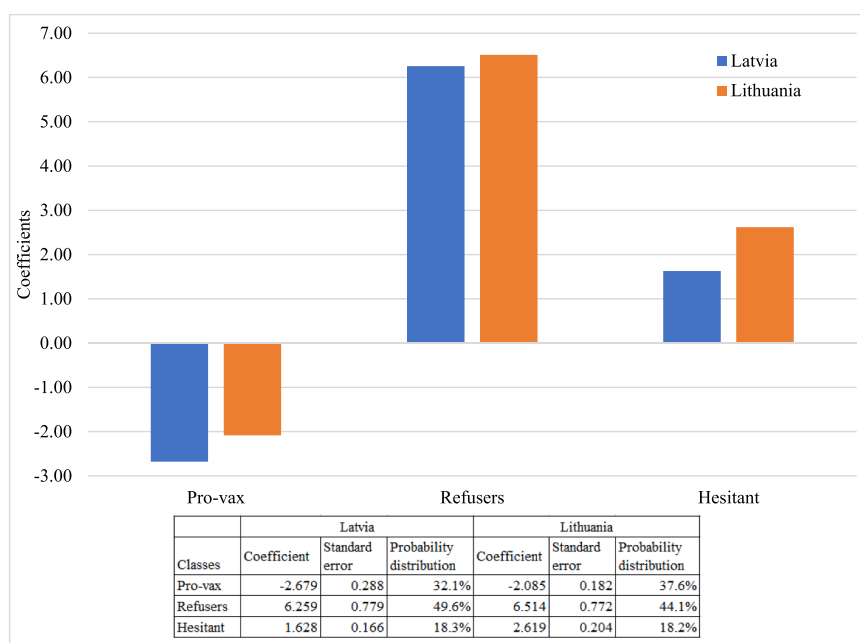

Classes	Latvia			Lithuania		
	Coefficient	Standard error	Probability distribution	Coefficient	Standard error	Probability distribution
Pro-vax	-2.679	0.288	32.1%	-2.085	0.182	37.6%
Refusers	6.259	0.779	49.6%	6.514	0.772	44.1%
Hesitant	1.628	0.166	18.3%	2.619	0.204	18.2%

Fig. 2. Latent class distribution by the 'opt-out' attribute.
Note: Latent Class model results. Latent class membership distribution stratified by ASC opt-out attribute (ASC = Alternative-specific constant); visually displays how different respondent subgroups are categorized by the model, derived from the Latent Class analysis coefficients. Sample size: Latvia $n = 1109$, Lithuania $n = 1010$.

religion, as a substantial body of research indicates its role as a contributing factor in vaccination uptake [25,26].

The Refusers class in both countries did not exhibit any statistically significant attribute preferences, suggesting indifference towards vaccine attributes and strong preferences against the vaccine option.

Therefore, we focus on the results for the Pro-vax and Hesitant classes. Fig. 3 illustrates the comparisons of Marginal Rates of Substitution (MRS) between the Pro-vax and Hesitant classes in Latvia and Lithuania. MRS quantifies the risk or attribute improvement required to offset changes in another vaccine attribute; higher MRS values reflect greater risk acceptance for a given attribute improvement.

Pro-vax respondents in both countries consistently preferred vaccines produced in the European Union, the United Kingdom, or the United States compared to a Chinese vaccine, while showing a markedly lower preference for vaccines developed in Russia—especially among Lithuanian Pro-vax.

Improvements in vaccine effectiveness compared to the baseline level (i.e., 40 % effectiveness) emerged as the second most important attribute in terms of increased willingness to accept risk: respondents in both countries and classes increasingly favored vaccines with higher effectiveness. However, longer protection duration did not correspond with greater willingness to accept risk; the highest utility was observed for a moderate duration of 12 months, rather than 24 months (compared to baseline of 3 months), suggesting a nonlinear association and possibly that extremely long protection periods may not offer additional perceived benefit.
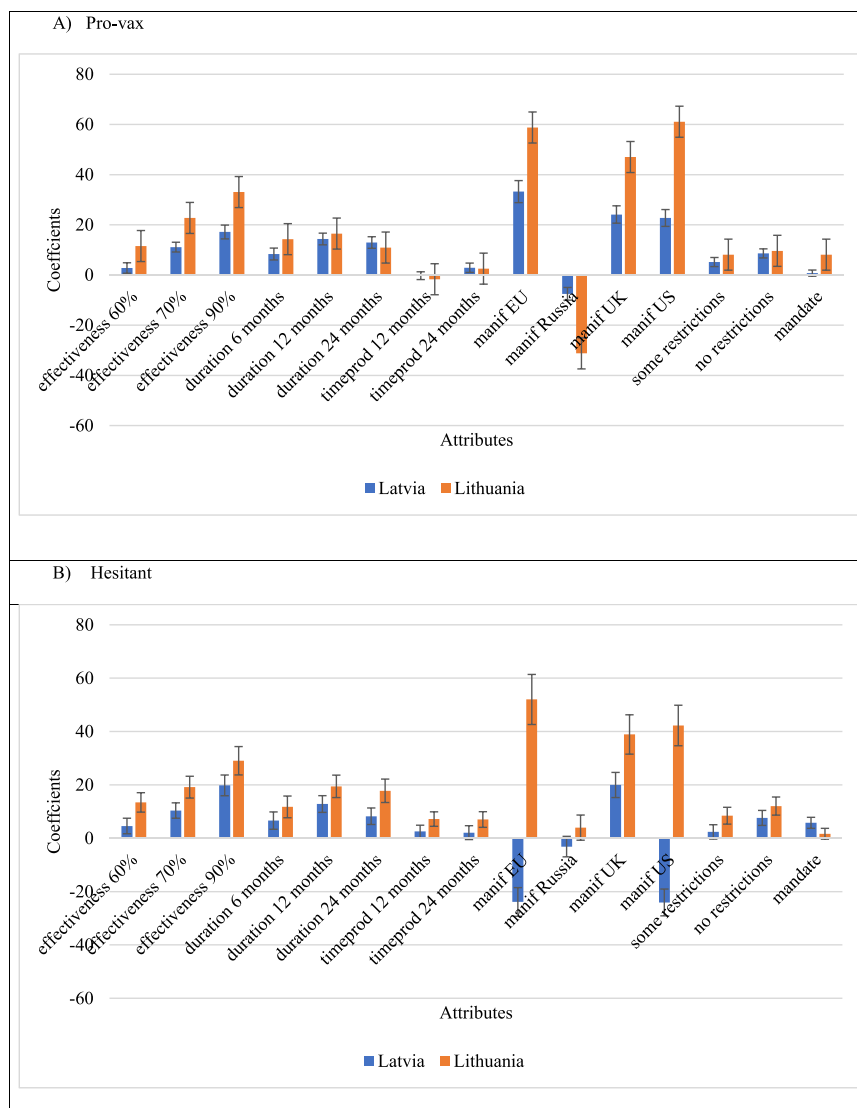

Fig. 3. Comparisons of the Marginal Rates of Substitution (per 100 000) in Latvian and Lithuanian Pro-vax (A) and Hesitant (B) classes.
Note: The Marginal Rates of Substitution are estimated from the Latent Class model coefficients. Marginal Rate of Substitution (MRS) measures respondents' willingness to accept increased risk for improvements in attribute levels compared to their baseline. Higher MRS values denote greater risk acceptance for perceived benefit.
Variables (for detail information see Table 2):
effectiveness – vaccine effectiveness,
duration – duration of protection,
timeprod – time between the first clinical trial and market approval,
manif – the origin of manufacturer,
restrictions – stringency of social restrictions,
mandates – vaccine mandates.

The speed of vaccine development was a significant factor only for Lithuanian Hesitant, indicating this subgroup's sensitivity to perceptions of how quickly a vaccine is brought to market.

Policy-related attributes—such as social restrictions and mandates—showed statistically significant but relatively modest associations. The most preferred condition in both countries was the absence of restrictions, suggesting a general preference for voluntary over mandatory approaches. However, this difference was very small among Lithuanian Pro-vax respondents, indicating a comparatively weaker aversion to mandates within that group.

Latent class analysis offered in-depth insights into preference heterogeneity for vaccine acceptance and rejection by accounting for a wide range of sociodemographic characteristics and behavioral factors. Coefficients in the Table 4 show associations between predictors and class membership probability. Positive coefficients indicate a greater likelihood of being in the specified class versus the reference (Hesitant).

Attitudinal and behavioural characteristics were the most important predictors of vaccination placements, referencing the Hesitant class, in both countries. TPHA emerged as a critical differentiator, though with different patterns: in Latvia, higher TPHA significantly increased the likelihood of being a Pro-vax and decreased Refusers membership, while in Lithuania, TPHA showed only a significant negative relationship with the Refusers class, suggesting that distrust drives rejection more than trust drives acceptance. Behavioral consistency was evident through prior COVID-19 vaccination status, which strongly predicted Pro-vax membership and significantly reduced Refusers likelihood in both countries, underscoring the continuity between past vaccination behavior and current attitudes. Similarly, general vaccine skepticism (VAX scale scores) was a robust predictor of Refusers membership in both countries, confirming that COVID-19 vaccine refusal reflects broader anti-vaccine attitudes rather than vaccine-specific concerns.

Some sociodemographic predictors showed more varied and country-specific patterns compared to attitudinal factors. A notable gender difference emerged only in Latvia, where women were significantly more likely to belong to the Refusers class, a pattern absent in Lithuania, suggesting different gendered responses to vaccine messaging between countries. Religious affiliation also varied by country: in

Lithuania, religious individuals were significantly less likely to belong to either Pro-vax or Refusers classes, indicating greater hesitancy among this group, while no such pattern was observed in Latvia. Interestingly, traditional sociodemographic divides (e.g. education and income) showed no significant associations with class membership in either country, suggesting that vaccine attitudes transcend these conventional socioeconomic boundaries and are more strongly driven by TPHA, prior behavior, and general vaccine attitudes.

Discussion and concluding remarks

This research substantially enhances comprehension of the changing dynamics of vaccine acceptance in two Baltic countries, Latvia and Lithuania, and underscores the necessity for tailored, context-specific approaches in vaccination policy and communication.

Notably, the analysis reveals significant proportions of the population sharing Refusers preferences in both countries, with our latent class analysis identifying that nearly half of respondents fall into the Refusers class (Latvia: 49.6 %, Lithuania: 44.1 %). This finding represents an escalation from earlier pandemic surveys conducted in 2021. For example, the January 2021 survey by the Research Centre SKDS indicated that 38 % of Latvian respondents expressed intention to refuse vaccination, while a Lithuanian population study conducted in August 2021 revealed that around 19 % of participants held negative opinions towards COVID-19 vaccines, while approximately 12 % were classified as unsure [27]. Our 2023 findings thus surpass these earlier results, thereby suggesting that vaccine refusal and hesitancy may have become more entrenched over time.

However, these high refusal rates in stated preferences appear to contrast with the relatively high COVID-19 vaccination rates reported in our sample in Latvia (71.7 %) and Lithuania (75.6 %). Two factors may reconcile this discrepancy between actual and stated behaviours. First, the hypothetical nature of our DCE, presenting a future pandemic scenario, elicits different responses than immediate, real-world threats. The COVID-19 pandemic involved urgent health risks, extensive public health campaigns, and social pressures that drove actual uptake beyond what stated preferences alone would predict. Second, experiences with COVID-19 vaccines, particularly their inability to prevent infection and waning effectiveness requiring boosters, likely heightened scepticism about future vaccines captured in our DCE. For example, a lower intent to get a COVID-19 booster vaccine has been reported from Lazarus et al. in a survey across 23 countries [28]. Thus, whilst actual behaviour under real pandemic conditions may differ from stated preferences, our DCE captures underlying hesitancy unmitigated by the exceptional circumstances that characterised the COVID-19 response.

Moreover, the timing of the surveys may also be a significant factor. Analysis employing representative data over the past 15 years indicates that perceptions of vaccine significance in Lithuania have evolved, and attitudes may be inconsistent [29]. Consequently, an increasing number of individuals may contemplate rejecting vaccination in the future. The study revealed that COVID-19 vaccination status and TPHA are important predictors of perception of vaccination in possible future emergency situation.

Crucially, our latent class analysis reveals that the Refusers class in both countries did not exhibit any statistically significant attribute preferences, suggesting indifference towards vaccine characteristics and strong preferences against vaccination per se. This finding indicates that nearly half the population in our sample demonstrates systematic vaccine avoidance that cannot be addressed through improvements in vaccine attributes alone, representing a fundamental challenge for future pandemic preparedness policies.

Furthermore, the study confirmed that TPHA is a crucial factor influencing attitudes towards vaccination in both Latvia and Lithuania, albeit with distinct patterns between countries. Latent class analysis indicates that in Latvia, heightened TPHA correlates with an increased propensity to support vaccination and a diminished possibility of being

Table 4
Class membership results (Reference group – Hesitant group).

	Latvia		Lithuania	
	Pro-vax	Refusers	Pro-vax	Refusers
Age above55	0.495**	0.446*	0.123	−0.041
	(0.217)	(0.246)	(0.207)	(0.242)
Female	−0.100	0.692***	−0.028	0.350
	(0.201)	(0.224)	(0.193)	(0.226)
Bachelor and over education	−0.195	−0.768	−0.249	0.123
	(0.209)	(0.239)	(0.229)	(0.254)
High income	−0.149	−0.191	0.096	0.083
	(0.240)	(0.292)	(0.378)	(0.446)
Religious	0.087	−0.117	−0.333*	−0.443*
	(0.206)	(0.233)	(0.201)	(0.238)
Trust public health authorities	0.527**	−1.187***	0.315	−0.748***
	(0.233)	(0.232)	(0.267)	(0.257)
Vax scale	−0.098	1.254***	−1.280	1.295***
	(0.134)	(0.142)		(0.142)
Fully vaccinated COVID-19	0.599	−1.847***	1.247***	−1.438***
	(0.409)	(0.333)	(0.471)	(0.339)

Notes: Latent Class model results. Coefficients represent the association between demographic and attitudinal variables and class membership probabilities in the Latent Class analysis. Positive coefficients show a higher likelihood of belonging to the specified class (e.g., Pro-vax, Refuser) relative to the reference group (Hesitant).

Samples: Latvia $n = 1109$, Lithuania $n = 1010$. Standard errors in parentheses below coefficients.

* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

categorised as a vaccine refuser. Conversely, in Lithuania, although the positive influence of TPHA on vaccination acceptance is less pronounced, distrust significantly drives vaccine rejection, indicating that the lack of trust exerts a greater effect than its existence. These insights are substantiated by population-based surveys. . A nationally representative survey in Lithuania, conducted in January 2021 [9], revealed that trust government authorities, science, and pharmaceutical firms significantly predicts vaccination intentions. A similar poll conducted in Latvia in September 2021 [10] confirms that institutional trust is directly correlated with vaccine uptake and the motivations behind vaccination decisions.

Consistent with the TPHA patterns, VAX scale scores—where higher values indicate more negative attitudes toward vaccines—are higher among Latvian respondents, supporting previous findings indicating that vaccine skepticism is more widespread in Latvia. Although we detect a moderate negative correlation between being vaccinated and VAX scale scores (−0.38 in Latvia; −0.50 in Lithuania), including both variables in our model allows us to control not only for respondents' COVID-19 vaccination behaviour but also for their broader attitudes toward vaccines in general. This distinction is important, as COVID-19 vaccines have been highly politicised [30], and, unlike other vaccines such as those for measles or tuberculosis, they do not prevent infection but rather significantly reduce the severity of the disease. As a result, some respondents may generally hold positive views about vaccination while remaining more cautious or even averse to the COVID-19 vaccine specifically.

Overall, our study indicates that social limitations and requirements had limited relationship with vaccination preferences. Policy-related attributes—such as social restrictions and mandates—showed statistically significant but relatively modest associations, with the most preferred condition in both countries being the absence of restrictions, suggesting a general preference for voluntary over mandatory approaches. This study raises an issue regarding the appropriateness of coercive policy instruments when vaccine resistance arises from broad scepticism rather than specific vaccine concerns.

A final noteworthy aspect concerns gender and religious differences. Specifically, a major gender disparity was detected solely in Latvia, where women were much more inclined to belong to the Refusers class—a pattern not evident in Lithuania. Religious affiliation added complexity; reluctance was heightened among religious individuals in Lithuania, while no such effect was observed in Latvia, one of Eastern Europe's most secular nations. The reluctance among the religious population appears paradoxical for Lithuania, considering that Roman Catholicism is a fundamental aspect of Lithuanian identity and culture, and that the Catholic Church has ardently endorsed COVID-19 vaccination. When the relationship between religion and the State focuses on the Roman Catholic Church and State authorities, the model of religious pluralism in Lithuania creates hierarchical dynamics between the State and various religious groups, resulting in religious inequality [31]. In this context, we may observe the impact of the status of religious minorities, as scientific evidence suggests that when an association was established between individuals' religious beliefs and uptake, minority religious groups demonstrated reduced probabilities of uptake [32].

Limitations

Despite the methodological rigour, comparative cross-national design, extensive behavioural segmentation, and qualitative socio-political contextualisation of vaccination acceptability in two Baltic countries, some limitations of this study should be acknowledged. Although demographically balanced, dependence on online panels may inadequately reflect populations with restricted internet access. Secondly, the collecting of data towards the end of the epidemic may have had an impact on the results, as the pandemic experience could have altered preferences. Moreover, surveys in Latvia and Lithuania were executed across disparate periods (late 2022 versus mid-2023), perhaps

resulting in contextual variations in public discourse or pandemic fatigue.

Comparative policy implications for Latvia and Lithuania

Latvia and Lithuania demonstrate that around 43–48 % of their inhabitants belong to a class marked by indifference or disengagement towards vaccine features, which correlates with diminished vaccination rates and TPHA. Importantly, this underscores a deep-seated scepticism that cannot be mitigated solely through enhancements in vaccine characteristics.

Furthermore, TPHA is the most significant predictor of vaccination acceptance: in Latvia, trust enhances pro-vaccine sentiment, whereas in Lithuania, distrust more profoundly influences rejection than trust does acceptance. Consequently, trust reconstruction serves as the focal point. Specifically, it is essential to implement long-term public communication initiatives aimed at addressing trust erosion; to create behavioural surveillance systems that monitor TPHA and vaccine confidence among various demographic groups. Additionally, the digital tools developed during the pandemic should be further refined to enhance knowledge of individual immunisations and to facilitate communication between the general population and public health as well as primary care professionals.

Moreover, prior COVID-19 vaccination significantly forecasts future uptake of new pandemic vaccinations, suggesting a path dependency in the development of health behaviours. Notably, the relationships between gender and religious affiliation with vaccine attitudes vary by country, requiring tailored segmentation in preparedness programs to properly address different behavioural aspects.

Conversely, coercive measures, such as mandates and passports, exhibit only a slight association with vaccination desire, indicating that these methods may be counterproductive in low-trust contexts by strengthening oppositional identities. Therefore, future vaccine policies ought to supplant coercion with empathetic, deliberate strategies—facilitating public discourse and participatory risk communication.

Statement: During the preparation of this work the authors used QuillBot for editing. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Ethical approval

Ethics approval has been obtained by the Human Care and Ethics Committee of the University of Newcastle (n. H-2021–0363).

CRediT authorship contribution statement

Liubove Murauskiene: Conceptualization, Writing – original draft, Writing – review & editing, Funding acquisition. **Daiga Behmane:** Writing – review & editing, Funding acquisition. **Ausra Berzanskyte:** Writing – review & editing, Visualization.

Declaration of competing interest

None declared.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.hlpt.2025.101146.

References

[1] Ten threats to global health in 2019 [Internet]. 2019 [cited 2025 Mar 21]. Available from: https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019.

[2] Hess S, Lancsar E, Mariel P, et al. The path towards herd immunity: predicting COVID-19 vaccination uptake through results from a stated choice study across six continents. Soc Sci Med 2022 Apr 1;298:114800 [Internet]Available from: https://www.sciencedirect.com/science/article/pii/S027795362200106X.

[3] Lithuania: country health profile 2023 [Internet], https://www.oecd.org/en/publications/lithuania-country-health-profile-2023_5ed683c8-en.html; 2023 Dec.

[4] Latvia: country health Profile 2023 [Internet], https://www.oecd.org/en/publications/latvia-country-health-profile-2023_bf2b15d6-en.html; 2023 Dec.

[5] Webb E, Winkelmann J, Scarpetti G, et al. Lessons learned from the Baltic countries' response to the first wave of COVID-19☆. Health Policy (New York) 2022 May 1;126(5):438–45. https://doi.org/10.1016/j.healthpol.2021.12.003 [Internet]Available from: https://www.sciencedirect.com/science/article/pii/S0168851021002931.

[6] Šteinbuka I, Austers A, Barānovs O, Malnačs N. COVID-19 lessons and post-pandemic recovery: a case of Latvia. Front Public Health 2022 Apr 7;10 [Internet] Available from: https://www.frontiersin.org/journals/public-health/articles/10.3389/fpubh.2022.866639/full.

[7] Antonini M, Genie MG, Attema AE, et al. Public preferences for vaccination campaigns in the COVID-19 endemic phase: insights from the VaxPref database. Health Policy Technol 2024 Mar;13(1):100849. https://doi.org/10.1016/j.hlpt.2024.100849 [Internet]Available from: https://linkinghub.elsevier.com/retrieve/pii/S2211883724000121.

[8] Eiduks K, Ozola E. They will force everyone": main themes in latvian COVID-19 anti-vaccine movement on Facebook, 247. SSE; 2022 [Internet]Available from: https://www.sseriga.edu/sites/default/files/2022-11/5Paper_Eiduks_Ozola.pdf.

[9] Galdikiene L, Jaraite J, Kajackaite A. Trust and vaccination intentions: evidence from Lithuania during the COVID-19 pandemic. PLoS One 2022 Nov 23;17(11): e0278060. https://doi.org/10.1080/21642850.2022.2085108 [Internet]Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0278060. Šuriņa S, Mārtinsone K, Upesleja G, Perepjolkina V. Factors associated with COVID-19 vaccination behaviour in Latvian population: cross-sectional study. Health Psychol Behav Med [Internet]. 2022 Dec 31;10(1):514–36. Available from: https://www.tandfonline.com/doi/full/10.1080/21642850.2022.2085108.

[10] Šuriņa S, Mārtinsone K, Upesleja G, Perepjolkina V. Factors associated with COVID-19 vaccination behaviour in Latvian population: cross-sectional study. Health Psychol Behav Med 2022 Dec 31;10(1):514–36. https://doi.org/10.1080/21642850.2022.2085108 [Internet]Available from:.

[11] Lucane Z, Kursite M, Sablinskis K, Gailite L, Kurjane N. COVID-19 vaccination coverage and factors influencing vaccine hesitancy among patients with inborn errors of immunity in Latvia: a mixed-methods study. Vaccines (Basel) 2023 Nov;11(11):1637. https://doi.org/10.3390/vaccines11111637 [Internet]Available from: https://www.mdpi.com/2076-393X/11/11/1637.

[12] Nacionalinis visuomenės sveikatos centras prie Sveikatos apsaugos ministerijos. 2023 m atliktos Lietuvos gyventojų žinių ir nuomonės apie vakcinaciją apklausos rezultatų analizė. Vilnius: Nacionalinis visuomenės sveikatos centras; 2023 [Internet][cited 2025 Mar 21]. Available from: https://nvsc.lrv.lt/public/canonical/1727065252/4864/Analiz%C4%97%2B2024-09-20.pdf.

[13] Antonini M, Genie MG, Attwell K, et al. Are we ready for the next pandemic? Public preferences and trade-offs between vaccine characteristics and societal restrictions across 21 countries. Soc Sci Med 2025 Feb 1;366:117687. https://doi.org/10.1016/j.socscimed.2025.117687 [Internet]Available from: https://www.sciencedirect.com/science/article/pii/S0277953625000164.

[14] Izmailova ES. The system of epidemic control in the USSR: short essay on its history. 20th Century sciences: beyond the metropolis. Paris: ORSTOM Éditions;

[15] 1996. p. 109–18 [Internet](Les sciences hors d'Occident au XXe siècle). Available from: https://horizon.documentation.ird.fr/exl-doc/pleins_textes/pleins_textes_7/carton07/010008877.pdf.

[15] Tyshler J, Manning N. How a Soviet past influences the present: vaccine hesitancy in the Russian-speaking population today. J Stud Res 2022 May 31;11(2). https://doi.org/10.47611/jsrhs.v11i2.2880 [Internet]Available from: https://www.jsr.org/hs/index.php/path/article/view/2880.

[16] Kurpas D, Stefanicka–Wojtas D, Soll–Morka A, et al. Vaccine hesitancy and immunization patterns in Central and Eastern Europe: sociocultural, economic, political, and digital influences across seven countries. Risk Manag Healthc Policy 2025 Jun 12;18:1911–34. https://doi.org/10.2147/RMHP.S519479 [Internet] Available from: https://www.dovepress.com/vaccine-hesitancy-and-immunization-patterns-in-central-and-eastern-eur-peer-reviewed-fulltext-article-RMHP.

[17] Vuolanto P, Almeida AN, Anderson A, et al. Trust matters: the addressing vaccine hesitancy in Europe study. Scand J Public Health 2024 May 1;52(3):379–90. https://doi.org/10.1177/14034948231223791 [Internet]Available from:.

[18] Gómez-Bravo R, Ares-Blanco S, Gefaell Larrondo I, et al. The use of COVID-19 mobile apps in connecting patients with primary healthcare in 30 countries: eurodata study. Healthcare. 2024;12(14):1420. https://doi.org/10.3390/healthcare12141420.

[19] COVID-19 vaccine tracker | European Centre for Disease Prevention and Control [Internet]. [cited 2025 Apr 5]. Available from: https://vaccinetracker.ecdc.europa.eu/public/extensions/covid-19/vaccine-tracker.html?fbclid=IwY2xjawLbIlRleHRuA2FlbQIxMQBicmlkETB4TGdiaUlEeXN3UjVhVEpIAR5V2o1fMUzTbrzpNV6qe6pS2jcrHmUsNBS8vR7lRq8aUDW4i5Ya272TJrNajw_aem_IF_cyaqkl0HpnNgn8il8fg#uptake-tab.

[20] Johnson FR, Lancsar E, Marshall D, et al. Constructing experimental designs for discrete-choice experiments: report of the ISPOR Conjoint Analysis Experimental Design Good research Practices Task Force. Value Health 2013 Jan 1;16(1):3–13. https://doi.org/10.1016/j.jval.2012.08.2223 [Internet]Available from: https://www.valueinhealthjournal.com/article/S1098-3015(12)04162-9/fulltext?_returnURL=https%3A%2F%2Flinkinghub.elsevier.com%2Fretrieve%2Fpii%2FS1098301512041629%3Fshowall%3Dtrue.

[21] Boxebeld S. Ordering effects in discrete choice experiments: a systematic literature review across domains. J Choice Model 2024 Jun 1;51:100489. https://doi.org/10.1016/j.jocm.2024.100489 [Internet]Available from: https://www.sciencedirect.com/science/article/pii/S1755534524000216.

[22] McFadden D, Zarembka P. Conditional logit analysis of qualitative choice behavior. Front Econometr 1974:105–42.

[23] Hess S. Latent class structures: taste heterogeneity and beyond. Handbook of choice modelling. Edward Elgar; 2014. p. 311–30 [Internet]Available from: https://www.stephanehess.me.uk/papers/book_chapters/Hess_2014.pdf.

[24] Vass CM, Wright S, Burton M, Payne K. Scale heterogeneity in healthcare discrete choice experiments: a primer. Patient 2018;(11):167–73. https://doi.org/10.1007/s40271-017-0282-4. Available from:.

[25] Tiwana MH, Smith J. Faith and vaccination: a scoping review of the relationships between religious beliefs and vaccine hesitancy. BMC Public Health 2024 Jul 6;24 (1):1806. https://doi.org/10.1186/s12889-024-18873-4 [Internet]Available from: .

[26] Trangerud HA. What is the problem with vaccines?" A typology of religious vaccine skepticism. Vaccine X 2023 Aug 1;14:100349. https://doi.org/10.1016/j.jvacx.2023.100349 [Internet]Available from: https://www.sciencedirect.com/science/article/pii/S2590136223000906.

[27] Latvian Public Media. 38% of Latvian population say they will refuse vaccination, study shows [Internet]. [cited 2025 Jul 7]. Available from: https://eng.lsm.lv/article/society/society/38-of-latvian-population-say-they-will-refuse-vaccination-study-shows.a390168/.

[28] Lazarus JV, White TM, Wyka K, et al. Influence of COVID-19 on trust in routine immunization, health information sources and pandemic preparedness in 23 countries in 2023. Nat Med 2025;30(6):1559–63. Available from: https://pubmed.ncbi.nlm.nih.gov/38684861/.

[29] Valinciute A, Schäfer MS. Lithuanians' perceptions of vaccination and their sources of information: a literature review. Int J Public Health 2020 Jul 1;65(6):981–91. https://doi.org/10.1007/s00038-020-01389-0 [Internet]Available from:.

[30] Bardosh K, de Figueiredo A, Gur-Arie R, et al. The unintended consequences of COVID-19 vaccine policy: why mandates, passports and restrictions may cause more harm than good. BMJ Glob Health 2022 May 26;7(5). https://doi.org/10.1136/bmjgh-2022-008684 [Internet]Available from: https://gh.bmj.com/content/7/5/e008684.

[31] Alisauskiene M. Religion and state relations in contemporary Lithuania: development and critical points of interaction [Internet] Notes de l'Observ 2018 [cited 2025 Jul 9]. Available from: https://obsreligion.cnrs.fr/note/religion-and-state-relations-in-contemporary-lithuania-development-and-critical-points-of-interaction/.

[32] de Figueiredo A, Simas C, Karafillakis E, Paterson P, Larson HD. Mapping global trends in vaccine confidence and investigating barriers to vaccine uptake: a large-scale retrospective temporal modelling study. Lancet 2020 Sep 26;396(10255): 898–908. https://doi.org/10.1016/S0140-6736(20)31558-0 [Internet]Available from, https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)31558-0/fulltext.