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## Determinants of COVID-19 vaccine hesitancy and resistance in Russia

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## ABSTRACT

Vaccination is the main tool available to handle the COVID-19 pandemic globally. Though no vaccine is proven to be 100% effective, vaccination secures against getting seriously ill and dying from the disease. Russia announced the development of its first domestic vaccine back in August 2020 and launched the nationwide immunization campaign at the beginning of 2021. Despite these achievements, as of mid-October 2021, only 36% of the population got at least one shot of the vaccine. Massive vaccination hesitancy and refusal pose a great threat to public health and postpone social and economic recovery. Using nationally representative data from the general adult population of Russia, this study explores the scope of vaccination hesitancy and refusal as well as the determinants of vaccination attitudes. The results suggest that only 45% of the Russian population demonstrated positive attitudes towards the COVID-19 vaccination prior to the launch of a nationwide vaccination program. We analyze a wide array of demographic, socio-economic, and health-related factors in relation to vaccination intentions and explore the deep-rooted causes of vaccination reluctance by looking at personality traits, religiosity, and trust. The obtained results are vital for designing policy measures to promote vaccination.

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## 1. Introduction

The world has been facing the global pandemic of COVID-19 since March 2020. As of 21 October 2021, the cumulative number of COVID-19 cases reported globally exceeded 242 million, and that of deaths was already over 4.9 million. Russia demonstrates one of the highest numbers of infected individuals in the world, ranking 8th globally with over 8 million cumulative cases or almost 55,000 cases for every 1 million of population. The death rates are also high with a total of over 223,000 confirmed deaths or 1,530 fatal cases for every 1 million of population [1]. To date, the disease has no medication with proven efficacy as yet, while treatment remains predominantly symptomatic [2]. (SEE Table 1).

Under these circumstances, vaccination is viewed as the most effective tool to handle the pandemic. Russia announced its first domestic vaccine Gam-COVID-Vak, also known as “Sputnik V”, in August 2020, when it was approved and registered by the Ministry of Health of the Russian Federation. The Phase III trial was conducted in September–November 2020 with the results claiming 91.6 % efficacy against COVID-19 [3]. A mass immunization cam-

paign was launched in Moscow in December 2020, followed with a nationwide campaign in January 2021. Vaccination is available free of charge for the whole adult population.

Despite significant achievements in developing and producing a domestic vaccine as well as launching the vaccination campaign, vaccination rates in Russia remain remarkably low, relative to what has been reported to date in other countries. As of mid-October 2021, ten months after the start of the national immunization program, only 36 % of the population has had at least one shot of the vaccine [1]. This is an especially low figure given the fact that the vaccine has been available simultaneously for the whole population and not for the most vulnerable groups, as observed in many European countries [4]. Moreover, this rate was reached only after the implementation of administrative enforcement in June 2021, when employees of several industries were obligated to receive immunization [5]. One month prior to obligatory vaccination, only 9 % of the population received at least one dose of the vaccine. In the meantime, by October 2021, 48 % of the population globally had received at least one dose of a COVID-19 vaccine, with the highest levels of uptake reaching over 95 % in certain countries (UAE), 14 countries covering more than 70 % of the population, and another 3 countries covering at least 60 % of their respective population [1].

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**Table 1**  
Determinants of vaccination attitudes, base outcome – conditional acceptance, RRR.

	Certain acceptance	Hesitancy	Resistance
<b>Demographic and socio-economic factors</b>			
Male	0.901 (0.0898)	0.995 (0.0870)	0.956 (0.0568)
Age/10	0.838 (0.147)	0.503*** (0.0712)	0.812** (0.0843)
Age squared /100	1.016 (0.0175)	1.072*** (0.0143)	1.030*** (0.0103)
Married	0.946 (0.0929)	1.052 (0.0969)	0.971 (0.0598)
Number of children under 18	0.819*** (0.0583)	0.840*** (0.0546)	1.006 (0.0350)
Presence of elderly family members 65+	1.014 (0.0842)	0.836** (0.0647)	0.860*** (0.0456)
Vocational college	1.155 (0.127)	0.897 (0.0865)	0.822*** (0.0558)
University education	1.107 (0.127)	0.831* (0.0824)	0.873** (0.0590)
Employed	1.302** (0.159)	1.143 (0.128)	0.955 (0.0722)
Unemployed	0.960 (0.357)	0.930 (0.281)	0.974 (0.195)
Student	1.057 (0.289)	0.617** (0.152)	0.863 (0.149)
Ln household per capita income	1.006 (0.0349)	0.972 (0.0249)	1.010 (0.0195)
Regional center (reference category – Moscow and Saint Petersburg)	0.849 (0.187)	0.445*** (0.0746)	0.639*** (0.0770)
City	0.532*** (0.121)	0.454*** (0.0779)	0.560*** (0.0700)
Village	0.807 (0.177)	0.451*** (0.0793)	0.580*** (0.0729)
<b>Behavioral patterns and personality traits</b>			
Openness to experience	0.956 (0.0523)	1.030 (0.0473)	1.011 (0.0334)
Conscientiousness	1.024 (0.0577)	0.839*** (0.0397)	1.015 (0.0338)
Extraversion	0.902** (0.0457)	0.948 (0.0411)	0.975 (0.0280)
Agreeableness	1.260*** (0.0678)	0.960 (0.0443)	1.064** (0.0332)
Neuroticism	1.069 (0.0524)	0.909** (0.0377)	1.148*** (0.0334)
Risk loving	1.005 (0.0495)	1.007 (0.0450)	1.165*** (0.0332)
Never visits religious services/non-believer (reference category – several times a year)	1.203* (0.116)	1.139 (0.0945)	1.391*** (0.0798)
Visits religious services once a month or more	0.946 (0.198)	0.856 (0.166)	1.352** (0.164)
General trust	0.834 (0.104)	1.394*** (0.144)	0.747*** (0.0550)
Does not use social media (reference category – uses every day)	1.559*** (0.194)	1.055 (0.114)	0.920 (0.0664)
Uses social media rarer than once a week	2.376*** (0.603)	1.711** (0.422)	1.219 (0.223)
Uses social media 2–3 times a week	1.359** (0.186)	0.963 (0.127)	0.759*** (0.0679)
<b>Self-rated health and COVID-19 experiences</b>			
Self-rated health - very bad (reference category – not bad but not good)	0.824 (0.661)	2.041* (0.881)	2.178** (0.751)
Self-rated health - bad	0.818 (0.139)	1.247* (0.164)	0.906 (0.0852)
Self-rated health - good	1.056 (0.110)	0.936 (0.0893)	0.910 (0.0581)
Self-rated health - very good	4.239*** (1.225)	0.565 (0.263)	2.155*** (0.496)
Had positive COVID-19 test or antibodies	2.170*** (0.565)	0.906 (0.238)	1.850*** (0.311)
COVID-19 case among family members	1.017 (0.272)	1.220 (0.267)	1.142 (0.182)
COVID-19 case among acquaintances	0.898 (0.0833)	0.878 (0.0725)	0.819*** (0.0462)
Regional 7-day moving average of incidence rate	0.881 (0.0829)	1.086 (0.0723)	1.144*** (0.0522)

Table 1 (continued)

	Certain acceptance	Hesitancy	Resistance
Self-perceived probability to get infected	1.019 (0.0459)	1.065* (0.0394)	0.851*** (0.0233)
Constant	0.376 (0.236)	3.494** (1.741)	2.680*** (0.985)
N = 8,529 Wald $\chi^2(102) = 720.88$ Prob > $\chi^2 = 0.0000$ Log pseudolikelihood = -9662.83 Pseudo R <sup>2</sup> = 0.0406 *** p < 0.01, ** p < 0.05, * p < 0.1			

Vaccination resistance and hesitancy pose serious risks to public health. Vaccination hesitancy is defined as having doubts about getting vaccinated, while resistance refers to objecting to vaccine despite its availability [6]. To our knowledge, there are only two cross-country studies [7–8] that reported the scope of vaccination hesitancy and refusal related to COVID-19 in Russia. However, the factors underlying vaccine attitudes need more attention. In this study, we estimate the scope of vaccination hesitancy and resistance in Russia prior to the start of the vaccination campaign, and examine a wide array of sociodemographic, health-related, and other determinants of vaccination attitudes. We look at vaccination intentions and highlight the deep-rooted causes of vaccination reluctance by looking at personality traits, religiosity, and trust. Although we focus on Russia, our results can be relevant for other countries, especially Eastern Europe due to shared aspects of culture [9] and lower levels of trust in these countries [10]. Unlike a large fraction of previous studies [11–13], this research is based on data from a reputable panel survey, covering a representative sample of the general adult population. Though this is not the first nationwide study dedicated to vaccine hesitancy in Russia [14], previous studies briefly explained high levels of vaccine hesitancy in the country with lack of information. This paper, based on data of better quality, shows that the reasons behind vaccination attitudes are more complex than generally considered and that there are social, economic, and psychological drivers behind them, as suggested in recent literature [15]. Identifying the factors that provoke vaccination hesitancy and resistance is vital for tailoring effective promotion and covering a larger portion of the population.

## 2. Background

Vaccine hesitancy and resistance is a common problem that existed long before the COVID-19 era. Even though the invention of vaccines allowed to dramatically reduce morbidity and mortality from infectious diseases, vaccination has always faced resistance from people fearing possible side effects [16]. Prior to the COVID-19 pandemic, vaccination hesitancy has been identified as one of the top ten threats to global health [17].

Attitudes towards vaccination are formed through complex interactions between different personal (i.e., socio-demographic, economic, psychological, health-related) and external factors. Several models were proposed to integrate the previous literature dedicated to the determinants of hesitancy. “3Cs” concept distinguishes three main elements underlying vaccination acceptance. These are complacency, which implies low perceived risks of the disease; convenience, which refers to vaccine availability and affordability; and confidence, meaning trust in vaccine safety and effectiveness as well as trust in the health care system, which delivers the vaccine, and authorities [18]. We proceed by considering several groups of factors that have consistently been shown to affect vaccination intentions.

### 2.1. Demographic and socio-economic factors

Research suggests that males are more inclined to get vaccinated in general and to receive a vaccine shot against COVID-19 [19–21]. However, comparative studies, analyzing evidence from different country settings, show mixed results [7]. Cultural framework, tendency to believe rumors, psychological factors specific to men and women, may serve as an explanation for the gender gap in vaccine uptake [22]. Age is another significant correlate of vaccination intentions. While younger groups are mainly reluctant to get vaccinated, those at risk (elderly groups 65 + ) generally demonstrate positive attitudes towards vaccination, which is consistent across different countries [19,23].

Evidence concerning the impact of education on vaccination attitudes is inconclusive. In some countries higher education is associated with the reduced chances of vaccine hesitancy and refusal [19,21,23], while in others, education either does not demonstrate any statistically significant relationship with vaccination intentions [20] or increases the chances of negative attitudes [13]. Alongside education, individual employment status and income have been shown to determine vaccination attitudes, with unemployed individuals demonstrating negative perceptions about vaccine safety and effectiveness across countries [24]. Similarly, income group appears to be one of the largest predictors of vaccine reluctance, with higher income being positively associated with vaccine acceptance [7,11,25].

### 2.2. Behavioral patterns and personality traits

Personality traits determine individual ways of thinking and behavioral patterns, which in the context of the pandemic may affect the vaccination intentions. In the current study, we rely on the well-established personality taxonomy “the Big Five” [26], which suggests that an individual can be described from the point of five broad categories: conscientiousness, openness to experience, neuroticism, agreeableness, and extraversion. Previous research has stated that the Big Five significantly influences individual health behaviors [27]. Regarding the current pandemic, individuals low in agreeableness [28] and conscientiousness, but high in neuroticism, tend to express negative attitudes towards COVID-19 vaccination [25].

Attitudes towards risk may serve as another psychological factor influencing vaccination intentions. Studies show that risk perceptions are biased: people tend to value natural risks, such as the probability to contract COVID-19, more favorably compared to man-made risks, such as getting side effects from the vaccination [22]. The perceived risk of the severity of the disease and of getting ill are significantly positively correlated with the probability to get vaccinated against the coronavirus [29].

There is a vast literature dedicated to the link between religious beliefs and vaccine hesitancy. In the context of the COVID-19 pan-

demic, religiosity is reportedly positively associated with vaccine hesitancy and refusal [21,25].

Lastly, the unwillingness to get vaccinated is reportedly strongly associated with a lack of trust in the vaccine safety and efficacy. Establishing this kind of trust requires trust in the authorities, the official sources of information, and the health care system which delivers the vaccine to the public. Those individuals who claim to trust institutions generally demonstrate higher levels of vaccine acceptance [7]. In contrast, those resistant to COVID-19 vaccine show lower levels of trust and prefer alternative sources of information [25]. Social media is one of such alternative sources. Those individuals who use social media as the main source of information are more inclined towards vaccination hesitancy [30] as social networks provide a platform for anti-vaccination activists to spread their views to wider audiences [31].

### 2.3. Health-related factors and COVID-19 experience

Some research states that neither chronic diseases nor COVID-19 related experiences (i.e., quarantine status, infection, or deaths of someone close) are statistically significant for vaccination attitudes [20]. International data prove this finding, suggesting that being sick or having family members sick with COVID-19 is not associated either with vaccination hesitancy, or with vaccination acceptance [7].

## 3. Methods

### 3.1. Data

For this study, data were drawn from a national panel household survey “Russian Longitudinal Monitoring survey”, RLMS-HSE [32], which is the most reputable non-state open data widely used in social science research. The survey has been conducted annually since 1994 and uses multistage probability sampling with primary sampling units selected from geographically determined strata, making it nationally representative. Besides representativeness and large sample size, RLMS-HSE has other important advantages. First, it covers a wide spectrum of individual demographic, socio-economic, health-related, psychological, behavioral, and other characteristics. Second, to our knowledge, it is the only open-source active panel dataset in Russia and its panel nature allows it to include characteristics from previous waves. In the global context, RLMS-HSE is similar to The German Socio-Economic Panel (GSOEP) [33]. We use the most recent data which were collected from October to January 2021 prior to the vaccine rollout. The resulting representative weighted sample consists of 8,529 adult individuals aged 18 or above. The model containing trust in institutions as an independent variable includes 7,046 observations due to sample attrition. Though data related to vaccine attitudes in Russia were collected earlier in other studies [8,14], these were cross-sectional cross-country studies with a limited number of socio-demographic variables.

### 3.2. Dependent variable - vaccination intentions

In 2020, a special block of questions, dedicated to individual behavior during the pandemic, was introduced to the survey. Vaccination intentions were assessed with the following question: “Are you planning to get vaccinated against COVID-19 once the vaccine becomes available?”. Therefore, the question did not mention any vaccine in particular. The answer choices were: “I will certainly get vaccinated”, “I will get vaccinated but only if I am sure about vaccine safety and reliability”, “I will not get vaccinated”, “Not sure whether I will get vaccinated”, “I have already recovered

from COVID-19 and I find it unnecessary to be vaccinated”, “I have already been vaccinated”. We removed the observations with the last two options from the sample as they do not represent vaccination attitudes.

We explore the link between vaccination intentions and four broad groups of explanatory variables, which are: 1) demographic and socio-economic factors; 2) behavioral patterns and personality traits, including trust; and 3) health-related factors.

### 3.3. Independent variables

The first group of factors includes gender, age (divided by 10 and its square divided by 100 to capture possible non-linearities), marital status (a binary variable that equals 1 if the respondent is married either formally or informally, and 0 otherwise), number of children younger than 18 years old, the presence of elderly family members (65 years old and above), the type of settlement (a categorical variable, including Moscow and Saint-Petersburg as a reference category, regional center, city, or village), level of education (a categorical variable, including university degree, vocational college, or no professional education as a reference category), employment status (a categorical variable, including employed, unemployed, studying, or inactive as a reference category), and the logarithm of the household's per capita income.

To address personality traits, we use a survey module consisting of 24 questions, each representing a facet related to one of the Big Five categories (for complete mapping, see Table 1A in the Appendix). Responses are self-evaluated on a scale from 1 to 4, depending on the frequency with which the facet is reflected in the respondent's daily behavior. Each of the five categories is calculated as an average of the corresponding facets, standardized with the mean of 0 and a standard deviation of 1. In addition, we measure individual risk attitudes. The survey module consists of 6 questions, each representing the respondent's willingness to take risks, either in general or in certain situations related to health, work safety, career promotion, driving, and financial decisions. Responses are self-evaluated on a scale from 0 (“not prepared to risk at all”) to 10 (“always prepared to take risks”). Risk attitude is calculated as an average of all the questions (if the respondent does not drive, the measure was calculated based on the remaining 5 questions) and standardized with the mean of 0 and a standard deviation of 1. We also look at the impact of religiosity on vaccination attitudes by including the frequency of attending religious services in the model (a categorical variable, including at least once a month, several times a year or less as a reference category, and never or non-believers).

We include two measures of trust into our analysis. The first measure represents the general level of trust and is measured with the following question: “Do you think that most people can be trusted or that one always has to be cautious with other people?”. This measure is the main and it is present in all the models. The second measure represents the level of trust in institutions and is measured with a set of consecutive questions formulated as follows: “To what extent do you trust: 1) the government; 2) the State Duma (the lower house of the Russian parliament)?” The correlation between the two questions is relatively high and significant (corr = 0.868,  $p < 0.01$ ). The questions were asked in 2018 but the panel nature of the survey allows us to attach these data to our 2020 sample. The overall level of trust in institutions is calculated as an average of these questions standardized with the mean of 0 and a standard deviation of 1 (results for this regression are present in Table 3A in the Appendix). Finally, we control for the frequency of social media use (a categorical variable, including every day as a reference category, 2–3 times a week, once a week or less, does not use social media at all) as a source of alternative information about COVID-19 and vaccination.

Finally, we look at the link between health-related factors and vaccination intention. By health-related factors we refer to self-rated health, COVID-19 experiences, and the epidemiological situation in the region of residence at the time of the survey. Individual self-rated health can be “very good”, “good”, “average” as a reference category, “bad”, and “very bad”. Additionally, we look at COVID-19 related experiences such as the presence of confirmed cases among family members (a binary variable), the presence of confirmed cases among acquaintances (a binary variable), personal confirmed case of COVID-19 in the past (a binary variable), and the self-perceived probability to get infected in the following 12 months, measured on a scale from 1 to 10 and standardized with the mean of 0 and a standard deviation of 1. Since Russia is a large country with a heterogeneous epidemiological situation across different regions, we additionally control for COVID-19 incidence rate in each region, measured as a 7-day moving average preceding the day of the survey.

### 3.4. Statistical analysis

We estimate multinomial logistic regression models to examine the impact of various factors on vaccination attitudes. First, we estimate a model where the dependent variable is vaccination intention, with four options: certain acceptance (the category includes those individuals who answered “I will certainly get vaccinated”), conditional acceptance (those who answered they would get vaccinated depending on the safety and reliability of the vaccine), resistance (those who answered they would not get vaccinated), and hesitancy (those who answered “Not sure whether I will get vaccinated”). The base outcome is conditional acceptance. We additionally present the results for the model with resistance as the base outcome (see Tables 4A and 5A in the Appendix). We suggest that a multinomial model is a better fit for the data compared to ordered models since a proportional odds assumption is not fulfilled in our data.

We conducted a sensitivity analysis to test for the robustness of our models in the presence of methodological changes. First, we estimated the same models with an age limitation of 18–60. The results remained practically unchanged, supporting the robustness of the results. Second, we estimated separate models for men and women since it is well-established that men and women differ a lot in their health behaviors [34]. We provide separate results for men and women in Table 6A of the Appendix.

In order to properly interpret the results, we estimated relative risk ratios (RRR) with corresponding 95 % confidence intervals (CI) and robust SEs due to heteroskedasticity. RRR greater than 1 shows that the risk of the outcome in the comparison group relative to the risk of the outcome in the referent group increases as the variable of interest increases. Similarly,  $RRR < 1$  shows the decrease of the risk as the variable of interest increases.  $RRR = 1$  indicates that the risk of the outcome in the comparison group is the same relative to the referent group.

## 4. Results

At the time of the survey, 8 % were certain about getting vaccinated once the vaccine became available, 36 % would get vaccinated if they were sure of the safety and reliability of the vaccine, 44 % were strongly resistant towards vaccination, while the remaining 12 % were hesitant.

### 4.1. Descriptive results attitudes

Table 2A in the Appendix summarizes mean values of explanatory variables across different vaccination intention groups. There

are no significant differences either in mean age across intention groups (50 years in the total sample) or in gender composition (40 % of the sample are males), but these groups seem to vary in terms of educational composition. The main cities, Moscow and Saint Petersburg, demonstrate higher proportions of respondents in the resistance and hesitancy groups ( $M = 0.15$  each) compared to certain ( $M = 0.09$ ) and conditional acceptance ( $M = 0.07$ ), while in regional centers, cities, and villages, the largest fraction of respondents fall into acceptance categories. We assume that vaccination reluctance in the two main cities may reflect greater medical capacities and the ability to provide medical assistance, in case of COVID-19 infection, compared to the rest of the regions.

We note clear patterns in personality traits distribution across vaccination intention groups. The certain acceptance group can be characterized by higher mean levels of openness ( $M = 0.03$ ), conscientiousness ( $M = 0.12$ ), and agreeableness ( $M = 0.17$ ). In contrast, the lowest levels of these traits are observed in the hesitancy group. A higher mean level of neuroticism is observed in the vaccine resistance group ( $M = 0.08$ ), but not in the hesitancy group ( $M = -0.07$ ). Contrary to previous research, the highest proportion of non-religious individuals is observed in the vaccine resistance group ( $M = 0.45$ ). The same group exhibits the highest mean level of general risk loving ( $M = 0.02$ ). In contrast, both acceptance and hesitancy groups contain risk averse individuals ( $M = -0.13$  in certain,  $M = -0.14$  in conditional acceptance, and  $M = -0.18$  in hesitancy).

Those respondents who report higher levels of trust in institutions are more inclined to get vaccinated. The highest mean value of general trust is observed in the hesitancy group ( $M = 0.46$ ), while the lowest is in the resistance group ( $M = 0.38$ ). Moreover, social media may indeed serve as an alternative source of information with predominantly antivaccine sentiments. Among vaccine resistant individuals the highest proportion uses social media on a daily basis ( $M = 0.47$ ), while in the certain acceptance group those never using social media prevail ( $M = 0.43$ ).

The highest proportion of individuals with bad self-rated health is concentrated in the hesitancy group ( $M = 0.15$ ), while the lowest is in the certain acceptance group ( $M = 0.09$ ). Bad self-rated health may imply that people are more focused on possible side effects associated with vaccination. Interestingly, individuals with COVID-19 experience are more present in both certain acceptance and resistance groups ( $M = 0.04$  each). Finally, individuals from the resistance and hesitancy groups come from the regions with worse epidemiologic situations.

### 4.2. Regression results

We continue by estimating a multinomial logit model for the determinants of vaccination attitudes (Table 1). First, among demographic and socio-economic factors, the following variables are significantly associated with the decreased risk of being vaccine resistant compared to being in the conditional acceptance group: number of children ( $RRR = 0.840$ ), presence of elderly family members ( $RRR = 0.836$ ), university education ( $RRR = 0.873$ ) compared to no professional education, and living in a regional center ( $RRR = 0.445$ ), a city ( $RRR = 0.454$ ) or a village ( $RRR = 0.451$ ) compared to living in Moscow or Saint-Petersburg. The decreased risk of being vaccine hesitant compared to being conditionally accepting is brought about by the presence of elderly family members ( $RRR = 0.860$ ), presence of a university ( $RRR = 0.873$ ) or a vocational college diploma ( $RRR = 0.822$ ) compared to no professional education and living in a regional center ( $RRR = 0.639$ ), a city ( $RRR = 0.560$ ) or a village ( $RRR = 0.580$ ) compared to living in Moscow or Saint-Petersburg. The results also demonstrate the existence of a non-linear relationship between age and willingness to get vaccinated: increasing age reduces the risks of being either vac-

cine resistant or vaccine hesitant but after a certain age the effect does a complete U-turn. Number of underaged children (RRR = 0.819) as well as living in a city (RRR = 0.532) also reduce the chances of certain vaccine acceptance, while employment (RRR = 1.302) increases these chances. Gender, marital status, unemployment, and income are statistically unrelated to vaccination attitudes.

Second, the increased risk of resistance compared to conditional acceptance is associated with higher levels of agreeableness (RRR = 1.064), neuroticism (RRR = 1.148), risk loving (RRR = 1.165), being both a non-believer (RRR = 1.391) and a believer (RRR = 1.352) compared to occasionally going to religious services. At the same time, conscientiousness (RRR = 0.839) and neuroticism (RRR = 0.909) reduce the risk of hesitancy. Being more agreeable (RRR = 1.260), less extraverted (RRR = 0.902), and a non-believer (RRR = 1.203) increases the chances of certain acceptance.

Third, general trust and frequency of social media use are both associated with the risks of being vaccine resistant compared to conditionally accepting: trust in people reduces the risks of resistance (RRR = 0.747), so does spending less time on social networks (RRR = 0.759 for individuals who visit social media 2–3 times a week compared to everyday users). General trust also increases the risks of vaccination hesitancy (RRR = 1.394) but is statistically insignificant for certain acceptance. Rare social media use increases the chances of being certainly accepting (RRR = 2.376 for individuals using social networks less than once a week, RRR = 1.559 for individuals not using social media at all, RRR = 1.359 for individuals using social media 2–3 times a week), and to a lesser extent the chances of being hesitant (RRR = 1.711 for individuals visiting social networks less than once a week. The model with trust in institutions further suggests that trust increases the chances of certain acceptance (RRR = 1.114) and reduces the risks of both resistance (RRR = 0.754) and hesitancy (RRR = 0.922) (see Table 3A in Appendix). Interestingly, including trust in institutions into the model leads to higher education being statistically insignificant. The reason for this is that people with a higher education generally express lower levels of trust compared to other education groups. Therefore, a major part of the effect of education on vaccination attitudes may be indirect and is mediated through other factors [15,16].

Ultimately, self-rated health is an important predictor of vaccination attitudes. The increased risk of resistance is associated with either a very bad (RRR = 2.178) or very good (RRR = 2.155) state of self-rated health. Having experienced COVID-19 in the past (RRR = 1.850) as well as living in a region with a worse epidemiologic situation (RRR = 1.144), increases the risk of vaccine resistance, while having a friend or a relative who has experienced COVID-19 (RRR = 0.819) or perceiving risks of infection as high (RRR = 0.851) reduces resistance. Having bad (RRR = 1.247) and a very bad self-rated health condition (RRR = 2.041) as well as perceiving risks of infection as high (RRR = 1.065) increases the risks of hesitancy, though the links are relatively weak. Being in a very good self-perceived health condition (RRR = 4.239) as well as experiencing COVID-19 in the past (RRR = 2.170) both increase the chances of certain vaccine acceptance.

#### 4.3. Gender differences in factors

Unlike the overall sample, age is not significant for vaccination resistance among males (see Table 6A in Appendix for full results). Being married is significantly correlated with vaccination intentions only among females, reducing the chances of resistance (RRR = 0.871). Presence of elderly family members is positively associated with health-protective behavior in both genders, however, for men it reduces the chances of any attitudes other than conditional acceptance, while for women it increases the chances

of certain acceptance (RRR = 1.274). Interestingly, education turned out to be significant only for the female subsample – both vocational and higher education reduce the chances of vaccination resistance (RRR = 0.806 and RRR = 0.849, respectively), higher education reduces the chances of hesitancy (RRR = 0.716), while vocational college increases the chances of certain acceptance (RRR = 1.355). Behavioral and psychological factors appear to have similar associations with vaccination attitudes in both genders. Extraversion is only significant in the male sample, reducing the chances of certain acceptance compared to conditional acceptance (RRR = 0.863), while agreeableness among men is only related to certain acceptance and not to resistance, as observed in the overall sample (RRR = 1.289). Higher general level of trust is associated with increased risks of vaccine hesitancy only for females (RRR = 1.565), simultaneously decreasing risks of vaccination resistance both in males (RRR = 0.704) and females (RRR = 0.771). Not using social media reduces resistance for males (RRR = 0.788), while rare use of social media increases certain acceptance among females (RRR = 3.253) and hesitancy among males (RRR = 2.559). Using social media 2–3 times a week compared to daily engagement reduces the chances of resistance in both genders but increases the chances of certain acceptance only for the female sample (RRR = 1.985). Finally, very bad self-rated health increases the risks of resistance only for females (RRR = 2.653), while very good self-perceived state of health increases the risks of resistance for males (RRR = 2.325) and that of certain acceptance (RRR = 7.159) and resistance (RRR = 1.889) for females, though the positive effect on acceptance is stronger both in terms of the size and the statistical significance.

## 5. Discussion

This is a nationally representative study, conducted in Russia, which explores the scope of vaccine acceptance and the potential determinants of vaccine attitudes. By focusing on vaccine hesitancy and resistance, we look at the part of the population which is the hardest to persuade to get a vaccine shot. We find that prior to the COVID-19 vaccination rollout in Russia, vaccination acceptance was quite low (45 %) and resistance was quite high (43 %) compared to other countries [7]. The number of hesitant individuals who can be persuaded through targeted information policy is rather low (13 %), leaving very little room for policy maneuver.

Since we use data that were collected before the launch of the nationwide vaccination campaign, the obtained results reflect the baseline attitudes towards COVID-19 immunization that significantly affect the advancement of the vaccination process. Our aim was to measure the root causes and mental attitudes associated with vaccination. These factors do not depend either on the availability, or on the characteristics of a particular vaccine. These root causes are the hardest to control and to shape, especially in case of an emergency such as the current pandemic.

We find that education is positively related to vaccination acceptance in Russia. Education is correlated with the level of awareness in health-related issues and defines what sources of information would be chosen in the decision-making process. Moreover, less educated individuals are more vulnerable to rumors [35]. However, once trust in institutions is included into the model, the effect of higher education becomes insignificant. Therefore, we believe that the effect of education that is widely reported in research literature may be mostly indirect [15,16]. We also report that age demonstrates a non-linear relationship with vaccination intentions. Family composition, namely number of children and presence of elderly family members, predict lower risks of hesitancy relative to acceptance. Gender, marital status, and income are not related to vaccination intentions.

Health-related factors, such as self-rated health and COVID-19 experiences, appear to be strong predictors of vaccination intentions, with better self-rated health simultaneously increasing the probability of acceptance and vaccination resistance. We conclude that individuals with bad self-rated health tend to overestimate the importance of side effects and, therefore, have high risks of being resistant and hesitant. We also find that the perceived risk of infection is an important factor reducing the risks of being vaccine resistant. Experiencing COVID-19 in the past simultaneously increases the risks of vaccine resistance and acceptance, and is probably dependent on the severity of the case. Previous studies indicated that COVID-19 related experiences are not associated with any vaccination attitudes [7,20], however, the perceived risks of infection are consistently positively related to vaccination intentions against various diseases, including coronavirus [23,29].

We find that behavioral and psychological factors are very important predictors of vaccination intentions. The key element of vaccination acceptance is trust in other people and institutions, since trust in a particular vaccine cannot be developed on its own without the proper environment. We state that trust in institutions increases the chances of vaccine acceptance, reducing the risks of resistance and hesitancy, which is a result supported by the empirical literature [7,36] and theoretical framework [37]. In contrast, those resistant to the COVID-19 vaccine show lower levels of trust and prefer alternative sources of information [25]. We also find that frequent use of social networks is negatively associated with acceptance of vaccination, suggesting that lack of trust pushes people to search for independent sources of information in social networks where anti-vaccination rhetoric prevails.

Our analysis suggests that personality traits, such as agreeableness, neuroticism, and risk attitudes, increase the chances of vaccine resistance, while conscientiousness, as a productive characteristic, reduces the risks of hesitancy. These results are in line with the existing literature [25]. There are several mechanisms which can be underlying the relationship between vaccination intentions and personality. One of them is the choice of informational sources related to the disease. People high in neuroticism are more likely to fall for false rumors [35], while conspiracy beliefs have been named as an important factor hindering vaccination intentions [28]. Another mechanism is the obedience to rules. Higher levels of agreeableness predict compliance with official COVID-19 guidelines [38,39], while poor compliance to guidelines predicts an unwillingness to get vaccinated [40]. Agreeableness is a psychological characteristic of prosocial behavior while willingness to protect others is associated with vaccine acceptance [11]. As for risk attitudes, most prior research focuses on health-related risks and individual perceptions of risk related to COVID-19 [29]. However, these risk perceptions are different compared to general risk preferences. We find that risk loving is positively associated with vaccine refusal. However, we do not find strong evidence for the association between religiosity and vaccination resistance as suggested by previous literature [21,25]. Both individuals never visiting religious services and visiting them regularly, demonstrate higher risks of being vaccine resistant compared to people who occasionally visit religious services.

Finally, we explore gender differences in vaccination determinants. Although some factors can be significant for vaccination intentions in one gender and not significant in another, the effects in both genders tend to head in the same direction, either being associated with protective health behaviors (increasing the chances of certain acceptance and/or decreasing the chances of resistance and hesitancy) or with risky health behavior (decreasing the chances of certain acceptance and/or increasing the chances of resistance and hesitancy).

The factors associated with vaccine hesitancy and resistance are not unique to COVID-19. There are systematic problems in vaccine

attitudes that are vital not only for the current situation but also for years to come. The main question is, what policy interventions should be implemented in order to achieve larger vaccine coverage? These interventions should be divided into short-term and long-term measures. We recognize several groups at risk that should be targeted by the vaccination campaign in the short term. These are individuals with bad self-rated health, risk loving and with low perceived risks of getting COVID-19, living in large cities and regions with high morbidity rates, and frequently using social media. The issue is that vaccine resistant and hesitant groups do not consider COVID-19 a severe illness and do not perceive themselves susceptible to the disease. These health beliefs (severity and susceptibility) should be influenced by targeted interventions. The long-term solution to vaccination hesitancy and resistance requires the development of trust in general.

## 6. Limitations

There are several limitations to the current study that can be addressed in future work. First, our data cover an early pre-vaccination period when neither the vaccine itself, nor vaccine-related information was available to the public. However, our study explores the general mindset and captures the attitudes important for the development of policy measures. Second, since the respondents were asked about their intent to get vaccinated at the time when neither vaccination, nor information about future vaccines were available, learning more details about the vaccines could potentially change their attitudes. Therefore, our estimates of vaccination intention might differ from the real uptake. Third, our data lack information about important factors which can affect hesitancy and resistance in the case of the COVID-19 vaccine. These are trust towards vaccines in general, trust in health professionals, previous experiences with vaccines, and other factors [41] which might be discussed in future rounds of the RLMS-HSE survey. Further studies may as well consider the issue of readiness for revaccination which becomes increasingly relevant due to escalating COVID-19 cases [42]. Finally, it is important to keep in mind possible mistakes due to changes in the use of social media when self-reported measures of engagement are used [43,44].

## 7. Conclusion

High levels of COVID-19 vaccination hesitancy and refusal, post a threat to public health. It is necessary to understand the reasons behind negative attitudes towards vaccination to tailor communication and vaccination campaigns. In Russia, one of the countries most affected by the pandemic in terms of public health [45], rapid vaccination-related actions are crucial. Our findings suggest that, prior to vaccination rollout, 43 % of the Russian adult population were resistant towards vaccination, while 13 % were hesitant. Vaccination attitudes depend on age, family composition, education, type of settlement, employment, self-perceived health condition, previous COVID-19 experience, and self-perceived risk of being infected. The results also state that personality traits, risk attitudes, and trust, reflect the deep-rooted causes of vaccination attitudes and predict vaccination intentions.

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## CRediT authorship contribution statement

**Yana Roshchina:** Conceptualization, Formal analysis, Methodology, Writing – review & editing. **Sergey Roshchin:** Conceptualization, Supervision, Writing – review & editing. **Ksenia Rozhkova:** Conceptualization, Writing – original draft, Writing – review & editing.

## Data availability

Data will be made available on request.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.vaccine.2022.08.042>.

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