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ORIGINAL ARTICLE

COVID-19 vaccine hesitancy in Serbia

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Summary

Introduction/Aim: Vaccine hesitancy is recognized as important determinant of routine immunization coverage, but also as a factor of inadequate acceptance of the COVID-19 vaccine. The World Health Organization proposed a "3C" model, with confidence, complacency and convenience as the core components of vaccine hesitancy. The purpose of this study was to assess the intention to receive COVID-19 vaccine through the 3C framework in Serbia.

Materials and Methods: This cross-sectional study was based on the data collected from 1,435 adult respondents from the general population using an online questionnaire in the period December 2020-January 2021. Convenience, non-probability sampling was applied. Participants were reached through the existing social networks and mailing lists. The main outcome variable was the intention to get vaccinated against COVID-19, with three categories: vaccine refusal, vaccine indecisiveness, and vaccine acceptance. To explore associations of predictor variables (socio-demographics, source credibility, general vaccine attitudes and COVID-19 vaccine hesitancy measured through three scales – Confidence, Convenience and Complacency) with the outcome variable, binary logistic regression models were conducted.

Results: Less than one third of respondents (28.6%) were vaccine refusing, 33.7% were vaccine accepting, while 37.7% were undecided. Increased likelihood of being both vaccine undecided and vaccine refusing was significantly associated with lower scores on Confidence and Convenience scales, and a higher score on the Complacency scale.

Conclusion: Confidence in health authorities and government, confidence in COVID-19 vaccine safety and efficacy, perception of ease of access to vaccination and complacency (perceived lack of need for vaccination) were the most important factors driving the intention to get vaccinated, confirming relevance of the "3C" model.

Keywords: COVID-19, vaccination intention, vaccine hesitancy, World Health Organization.

INTRODUCTION

Less than a year before the COVID-19 pandemic was declared, the World Health Organization (WHO) identified vaccine hesitancy as one of the 10 most important global health threats (1). The first conceptualization of the global phenomenon of vaccine hesitancy was provided by the WHO in 2014, which defined the concept of vaccine hesitancy as a delay in the acceptance or refusal of vaccines despite the availability of vaccination services (2). In fact, the WHO proposed a so-called "3C" model which has three core components of vaccine hesitancy: confidence, complacency and convenience.

Confidence has been defined as trust in the effectiveness and safety of vaccines as well as in the system that provides the vaccines and the policymakers who decide on target populations for vaccination. Complacency is related to the perceived lack of need for vaccinations, where the risks of vaccine-preventable disease are perceived as low, and vaccines are perceived as unnecessary. Convenience accounts for the perceived constraints to access vaccinations such as physical availability, affordability, willingness to pay, geographical accessibility, ability to understand, and quality of the immunization services.

During the COVID-19 pandemic, it was apparent that all three components were prominent as the drivers of vaccine hesitancy. Specifically, confidence in vaccines was largely hampered because of the information overload and delivery of inaccurate information through various communication channels (3, 4). This gave rise to the infodemic, which resulted in low coverage rates. In addition, complacency was in place largely because of the rapid spread of information giving way to conspiracy theories (5). Indeed, convenience seen through access and global allocation of vaccines and vaccine deployment (6) reflected larger structural issues that were country- and/or region-specific (7).

Bearing all mentioned above in mind, the vaccine hesitancy concept is important now more than ever before, because in the post-COVID-19 pandemic period, the propensity toward the decrease in vaccination coverage of vaccines in the childhood immunization programs is high. In fact, in the Republic of Serbia there has been a downward trend in immunization coverage in children over the past two decades (8). Vaccine hesitancy is especially prominent in Serbia, resulting in a major measles outbreak just before the onset of the COVID-19 pandemic (9). This means that systematic efforts need to be made to combat vaccine hesitancy in order to keep the optimum coverage and maintain herd immunity in the population (10).

Applying a "3C lens" to the issue of intention to receive the COVID-19 vaccine could help to calibrate the public health response to vaccination in the post COVID-19 pandemic period and provide necessary clues on how to frame future health policies. The aim of this study was to evaluate 1) the intention to receive COVID-19 vaccine, 2) components of the 3C model in the COVID-19 vaccine hesitancy context, and 3) psycho-social factors associated with COVID-19 vaccination intention.

MATERIAL AND METHODS

Participants and procedure

A cross-sectional online survey was conducted in the period December 2020-January 2021 among adult general population in Serbia. Convenience non-probability sampling was applied. Respondents were reached through the existing social networks and mailing lists. The self-administered questionnaire was disseminated through Google Forms platform, and it required approximately 15 minutes to be completed. The introductory part of the questionnaire included information for respondents including the purpose of the study and their rights as participants. Informed consent of respondents was assumed by their competition of the survey. The questionnaire was anonymous, no personally identifying data were collected. Participation in the study was voluntary, no incentives were provided to respondents. The study protocol was approved by The Ethics Commission of the Faculty of Medicine, the University of Belgrade (approval number: 1322/ XII-7).

Study instrument and measures

The questionnaire consisted of six parts:
1. The primary outcome – *intention to get vaccinated against COVID-19.* was measured by a single item assessing the likelihood of getting vaccinated on a 10-point scale (ranging from 1 – extremely unlikely to 10 – extremely likely). This variable was compressed into three categories: vaccine refusal, vaccine indecisiveness, and vaccine acceptance.
2. *Socio-demographic* questionnaire included: gender, age, region, type of settlement, education level, employment, income, marital status, religiosity, having children and the number of household members.
3. *Health-related characteristics* included three binary (yes/no) items: having had COVID-19 infection, pre-existing health conditions in the respondent, and pre-existing health conditions in household members. In addition, health self-assessment was measured by a single 5-point scale item ranging from 1 "very poor "to 5 "very good".
4. The *source credibility* was assessed by the list of various sources of information concerning the COVID 19 vaccines: domestic scientific literature, international scientific literature, national TV channels, internet portals, You Tube channels, social networks (Facebook, Viber, WhatsApp), and family/friends. The

respondents were asked to indicate the credibility of each source on the 5-point scale (ranging from 1 "does not represent a useful source at all" to 5 "represents an entirely useful source").

5. *General vaccine attitudes* were measured by two five-point items (ranging from 1 "strongly disagree" to 5 "strongly agree"): 1) In general, I believe vaccines are safe, and 2) In general, I believe vaccines are efficacious.

6. *COVID-19 Vaccine Hesitancy Questionnaire (COVID-19 VHQ)* included eight statements. Factor analysis confirmed three-factor structure based on the "3C" vaccine hesitancy model, with the factors being Confidence, Complacency and Convenience. Four items represented the Confidence aspect of vaccine hesitancy (items 1-4), two items represented Complacency (items 5-6), and two items represented Convenience (items 7-8). Responses to each item were graded on a 5-point Likert scale ranging from 1 "strongly disagree" to 5 "strongly agree". This questionnaire was previously developed within the 3C framework and showed excellent psychometric properties (11).

Statistical analysis

Descriptive statistics were used to characterize the sample and study variables. To explore factors associated with the intention to get vaccinated against COVID-19, the binary logistic regressions were conducted. Two regression models were run. The outcome variable in the first model was coded so that those who were refusing the vaccine were compared with those who were vaccine accepting. The outcome variable in the second model was coded so that those who were undecided about the vaccine were compared with those who were vaccine accepting. Dummies were created for multinomial variables (region, type of settlement, education level, income, marital status). Variables found to be significant in the univariate analysis were entered in the multiple analysis for both models. The hierarchical multiple analysis using consecutive blocks was conducted to assess the respective contributions of the five sets of variables: 1) socio-demographics, 2) health-related variables, 3) general vaccine attitudes, 4) sources credibility, and 5) Confidence, Complacency and Convenience.

All analyses were performed in Statistical Package for Social Sciences (SPSS) for Windows, version 25 (IBM Corp., Armonk, NY) and $p < 0.05$ was considered statistically significant.

RESULTS

The total number of respondents who completed the survey was 1,435. Socio-demographic and health-related characteristics of respondents are presented in **Table 1**.

The average age was 40.4±11.9 years. Women accounted for 68.4% of the respondents. Only 12.8% of respondents had laboratory confirmed COVID-19, and 15.8% reported the presence of a chronic disease.

Table 1. Socio-demographic and health-related characteristics of respondents

Socio-demographic variables	N (%)
Age (Mean.±SD)	40.4±11.9
Gender	
Male	454 (31.6)
Female	891 (68.4)
Region	
Belgrade	742 (51.7)
Šumadija and Western Serbia	348 (24.3)
Vojvodina	199 (13.9)
South and Eastern Serbia	146 (10.2)
Type of settlement	
Less than 5000 inhabitants	11.8 (8.2)
5000-100.000 inhabitants	538 (37.5)
100.000-million inhabitants	275 (19.2)
Over million inhabitants	504 (35.1)
Education	
Elementary school	7 (0.5)
Secondary school	246 (17.1)
Bachelor's degree	408 (28.4)
Master's degree	679 (47.3)
Doctoral degree	95 (6.6)
Employment	
Yes	1,132 (78.9)
No	303 (21.1)
Marital status	
Unmarried	435 (30.3)
Married	845 (58.9)
Divorced	11 (7.7)
Widowed	44 (3.1)
Having a child	
Yes	802 (55.9)
No	633 (44.1)
No of household members	
1	161 (11.2)
2	374 (26.1)
3	348 (24.3)
4	359 (25.0)
5 and more	175 (12.2)
Income per household member	
< 250 €	283 (19.7)
250-400 €	306 (21.3)
400-550 €	328 (22.9)
> 550 €	518 (36.1)
Religiosity	
Yes	781 (54.4)
No	654 (45.6)
Confirmed COVID-19	
Yes	184 (12.8)
No	1,240 (86.4)
Health self-assessment	
Very poor	3 (0.2)
Poor	39 (2.7)
Neither poor nor good	165 (11.5)
Good	714 (49.8)
Very good	514 (35.8)

Table 2. General vaccine attitudes and attitudes towards the credibility of sources of information about COVID-19 vaccines

General vaccine attitudes	Strongly disagree (N(%))	Disagree (N(%))	Neither disagree nor agree (N(%))	Agree (N(%))	Strongly agree (N(%))
1. Generally, I believe vaccines are safe	120 (8.4)	92 (6.4)	262 (18.3)	392 (27.4)	565 (39.5)
2. Generally, I believe vaccines are efficacious	85 (5.9)	71 (4.9)	219 (15.3)	383 (26.7)	676 (47.1)
Sources of information about COVID-19 vaccines perceived as credible					
1. Domestic scientific literature	117 (8.2)	181 (12.6)	458 (31.9)	366 (25.5)	313 (21.8)
2. International scientific literature	56 (3.9)	90 (6.3)	303 (21.1)	432 (30.1)	554 (38.6)
3. National TV channels	643 (44.8)	358 (24.9)	322 (22.4)	77 (5.4)	35 (2.4)
4. Internet portals	246 (17.1)	297 (20.7)	535 (37.3)	247 (17.2)	110 (7.7)
5. You Tube	401 (27.9)	362 (25.2)	459 (32.0)	156 (10.9)	57 (4.0)
6. Social networks (Facebook, Viber, WhatsApp)	477 (33.2)	355 (24.7)	391 (27.2)	150 (10.5)	62 (4.3)
7. Family and friends	281 (19.6)	333 (23.2)	536 (37.4)	194 (13.5)	91 (6.3)

General vaccine attitudes are presented in **Table 2**. A smaller proportion of respondents agreed (27.4%) and strongly agreed (39.5%) that vaccines are generally safe, while 26.7% agreed and 47.1% strongly agreed that vaccines are generally efficacious.

Source credibility concerning COVID-19 vaccines is presented in the **Table 2**. Great majority of respondents agreed (30.1%) and strongly agreed (38.6%) that international scientific literature is the most credible source of information on COVID-19 vaccines.

COVID-19 vaccine hesitancy

The average total score on the Confidence sub-scale was 11.42 ± 4.59 out of a maximum of 20, while on the Convenience sub-scale it was 5.60 ± 2.77 out of a maximum of 10. On the Complacency sub-scale, the average total score was 4.02 ± 2.10 out of a maximum of 10 points. The distribution of responses on each item of the questionnaire is presented in Table 3. Nearly half of respondents agreed (20.7%) or strongly agreed (24.0%) that mass immunization would not have been planned if COVID-19 vaccines were not effective and safe. However, more

than half of respondents disagreed (19.9%) or strongly disagreed (37.9%) with the statement expressing trust in health authorities and government when it comes to the decision on the choice of the COVID 19 vaccine that will be procured.

Intention to get vaccinated against COVID-19

Less than one third of respondents (28.6%) were extremely unlikely to get vaccinated against COVID-19 and were therefore labeled as vaccine refusing. Furthermore, 33.7% of respondents were vaccine accepting, while 37.7% were undecided.

Predictors of vaccine indecisiveness

All the variables found to be significant in univariate analyses were subjected to the hierarchical binary logistic regression model predicting risk for vaccine indecisiveness relative to vaccine acceptance. The results are presented in **Table 4**.

The final model explained 63.2% (Nagelkerke R^2) of the variance in vaccine indecisiveness outcome. In-

Table 3. COVID-19 Vaccine Hesitancy Questionnaire score distribution.

Items	1	2	3	4	5
1. If the vaccine against COVID 19 was not safe and effective, mass vaccination would certainly not have been planned.	281 (19.6)	185 (12.9)	328 (22.9)	287 (20.7)	344 (24.0)
2. I trust the health authorities and the state (government) when it comes to the decision on the choice of the COVID 19 vaccine that will be procured.	544 (37.9)	285 (19.9)	336 (23.4)	180 (12.5)	90 (6.3)
3. A vaccine against the coronavirus would enable a return to normal life.	210 (14.6)	119 (8.3)	400 (27.9)	398 (27.7)	308 (21.5)
4. The vaccine against COVID 19 should be mandatory for all citizens.	560 (39.0)	142 (9.9)	286 (19.9)	163 (11.4)	284 (19.8)
5. I believe that I am immune to the corona virus, so there is no need to get vaccinated.	837 (58.3)	214 (14.9)	243 (16.9)	69 (4.8)	72 (5.0)
6. Given that a sufficient number of people will receive the COVID 19 vaccine, I do not think it is necessary for me to be vaccinated.	627 (43.7)	272 (19.0)	317 (22.1)	84 (5.9)	135 (9.4)
7. Even if not enough vaccines against COVID 19 are available, I would try to get one.	455 (31.7)	190 (13.2)	313 (21.8)	175 (12.2)	302 (21.0)
8. Even if the state did not provide a sufficient number of free vaccines against COVID 19, I would be willing to pay for the vaccination.	499 (34.8)	157 (10.9)	246 (17.1)	162 (11.3)	371 (25.9)

creased likelihood of being vaccine undecided was significantly associated with lower scores on Confidence and Convenience scales, and higher score on the Complacency scale. Socio-demographic characteristics (Table 1) explained 11.7% of variance. Respondents inhabiting Vojvodina region had higher chances to be vaccine accepting, while respondents living in Šumadija and West Serbia region had higher chances to be vaccine undecided. Respondents holding PhD degree had higher chances to be vaccine accepting, while respondents who identified themself as religious and were younger than 30 years had higher chances to be vaccine undecided. Health-related characteristics (Table 2) increased the explained variance of the model to 12.2%. General vaccine attitudes (Table 3) explained additional 23.1% of variance. When source credibility (Table 4) was added, it resulted in the increase of 3.8% in explained variance. Considering the international scientific literature and social networks groups as less credible, and YouTube channels and family/friends as more credible sources of information were significantly associated with higher likelihood of being vaccine undecided. Finally, when Confidence, Complacency and Convenience scores were included (Table 5), it explained an additional 24.1% of variance.

Predictors of vaccine refusal

The variables exhibiting significant associations in univariate analyses were then used in the hierarchical binary logistic regression model predicting risk for vaccine refusal relative to vaccine acceptance, and the results are showed in Table 5.

The final model explained 95% (Nagelkerke R^2) of the variance in the vaccine refusal outcome. Similar to vaccine indecisiveness, the only significant predictors of vaccine refusal in the final model were lower scores on Confidence and Convenience and higher score on Complacency.

Socio-demographic characteristics (Table 1) explained 26% of variance, with female gender, age younger than 30 years, larger number of household members and being religious presenting significant predictors of vaccine refusal. Respondents who had master and doctoral level of education had higher chances to be vaccine accepting. Health-related characteristics (Table 2) explained additional 2.2% of variance. Not having chronic disease and better health self-assessment were significantly associated with increased likelihood of vaccine refusal. When general attitudes towards vaccines were added (Table 3), they explained additional 48% of variance,

Table 4. Hierarchical regression analysis of factors associated with the vaccine indecisiveness vs. acceptance (as the reference)

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age					
18-29 years	Ref.	Ref.	Ref.	Ref.	Ref.
30-41 years	1.76 (1.14-2.72)*	1.76 (1.14-2.72)*	1.87 (1.15-3.05)*	2.00 (1.21-3.32)	1.75 (0.93-3.32)
42-53 years	2.47 (1.52-4.00)**	2.40 (1.48-3.89)**	2.64 (1.53-4.55)**	2.74 (1.56-4.83)	1.97 (0.97-4.00)
54+ years	1.84 (1.06-3.20)*	1.73 (0.99-3.01)	2.05 (1.10-3.82)*	2.37 (1.23-4.56)	1.53 (0.67-3.49)
Region					
Belgrade	Ref.	Ref.	Ref.	Ref.	Ref.
Šumadija and West Serbia	0.70 (0.49-099)*	0.71 (0.50-1.00)	0.84 (0.57-1.26)	0.78 (0.52-1.18)	0.92 (0.55-1.53)
Vojvodina	1.66 (1.10-2.51)*	1.65 (1.09-2.49)*	1.69 (1.06-2.68)*	1.65 (1.02-2.66)*	1.60 (0.89-2.87)
South and East Serbia	1.42 (0.90-2.25)	1.39 (0.88-2.20)	1.43 (0.85-2.40)	1.35 (0.80-2.28)	1.19 (0.63-2.23)
Education					
Elementary/high school	Ref.	Ref.	Ref.	Ref.	Ref.
Bachelor's degree	1.38 (0.90-2.12)	1.38 (0.90-2.12)	1.32 (0.80-2.16)	1.44 (0.86-2.40)	1.15 (0.62-2.16)
Master's degree	1.28 (0.85-1.92)	1.27 (0.85-1.91)	1.12 (0.71-1.78)	1.13 (0.70-1.83)	1.17 (0.65-2.12)
PhD	2.16 (1.17-3.96)*	2.16 (1.17-3.98)*	1.37 (0.70-2.69)	1.22 (0.60-2.47)	1.75 (0.74-4.18)
Marital status					
Married	Ref.	Ref.	Ref.	Ref.	Ref.
Single	0.88 (0.62-1.25)	0.90 (0.63-1.28)	1.02 (0.68-1.52)	0.99 (0.66-1.50)	0.97 (0.59-1.61)
Divorced	0.74 (0.43-1.26)	0.75 (0.44-1.28)	0.73 (0.41-1.33)	0.74 (0.40-1.36)	0.86 (0.40-1.83)
Widowed	0.63 (0.27-1.48)	0.62 (0.26-1.45)	0.57 (0.22-1.51)	0.60 (0.22-1.60)	0.40 (0.12-1.37)
Revenue					
< 250 €	Ref.	Ref.	Ref.	Ref.	Ref.
250-400 €	1.00 (0.64-1.56)	1.00 (0.63-1.56)	1.05 (0.63-1.75)	1.08 (0.64-1.83)	0.85 (0.44-2.12)
400-550 €	1.07 (0.68-1.66)	1.08 (0.69-1.69)	1.15 (0.69-1.91)	1.15 (0.68-1.92)	1.01 (0.53-1.91)
> 550 €	1.19 (0.77-1.83)	1.20 (0.78-1.85)	1.27 (0.77-2.07)	1.29 (0.78-2.13)	0.90 (0.48-1.67)
No of household members	0.91 (0.80-1.03)	0.91 (0.80-1-03)	0.91 (0.79-1.04)	0.90 (0.78-1.03)	0.89 (0.74-1.05)
Religiosity					
No	Ref.	Ref.	Ref.	Ref.	Ref.
Yes	0.47 (0.36-0.62)**	0.47 (0.36-0.62)**	0.76 (0.56-1.03)	0.88 (0.64-1.21)	0.83 (0.55-1.23)

Chronic disease				
No	Ref.	Ref.	Ref.	Ref.
Yes	1.41 (0.99-2.02)	1.56 (1.04-2.33)*	1.45 (0.96-2.19)	1.21 (0.74-1.99)
Vaccine safety		2.78 (2.05-3.76)**	2.59 (1.90-3.51)**	1.37 (0.96-1.97)
Vaccine efficacy		2.01 (1.42-2.86)**	1.76 (1.22-2.52)**	1.21 (0.80-1.84)
National scientific literature			0.92 (0.78-1.10)	0.89 (0.72-1.11)
International scientific literature			1.67 (1.33-2.10)**	1.03 (0.77-1.37)
You Tube channels			0.86 (0.72-1.03)	1.00 (0.80-1.24)
Social networks			1.32 (1.11-1.57)**	1.11 (0.90-1.37)
Friends and family			0.82 (0.69-0.97)*	0.85 (0.70-1.04)
Confidence				1.42 (1.31-1.54)**
Convenience				0.67 (0.59-0.77)**
Complacency				1.45 (1.31-1.62)**
Nagelkerke R²	0.117	0.122	0.353	0.391	0.632

*$p<0.05$; **$p<0.001$

with more negative attitudes towards general vaccine safety and vaccine efficacy being significant predictors of vaccine refusal. Source credibility **(Table 4)** explained an additional 2.8% of variance. Respondents who considered the international scientific literature and national TV channels as more credible sources of information had significantly lower chance of vaccine refusal. Finally, when confidence, complacency and convenience scores were added **(Table 5)**, an additional 16% of variance was explained.

DISCUSSION

Our study used the WHO-proposed "3C" model to examine COVID-19 vaccine hesitancy and intention to receive the vaccine in Serbia. The results of this study support previous research findings which suggested that vaccine hesitancy would present a significant obstacle in the effort to reach an adequate COVID-19 vaccine coverage in diverse populations (12-15). Overall, more than one third (33.7%) of the surveyed participants intended

Table 5. Hierarchical regression analysis of factors associated with the vaccine rejection vs. acceptance (as the reference)

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Gender					
Male	Ref.	Ref.	Ref.	Ref.	Ref.
Female	0.62 (0.44-0.87)**	0.59 (0.42-0.82) **	0.56 (0.32-0.96)*	0.66 (0.37-1.18)	1.07 (0.34-3.36)
Age					
18-29 years	Ref.	Ref.	Ref.	Ref.	Ref.
30-41 years	1.99 (1.25-3.17) **	1.89 (1.19-3.03) **	2.77 (1.33-5.77)**	3.06 (1.41-6.62)**	2.78 (0.47-16.63)
42-53 years	2.75 (1.65-4.59) **	2.31 (1.37-3.91) **	4.82 (2.05-11.34)**	5.63 (2.26-14.02)**	3.33 (0.46-24.1809
54+ years	2.22 (1.29-3.83) **	1.75 (0.99-3.07)	4.87 (1.93-12.27)**	7.33 (2.68-20.02)**	4.81 (0.65-35.53)
Region					
Belgrade	Ref.	Ref.	Ref.	Ref.	Ref.
Šumadija and West Serbia	0.79 (0.49-1.29)	0.75 (0.46-1.23)	0.66 (0.31-1.41)	0.62 (0.28-1.39)	1.98 (0.34-11.57)
Vojvodina	1.24 (0.73-2.09)	1.19 (0.70-2.02)	1.79 (0.72-4.46)	2.00 (0.76-5.27)	5.05 (0.61-41.89)
South and East Serbia	1.29 (0.72-2.31)	1.18 (0.66-2.12)	1.25 (0.51-3.10)	1.28 (0.50-3.26)	1.49 (0.20-11.13)
Education					
Elementary/high school	Ref.	Ref.	Ref.	Ref.	Ref.
Bachelor's degree	1.20 (0.75-1.92)	1.23 (0.76-1.98)	1.34 (0.59-3.07)	1.33 (0.54-3.27)	1.18 (0.19-7.35)
Master's degree	1.68 (1.07-2.63)*	1.77 (1.12-2.78) *	1.12 (0.52-2,42)	0.91 (0.38-2.17)	0.58 (0.11-3.10)
PhD	2.93 (1.40-6.12)**	3.06 (1.45-6.48) **	1.28 (0.38-4.29)	0.85 (0.23-3.31)	0.42 (0.05-3.87)
Settlement					
< 5000	Ref.	Ref.	Ref.	Ref.	Ref.
5000-100 000	0.71 (0.40-1.26)	0.72 (0.40-1.27)	0.86 (0.35-2.11)	0.91 (0.36-2.30)	0.08 (0.01-0.53)**
100 000-1 000000000	0.77 (0.42-1.44)	0.78 (0.42-1.45)	0.84 (0.32-2.21)	1.02 (0.37-2.81)	0.18 (0.03-1.22)
>1 000000000	0.89 (0.46-1.74)	0.89 (0.45-1.73)	1.01 (0.35-2.90)	1.34 (0.44-4.03)	0.19 (0.02-1.91)
Employment					
No	Ref.	Ref.	Ref.	Ref.	Ref.
Yes	1.23(0.82-1.86)	1.29 (0.85-1.96)	1.60 (0.81-3.14)	1.48 (0.71-3.08)	1.50 (0.29-7.90)
No of household members	0.84 (0.74-0.95)**	0.84 (0.74-0.95)**	0.97 (0.80-1.18)	0.97 (0.79-1.19)	0.96 (0.61-1.50)
Religiosity					
No	Ref.	Ref.	Ref.	Ref.	Ref.

Yes	0.22 (0.16-0.30)**	0.21 (0.15-0.29)**	0.42 (0.25-0.69)**	0.48 (0.28-0.83)**	0.62 (0.20-1.93)
Health self-assessment		0.76 (0.61-0.96) *	0.75 (0.52-1.10)	0.79 (0.53-1.18)	2.10 (0.91-4.83)
Chronic disease					
No		Ref.	Ref.	Ref.	Ref.
Yes		1.79 (1.12-2.84) *	3.03 (1.38-6.67)**	3.07 (1.33-7.07)**	5.84 (0.87-39.38)
Vaccine safety			4.18 (2.86-6.13)**	4.16 (2.72-6.36)**	1.51 (0.62-3.73)
Vaccine efficacy			3.43 (2.26-5.20)**	2.72 (1.70-4.37)**	1.27 (0.47-3.43)
National scientific literature				0.84 (0.62-1.13)	0.50 (0.25-1.00)
International scientific literature				1.98 (1.39-2.84)**	1.81 (0.75-4.40)
National TV channels				1.83 (1.39-2.41)**	1.28 (0.71-2.31)
You Tube channels				0.79 (0.61-1.02)	0.83 (0.45-1.53)
Friends and family				0.80 (0.63-1.03)	0.86 (0.51-1.43)
Confidence					1.92 (1.52-2.43)**
Complacency					0.64 (0.48-0.87)**
Convenience					2.33 (1.72-3.15)**
Negelkerke R²	0.260	0.282	0.762	0.790	0.950

*p<0.05; **p<0.001

to get vaccinated against COVID-19. Still, a similar proportion claimed to be undecided (37.7%) while more than one quarter were extremely unlikely to accept the vaccine (28.6%). The proportion of refusing and undecided respondents is larger in our sample compared to other studies (16-18). This means that despite the availability of vaccines against SARS-CoV-2, Serbia faced significant reluctance to vaccination in its population. Therefore, getting a deeper insight into the factors that possibly drive the intention to vaccinate could inform the development of a tailored public intervention to increase COVID-19 vaccine acceptance.

First, we explored the extent of COVID-19 vaccine hesitancy in our sample. Given that the COVID-19 vaccination rollout in Serbia is carried out successfully, with a sufficient supply of free vaccines for all the interested citizens (19), we can conclude that the most significant factor to be considered when addressing COVID-19 vaccine hesitancy in Serbia is confidence. The observed result that a minority of respondents has trust in health authorities and the government when it comes to the choice of the vaccine is not surprising in the context of the global structural crisis of trust in institutions (20). Although the majority of respondents still perceive scientific literature as a credible source of information about COVID-19 vaccines, only 7.8% value national TV channels as credible. This result suggests that in order to enhance the sustainability of vaccination promotion programs public health authorities should employ different approach in educating people about vaccines, relying on scientific authorities rather than state officials and political figures.

Second, our results indicate that significant predictors of both vaccine indecisiveness and vaccine refusal were COVID-19 vaccine hesitancy constructs - confidence, complacency and convenience, confirming the significance of the "3C" vaccine hesitancy model in the COVID-19 context. However, general vaccine attitudes explained far larger proportion of variance in vaccine refusal compared to vaccine indecisiveness. This finding is in line with the results of other studies, where negative attitude towards vaccination and distrust in science were the main factors that differed between undecided and unwilling to get vaccinated (13, 21). These findings imply that adamant refusal of COVID-19 vaccines has its roots in a much wider negative attitude toward vaccines in general, and a general lack of trust in science.

Third, sociodemographic variables explained moderately high level of variance in both vaccine indecisiveness and vaccine refusal. The association between socio-demographic factors and COVID-19 vaccine acceptance is highly heterogeneous between countries, which can be attributed to different cultural, socio-environmental and psychological factors (22). Younger age (below 30 years old) was associated with both vaccine indecisiveness and vaccine refusal, which was found in numerous other studies (12, 13, 15, 16, 18). This finding could be expected, given that older people are more susceptible to serious forms of COVID-19 infection, and expectedly have a greater perceived risk of COVID-19 infection. That higher level of education is strongly associated with general vaccine confidence and vaccine uptake is a well-known and empirically confirmed fact (23), and our study results endorse that education is similarly associated with COVID-19 vaccine acceptance. Our finding that religious study participants were less willing to accept the vaccine is in accordance with the research conducted in Illinois, where significant negative association between the religiosity and COVID-19 vaccination intention was found. It can be assumed that the religious respondents are more prone to rely on the external locus of control (24). Our study also revealed that respondents from some regions in Serbia are particularly vaccine undecided, which is potentially valuable information for vaccination campaigns. In addition, female respondents who did

not have any chronic conditions and who assessed their health as better had higher chances to refuse vaccine, which was expected, given that individual characteristics associated with more serious forms of COVID-19 disease are male gender and co-morbidities, and in line with results of other research (16).

Fourth, trust in sources of information explained a small proportion of variance in both outcomes. However, trust in the international scientific literature was negatively associated with both vaccine indecisiveness and vaccine refusal, confirming that trust in science is the cornerstone of vaccine confidence. Trust in YouTube channels was significantly associated with vaccine indecisiveness, which supports the finding that the rapid spread of information of questionable quality (a phenomenon labeled as "infodemic") further undermines trust in science and institutions, providing space for misconceptions and conspiracy theories (25).

This study had several limitations. First, we employed convenience sampling, which does not offer the same level of representativeness provided by probability sampling. Second, due to the COVID-19 physical distancing measures being active at the time of conducting the survey, the survey was administered using online platforms, which potentially limited our sample to respondents who have internet access and use digital technologies. Third, the cross-sectional design of the study does not allow conclusions about causal relationship between variables.

CONCLUSIONS

To conclude, although Serbia has carried out a successful initial phase of COVID-19 vaccination, a large proportion of people had the intention to skip vaccination. Confidence in health authorities and government, confidence in COVID-19 vaccine safety and efficacy, perception of ease of access to vaccination and complacency were the most important factors driving the intention to accept the vaccine. People who had higher chances of being undecided or vaccine refusing were females, in good health, younger than 30 years, less educated, religious and relying on information from YouTube. Our findings can contribute to the development of sustainable vaccination programs and public campaign tailoring by emphasizing information on necessity, safety and effectiveness of offered vaccines, from the credible scientific source, specifically targeting socio-demographic groups most likely to be vaccine hesitant or vaccine refusing.

Conflicts of interest: None to declare.

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NEODLUČNOST U VEZI SA VAKCINACIJOM PROTIV COVID-19 U SRBIJI

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Sažetak

Uvod/Cilj: Vakcinalna neodlučnost prepoznata je kao značajan faktor smanjenog obuhvata rutinskom imunizacijom u svetu, ali i kao faktor koji je uticao na nedovoljnu prihvaćenost vakcine protiv kovida 19 tokom pandemije. Svetska zdravstvena organizacija predložila je „3C" model koji obuhvata tri ključne komponente vakcinalne neodlučnosti: poverenje (*confidence*), komotnost (*complacency*) i pogodnost (*convenience*). Cilj ovog rada je procena namere da se primi vakcina protiv kovida 19 u okviru „3C" modela u Srbiji.

Materijal i metode: Studija preseka sprovedena je u uzorku od 1.435 odraslih stanovnika Srbije, u periodu od decembra 2020. do januara 2021. godine. Primenjeno je prigodno uzorkovanje, a upitnik je diseminovan onlajn putem društvenih mreža i mejling lista. Glavna ishodna varijabla bila je namera da se primi vakcina, sa tri kategorije: odbijanje vakcinacije, vakcinalna neodlučnost i prihvatanje vakcinacije. Za utvrđivanje povezanosti prediktornih varijabli (socio-demografskih činilaca, kre-dibilnosti izvora informisanja, opštih stavova prema vakcinaciji i vakcinalne neodlučnosti merene putem tri skale – poverenja, komotnosti i pogodnosti) sa ishodnom varijablom primenjena je logistička regresiona analiza.

Rezultati: Manje od jedne trećine ispitanika (28,6%) je odbilo vakcinaciju protiv kovida 19, 33,7% je nameravalo da se vakciniše, dok je 37,7% bilo neodlučno u vezi sa vakcinacijom. Povećana verovatnoća i neodlučnosti u vezi sa vakcinacijom i odbijanja vakcinacije bila je značajno povezana sa nižim skorovima na skalama poverenja i pogodnosti i višim rezultatom na skali komotnosti.

Zaključak: Poverenje u zdravstvene autoritete i vladu, poverenje u bezbednost i efikasnost vakcine protiv kovida 19, doživljaj adekvatnog pristupa i dostupnosti vakcinacije i komotnost (doživljaj vakcinacije kao nepotrebne) imali su najveći uticaj na nameru ispitanika da se vakaciniše protiv kovida 19, potvrđujući relevantnost „3C" modela.

Ključne reči: kovid 19, namera vakcinacije, neodlučnost u vezi sa vakcinacijom, Svetska zdravstvena organizacija