DETERMINANTS OF COVID-19 VACCINE HESITANCY: QUESTIONNAIRE DEVELOPMENT AND VALIDATION

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SUMMARY

Objectives: Vaccine hesitancy presents one of the critical constraints in combating COVID-19 pandemic. The aim of this study was to develop and validate an instrument for measuring factors that contribute to COVID-19 vaccine hesitancy.

Methods: The key constructs in the study instrument were factors that constitute the "3C" model of vaccine hesitancy: Confidence, Complacency and Convenience. Using a cross-sectional, online survey design, the 8-item COVID-19 Vaccine Hesitancy Questionnaire was administered to a sample of 667 adult citizens of Serbia in December 2020. We used confirmatory factor analysis to investigate the model that assumes three latent variables. To ensure that the instrument measures the same constructs in different groups, the measurement invariance examination was conducted. To examine criterion validity, Spearman's correlation was applied to determine the association between the instrument total score and the single-item measuring the likelihood of getting vaccinated against SARS-CoV-2.

Results: Confirmatory factor analysis established the three-factor structure, with subscales fitting within the "3C" model of vaccine hesitancy comprising confidence, convenience and complacency. The full scalar invariance was found across gender, and the partial scalar invariance was achieved for the age, region and education level. A higher level of the COVID-19 vaccine hesitancy was associated with the lower likelihood to get vaccinated against the SARS-CoV-2 virus.

Conclusion: Our scale is brief and consistent, maintaining a good fit across key socio-demographic subgroups. This result implies that the scale could be useful for quick assessment of COVID-19 vaccine hesitancy in various target populations.

Key words: vaccination, vaccine hesitancy, COVID-19 vaccines, surveys and questionnaires, factor analysis, psychological/behavioural medicine

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INTRODUCTION

The coronavirus disease (COVID-19) pandemic has created a global health crisis that impacts all aspects of human life. A growing number of COVID-19 vaccines have shown satisfying efficacy without significant safety concerns in phase 3 trials, resulting in their approval for use in a rising number of countries worldwide (1). However, the success of the vaccination programmes depends on the rates of vaccine uptake in the populations. A survey conducted in June 2020 in 19 countries revealed significant differences in COVID-19 vaccine acceptance rates among countries, ranging from almost 90% in China to less than 55% in Russia (2). These variable levels of COVID-19 vaccine acceptance cause concerns since potential refusals may jeopardize global control of the pandemic.

Vaccine hesitancy was defined as a delay in acceptance or refusal of vaccines despite the availability of vaccination services (3). It is identified as one of the crucial contributors to the global decline in vaccine coverage for several well-established vaccines. The Strategic Advisory Group of Experts on Immunization (SAGE) has adopted and implemented one of the most widely accepted models of vaccine hesitancy – the "3C" model, including three factors: Confidence, Complacency and Convenience (4). Confidence refers to the trust in the effectiveness and safety of vaccines, the system that delivers vaccines, and the policymakers who decide on the vaccination. Complacency implies the perception that the vaccine is not needed since the risks of the vaccine-preventable disease are low. Convenience refers to difficulties in accessing vaccines, including geographical accessibility, physical availability, ability to pay, quality, and cultural appropriateness of healthcare services that deliver vaccines.

Addressing vaccine hesitancy is a critical factor of reaching herd immunity and, therefore, a critical success factor of vaccination programmes. Understanding factors that contribute to COVID-19 vaccine hesitancy in individuals may help tailor targeted vaccination strategies and communication campaigns to increase vaccine confidence and acceptance. Several studies in Europe, UK, USA, Australia, and Asia aimed to explore attitudes toward the COVID-19 vaccine and intention to be vaccinated (5–9). Conversely, in Serbia there have been no scientific studies investigating factors associated with the intention to be vaccinated against COVID-19. According to the latest multinational research

of vaccine confidence, it is estimated that the general confidence in vaccine safety in the Serbian population fell between 2015 and 2019 (10). Although Serbia started the COVID-19 vaccine rollout rapidly, being the second country in highest vaccination rate per capita in Europe in February 2021 (11), the Our World in Data figures show that only 47.68% of Serbian adult population have been completely vaccinated against COVID-19 until 18 May 2022, despite the availability of several types of vaccines (12). This observation implies that a large portion of the Serbian population is COVID-19 vaccine-hesitant or intends to refuse vaccination. It is well recognized that a valid and reliable measure to identify factors contributing to the refusal of vaccination can help to achieve the effectiveness of interventions that aim to increase vaccine uptake (13, 14).

The aim of this study was to develop and validate an instrument for measuring factors that contribute to COVID-19 vaccine hesitancy, based on the "3C" model of vaccine hesitancy. If proven psychometrically valid, this instrument could allow the assessment and identification of COVID-19 vaccine hesitancy determinants in a particular population. Furthermore, once identified these determinants can be addressed in the future vaccination campaigns.

MATERIALS AND METHODS

COVID-19 Vaccine Hesitancy Questionnaire

The COVID-19 Vaccine Hesitancy Questionnaire (COVID-19 VHQ) consists of 8 five-point Likert scale items (from 1 "strongly disagree" to 5 "strongly agree"). Confidence was represented by four items, Complacency was represented by two items, while Convenience included two items inquiring about two types of barriers: physical availability and ability to pay.

The total score was calculated by summing up the responses to all items. A higher score indicates a higher level of vaccine hesitancy. Items from the Confidence and Convenience subscales were reverse coded. The respondents' scores were evaluated as very low, low, moderate, high, and very high. They were divided into five groups and the group span value was calculated as 32/5 = 6.40 for the total score, 16/5 = 3.20 for Confidence, and 8/5 =1.6 for Convenience and Complacency.

Content validity was assessed in two steps. First, the instrument was sent to a panel consisting of a total of 5 experts coming from relevant fields (psychology, public health and epidemiology), who confirmed that the instrument items are relevant and accurately represent underlying constructs. Second, the instrument was piloted in a sample of 10 respondents to assess the intelligibility of the items.

Study Design and Sampling

A cross-sectional study took place in December 2020. We collected data employing an online questionnaire from a national sample of adult citizens of Serbia. Sample size of 663 respondents was calculated in the Qualtrics sample size calculator, based on a 5% margin of error and 99% confidence level. To represent all defined age groups (18–29, 30–41, 42–53, 54+) and both genders, we recruited approximately evenly within these groups. We involved citizens from four regions in Serbia fulfilling predetermined quota reflecting population numbers for these regions, in accordance with the data of the valid census (15).

Data Collection Procedure

The questionnaire was disseminated using the Google Forms platform, and was shared via social networks (Facebook, Viber, WhatsApp) and publicly available email addresses between December 3 and December 20. Dissemination of the questionnaires was closed when quotas got fulfilled. The survey was anonymous, collecting no personally identifiable information. The participants were informed about the purpose of the study, and consent was implied. No incentives were received. The questionnaire took approximately 7–10 minutes to complete.

Other Measures

Four socio-demographic measures represent gender, age, residential region, and education level.

The criterion validity of the COVID-19 VHQ was established assessing the association of the total score on the scale and the likelihood of getting vaccinated against COVID-19 on a ten-points scale (from "extremely unlikely" to "extremely likely").

Statistical Analysis

The model that assumes three latent variables and eight empirical indicators was tested by confirmatory factor analysis (CFA) using maximum likelihood estimation (MLE). Model fit was evaluated and compared using a range of common fit statistics: the Tucker-Lewis index (TLI), comparative fit index (CFI), goodness of fit (GFI), normed-fit index (NFI), root mean-square of approximation (RMSEA), and standardized root mean square residual (SRMR). TLI, CFI, GFI and NFI between 0.95 and 1.00 and RMSEA and SRMR values at 0.08 or lower are considered to indicate good fit (16). The Kaiser-Meyer-Olkin (KMO) test was used to measure sampling adequacy and Bartlett's test of sphericity was applied for the evaluation of factor analysis.

To ensure that COVID-19 VHQ measures the same constructs in different groups, enabling the meaningful interpretation of differences between them, the measurement invariance examination was conducted. We checked whether the established factor structure held for different gender, age, residential region, and education level. Measurement invariance tests were done in hierarchical fashion adding a series of increasingly stringent equality constraints to the models (17). The evaluation of configural, metric and scalar invariance was conducted. Configural invariance was tested by estimating multi-group CFA without setting any constraints on the equality of model parameters (18). Metric invariance was evaluated by constraining factor loadings to be equivalent in the groups. Scalar invariance was tested by imposing constraints to the factor loadings and the item intercepts. Gradually imposed constraints lead to a decrease in model fit. A decrease in model fit was considered indicative of non-invariance if the decrease was more than 0.015 for RMSEA and more than 0.01 for CFI and TLI (18–20). Furthermore, the partial invariance was examined in the case that the full measurement invariance could not be established (21). Three levels of invariance were tested simultaneously employing series of multi-group CFA (MG-CFA).

Descriptive statistics were used to detail the sample characteristics and to summarize the variables. To determine internal consistency, Cronbach's alpha and the inter-item correlations were calculated. Spearman's correlation was conducted to determine the association between the COVID 19-VHQ total score and the single-item measuring the likelihood of getting vaccinated against SARS-CoV-2. To examine the significant associations between socio-demographic characteristics and vaccine hesitancy we performed either an independent sample t test or analysis of variance (ANOVA). Tukey's HSD test was used for post-hoc comparisons. For post-hoc comparisons and testing the group differences on educational level Bonferroni correction with probability cut-off adjusted to 0.008 was applied. A two-tailed p value of < 0.05 was considered statistically significant. Statistical analyses were performed using IBMSPSS V.22 and SPSS AMOS V.22.

RESULTS

Baseline Characteristics of Respondents

A total of 1,400 participants agreed to complete the survey, 225 participants failed to complete the questionnaire, 94 did not consent for their data to be used, and 414 were excluded once the pre-determined quotas were reached. Finally, 667 respondents were selected to form the sample fulfilling predetermined quotas. The baseline characteristics of the survey participants are showed in Table 1. The respondents' age ranged from 18 to 75 (mean = 39.99, SD = 14.09). The majority of respondents were women (52.6%), with residence in the Belgrade region (31.5%), and who were university educated (36.6%). Approximately one quarter of the respondents (24.3%) reported that they are extremely likely to get the COVID-19 vaccine, whereas one fifth of them (21.4%) stated that they are extremely unlikely to get vaccinated.

Table 1. *Demographic characteristics of general population sample in Serbia, December 2020 (N = 667)*

Participants characteristics	n	%
Gender		
Male	316	47.4
Female	351	52.6
Age		
18–29 years	180	27.0
30–41 years	179	26.8
42–53 years	158	23.7
54+ years	150	22.5
Region		
Belgrade	210	31.5
Sumadija and West Serbia	194	29.1
Vojvodina	156	23.4
South and East Serbia	107	16.0
Education		
Elementary or high school	182	27.3
Bachelor's degree	207	31.0
Master's degree	244	36.6
Doctoral degree (PhD)	34	5.1

Model Fit and Measurement Invariance

The CFA was run in order to test the established three-factor structure developed based on the "3C" vaccine hesitancy model. Bartlett's test of sphericity ($\chi^2 = 2175.136$; $p < 0.001$) and the Kaiser-Meyer-Olkin (KMO = 0.90) measure of sampling adequacy indicated that the sample was suitable for factor analysis. A measurement model with three latent variables and with eight indicators was developed. Four indicators were expected to load on the first factor, named Confidence, while the other two factors, termed Complacency and Convenience, are expected to be saturated with two items each. All the latent variables were allowed to correlate with each other. Results yielded $\chi^2(17) = 46.997$, $p < 0.001$, minimum chi-square (CMIN)/df = 2.77, CFI = 0.99, TLI = 0.98, GFI = 0.98, NFI = 0.98, RMSEA = 0.051, 90% confidence interval (CI) = 0.034–0.069, and SRMR = 0.026. The obtained values indicated good model fit and satisfactory factor loadings with standardized values ranging from 0.60 to 0.85 (Table 2).

Furthermore, we examined configural, metric, and scalar invariance. The three levels of invariance examined if the established factor structure holds in different gender and age groups, as well as in the groups of the respondents living in different residential regions, and in the groups of individuals having diverse educational level. An inspection of Table 3 reveals that both the configural and metric invariance models for Confidence, Complacency and Convenience may be accepted based on the global fit measures across all the examined groups, implying that different groups of the respondents are interpreting the items in the same way.

The full scalar invariance across gender was established. However, the results did not support the full scalar invariance across the age, region and education level groups. Across the age groups, RMSEA displayed allowable change, whereas CFI (ΔCFI = 0.024) and TLI (ΔTLI = 0.023) decreased more than the recommended 0.01 criteria. Also, CFI across the region (ΔCFI = 0.012) and the education groups (ΔCFI = 0.014) displayed the change slightly over the allowed criteria. Furthermore, we tested for partial scalar invariance by releasing the equality constraint for the intercept of the item No. 6 stating "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". The equality constraint on this intercept was released because it displayed the most severe violation of invariance compared to the other indicator intercepts in the model, for each of the three groups. After releasing this intercept, partial scalar invariance could be guaranteed.

Internal Consistency

Descriptive statistics and reliabilities of the three subscale scores are presented in Table 4. Cronbach's alpha coefficient (0.87) indicated a good internal consistency for the overall scale. Reliability coefficients for the subscales ranging from 0.61 to 0.83 demonstrated acceptable or good internal consistency. The subscale inter-correlations are shown in Table 5. They ranged from −0.48 to 0.74, and all the subscales were significantly ($p < 0.01$) and strongly correlated with the total score. Confidence positively

Table 2. *Summary of items, means, standard deviations and factor loadings for estimated three-dimensional model of COVID-19 VHQ in sample of general population in Serbia, December 2020*

Factors	Items	Mean	SD	Factor loadings
Confidence	If the vaccine against COVID-19 was not safe and effective, mass vaccination would certainly not have been planned.	3.19	1.45	0.85
	I trust the health authorities and the state (government) regarding the decision on the choice of the COVID-19 vaccine that will be procured.	2.33	1.28	0.68
	A vaccine against the coronavirus would enable a return to normal life.	3.38	1.31	0.73
	The vaccine against COVID-19 should be mandatory for all citizens.	2.65	1.57	0.75
Complacency	I believe that I am immune to the coronavirus, so there is no need to get vaccinated.	1.85	1.16	0.60
	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.	2.19	1.32	0.82
Convenience	Even if not enough vaccines against COVID-19 are available, I would try to get one.	2.75	1.49	0.61
	Even if the state did not provide sufficient number of free vaccines against COVID-19, I would be willing to pay for the vaccination.	2.79	1.60	0.72

The range of individual item scores was from 1 to 5 for all items.
COVID-19 VHQ – COVID-19 Vaccine Hesitancy Questionnaire

Table 3. *Comparing three levels of measurement invariance across gender, age, region, and educational level in sample of general population in Serbia, December 2020*

	χ^2	df	$\Delta\chi^2$	RMSEA	ΔRMSEA	CFI	ΔCFI	TLI	ΔTLI
Males vs. females									
Configural invariance	75.486	34		0.043		0.981		0.969	
Metric invariance	80.701	39	5.215 (5)	0.040	0.003	0.981	0.000	0.973	0.004
Scalar invariance	87.702	47	12.216 (13)	0.036	0.004	0.981	0.000	0.978	0.005
Age groups									
Configural invariance	92.599	68		0.023		0.989		0.982	
Metric invariance	115.335	83	22.736 (15)	0.024	0.001	0.985	0.004	0.980	0.002
Scalar invariance	195.288	107	102.629 (39)*	0.035	0.011	0.960	0.024	0.958	0.023
Partial scalar invariance	158.118	104	65.519 (36)*	0.028	0.004	0.975	0.010	0.974	0.006
Region									
Configural invariance	85.586	68		0.020		0.992		0.987	
Metric invariance	108.356	83	22.77 (15)	0.021	0.001	0.988	0.004	0.984	0.003
Scalar invariance	158.330	107	72.744 (39)*	0.027	0.006	0.976	0.012	0.975	0.009
Partial scalar invariance	140.434	104	54.848 (36)*	0.023	0.002	0.983	0.005	0.982	0.002
Education									
Configural invariance	88.098	68		0.021		0.991		0.985	
Metric invariance	121.292	83	33.194 (15)*	0.026	0.005	0.982	0.009	0.976	0.009
Scalar invariance	176.761	107	88.663 (39)*	0.031	0.015	0.968	0.014	0.966	0.010
Partial scalar invariance	156.435	104	68.337 (36)*	0.028	0.003	0.976	0.006	0.974	0.002

*Significant at the level of 0.05; χ^2 – Chi-square goodness of fit test; df – degrees of freedom; RMSEA – root mean square of approximation; CFI – comparative fit index; TLI – Tucker-Lewis index; cut-off values for measurement invariance are ΔRMSEA ≤ 0.015, ΔCFI ≤ 0.010 and ΔTLI ≤ 0.010.

correlated with Convenience, and negatively with Complacency, whereas correlation between Convenience and Complacency had a negative direction. The average inter-item correlation for the eight-item scale was 0.16 and ranged from −0.46 to 0.65 indicating low to moderate correlation.

Criterion Validity

Spearman's correlations between the COVID-19 VHQ subscales (Confidence, Convenience and Complacency) and COVID-19 VHQ total, and the score on the single-item measure assessing the likelihood of getting vaccinated against SARS-

Table 4. *Summary of means, standard deviations, skewness and kurtosis, reliabilities and mean inter-item correlations across COVID-19 VHQ and its subscales in sample of general population in Serbia, December 2020*

Scales	Mean (range)	SD	Skewness	Kurtosis	Level	α	R-mean
Confidence	11.55 (4–20)	4.60	−0.07	−1.09	Moderate	0.83	0.56
Complacency	4.03 (2–10)	2.10	0.82	−1.10	Low	0.66	0.50
Convenience	5.53 (2–10)	2.67	0.17	−0.19	Moderate	0.61	0.44
COVID-19 VHQ	22.95 (8–40)	8.09	0.15	−0.95	Moderate	0.87	0.16

COVID-19 VHQ – COVID-19 Vaccine Hesitancy Questionnaire; α – Cronbach's coefficient of reliability; R-mean – mean inter-item correlation. Score range for the levels of Confidence are: 4.00–7.19 (very low), 7.20–10.39 (low), 10.40–13.59 (moderate), 13.60–16.79 (high), 16.80–20.00 (very high). Score range for the levels of Complacency and Convenience are: 2–3.59 (very low), 3.60–5.19 (low), 5.20–6.79 (moderate), 6.80–8.39 (high), 8.40–10.00 (very high). Score range for the levels of the COVID-19 VHQ are: 8.00–14.39 (very low), 14.40–20.79 (low), 20.80–27.19 (moderate), 27.20–33.59 (high), 33.60–40.00 (very high).

Table 5. *Inter-correlations between three extracted subscales and total scale in sample of general population in Serbia, December 2020*

Scales	I	II	III	VHQ
I Confidence	1			
II Complacency	−0.48**	1		
III Convenience	0.74**	−0.47**	1	
VHQ	−0.94**	0.69**	–0.87**	1

**p < 0.01; VHQ – COVID-19 Vaccine Hesitancy Questionnaire

CoV-2 were calculated in order to establish the criterion validity. The respondents who reported greater likelihood to get vaccinated had a higher level of Confidence (rs = 0.81, p < 0.01) as well as a higher level of Convenience (rs = 0.78, p < 0.01). Furthermore, the higher likelihood to get the vaccine was associated with the lower levels of Complacency (rs = −0.56, p < 0.01) and the overall vaccine hesitancy (rs = −0.87, p < 0.01).

Vaccine Hesitancy

The average total score on the COVID-19 VHQ (mean = 22.95, SD = 8.09) reflected moderate vaccine hesitancy. The average scores for the subscales are presented in Table 4. For the Confidence subscale (mean = 11.55, SD = 4.60) the average score indicates a moderate trust in the vaccines' effectiveness and safety, as well as in the system and the policymakers. For example, less than half of the respondents strongly agreed (24.6%) or agreed (22.0%) that mass vaccination would not have been planned if the vaccine was not safe and effective, while only a small percentage (6.9%) have complete trust in the health authorities and the state when it comes to the decision on the choice of the vaccine that will be procured (Table 6). Additionally, the average score obtained on the Convenience scale (mean = 5.53, SD = 2.67) demonstrated the moderate difficulties in accessing vaccines. Nearly a third of respondents strongly agreed (19.6%) or agreed (11.8%) that they would try to get the vaccine even if not enough vaccines are available. The average score attained on Complacency scale (mean = 4.03, SD = 2.10) reflected a low

Table 6. *COVID-19 VHQ score distribution per item in sample of general population in Serbia, December 2020 (N = 667)*

Items	1	2	3	4	5
	n (%)				
If the vaccine against COVID-19 was not safe and effective, mass vaccination would certainly not have been planned.	134 (20.1)	78 (11.7)	144 (21.6)	147 (22.0)	164 (24.6)
I trust the health authorities and the state (government) regarding the decision on the choice of the COVID-19 vaccine that will be procured.	248 (37.2)	132 (19.8)	154 (23.1)	87 (13.0)	46 (6.9)
Vaccine against the coronavirus would enable a return to normal life.	92 (13.8)	65 (9.7)	165 (24.7)	190 (28.5)	155 (23.2)
Vaccine against COVID-19 should be mandatory for all citizens.	256 (38.4)	69 (10.3)	130 (19.5)	75 (11.2)	137 (27.5)
I believe that I am immune to the coronavirus, so there is no need to get vaccinated.	387 (58.0)	90 (13.5)	123 (18.4)	40 (6.0)	27 (4.0)
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.	296 (44.4)	116 (17.4)	154 (23.1)	37 (5.5)	64 (9.6)
Even if not enough vaccines against COVID-19 are available, I would try to get one.	207 (31.0)	95 (14.2)	155 (23.2)	79 (11.8)	131 (19.6)
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.	229 (34.3)	86 (12.9)	113 (16.9)	77 (11.5)	162 (24.3)

The columns show the percentages of respondents with regard to the answers given to individual items.
COVID-19 VHQ – COVID-19 Vaccine Hesitancy Questionnaire

level of perception that the vaccine is not needed, since the risks of the vaccine-preventable disease are small. For example, only a small number of participants agreed (6.0%) or strongly agreed (4.0%) that there is no need to get vaccinated since they believed that they are immune to coronavirus (Table 6).

Socio-demographic Differences

No significant gender or between-region differences were found in any of the subscales, nor in the total scale (Table 7). However, the analysis of variance revealed that among the different age groups there were significant differences in Confidence ($F(3,663) = 4.110$; $p < 0.01$) and Convenience ($F(3,663) = 15.233$; $p < 0.001$), as well as in overall COVID-19 vaccine hesitancy ($F(3,663) = 6.692$; $p < 0.01$). Post-hoc tests showed that, compared to the other age groups, the youngest group (18–29 years old) had significantly higher level of vaccine hesitancy (mean = 25.14, SD = 7.51). Furthermore, young people aged 18–29 years scored significantly lower in Convenience (mean = 4.48, SD = 2.34), and had significantly lower level of confidence (mean = 10.56, SD = 4.58).

In general, findings indicate that Confidence ($F(3,663) = 3.046$; $p < 0.05$), Complacency ($F(3,663) = 2.910$; $p < 0.05$) and Convenience ($F(3,663) = 8.811$; $p < 0.01$), as well as the overall vaccine hesitancy ($F(3,663) = 5.612$; $p < 0.01$) were significantly affected by the educational level. Further post-hoc analysis identified significantly higher vaccine hesitancy in respondents with elementary or secondary education (mean = 24.14, SD = 7.94) compared to those who had a doctoral degree (mean = 18.82, SD = 7.17). Also, the respondents with elementary or secondary education (mean = 4.94, SD = 2.50) scored significantly lower on the Convenience scale compared to those with a master (mean = 3.10, SD = 1.35) or doctoral degree (mean = 3.23, SD = 1.34).

DISCUSSION

In this study, the main purpose was to validate the structure of the COVID-19 Vaccine Hesitancy Questionnaire developed according to the "3C" model, and to test the measurement invariance across the four socio-demographic variables (gender, age, educational level, and region of living).

Confirmatory factor analysis confirmed the three-factor structure, with subscales fitting within the "3C" model of vaccine hesitancy. The full scalar invariance established across gender, and the partial scalar invariance achieved for age, region and education level, confirmed that different groups use the response scale in a similar way.

Overall, the instrument showed good internal consistency, and the subscales were correlated in expected ways. These cor-

Table 7. *Differences between diverse groups of respondents compared according to confidence, complacency, convenience, and overall vaccine hesitancy in sample of general population in Serbia, December 2020*

Participants characteristics	Confidence		Complacency		Convenience		Vaccine hesitancy	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Gender								
Male	11.75	4.51	3.92	2.06	5.61	2.66	22.56	7.89
Female	11.37	4.68	4.13	2.14	5.47	2.68	23.30	8.25
	t = 1.073; p = 0.284		t = −1.291; p = 0.197		t = 0.677; p = 0.499		t = −1.169; p = 0.242	
Age								
18–29 years	10.56	4.58	4.17	2.08	4.48	2.34	25.14	7.51
30–41 years	11.72	4.54	4.08	2.16	5.63	2.61	22.73	8.11
42–53 years	12.13	4.39	3.84	2.11	5.94	2.68	21.77	8.13
54+ years	11.93	4.75	4.01	2.06	6.25	2.75	21.83	8.23
	F = 4.110; p < 0.01		F = 0.735; p = 0.532		F = 15.233; p < 0.001		F = 6.690; p < 0.001	
Region								
Belgrade	11.35	4.46	3.91	2.01	5.66	2.69	22.90	7.76
Sumadija and West Serbia	11.05	4.45	4.30	2.10	5.11	2.52	24.14	7.63
Vojvodina	12.00	4.73	3.91	2.15	5.65	2.73	22.12	8.59
South and East Serbia	11.55	4.60	3.96	2.20	5.88	2.76	22.08	8.58
	F = 2.104; p = 0.098		F = 1.500; p = 0.213		F = 2.465; p = 0.061		F = 2.370; p = 0.690	
Education								
Elementary or high school	11.10	4.65	4.18	2.18	4.94	2.50	24.14	7.94
Bachelor's degree	11.23	4.79	4.24	2.17	5.45	2.64	23.56	8.32
Master's degree	11.91	4.43	3.84	1.97	5.81	2.71	22.12	7.88
Doctoral degree (PhD)	13.29	3.83	3.35	1.98	7.24	2.64	18.82	7.17
	F = 3.046; p = 0.028		F = 2.910; p = 0.034		F = 8.810; p < 0.008		F = 5.612; p < 0.01	

F – Fisher's ratio; t – Student's t-test

relations are in line with the "3C" model, according to which vaccine hesitancy occurs where confidence in vaccination and convenience (vaccination is not easily accessible) are lower, and where complacency is higher (individuals do not perceive a need for vaccination) (22). Furthermore, our scale demonstrated satisfying criterion validity: higher level of the overall COVID-19 vaccine hesitancy was associated with the lower likelihood to get vaccinated against the SARS-CoV-2 virus. Also, lower levels of confidence and convenience and higher level of complacency were associated with the lower likelihood of getting vaccinated, which is in line with the results of several previous studies (23).

Moderate COVID-19 vaccine hesitancy level was expected based on the results of the previous research suggesting that more than 30% of Serbian population would certainly not take a COVID-19 vaccine (24). Our results suggest that main drivers of COVID-19 vaccine hesitancy in our sample were lack of confidence and perception of the obstacles in accessing vaccination. More than 50% of respondents expressed distrust towards health authorities and the state, while less than half of them (48.6%) were confident in safety and effectiveness of mass vaccination. For almost one half of the respondents (45.2%) unavailability of vaccines would influence their intent to get vaccinated, and nearly half of them (47.2%) are not willing to pay for the vaccine if they are not offered it for free. This result corresponds to findings from a study on COVID-19 vaccination intention in the UK (25). Lack of confidence and perceived barriers were also found in a survey of the COVID-19 vaccine hesitancy and demand conducted in May 2020 in China (26).

Additionally, we were interested in knowing whether gender, age, region of residence, and educational level play a role in vaccine hesitance. Males and females, and people living in different regions, did not differ in degree of vaccine hesitancy, or in the level of confidence, complacency and convenience. However, younger people (18–29 years old) had a significantly higher level of COVID-19 vaccine hesitancy compared to the other age groups. A higher level of COVID-19 vaccine hesitancy was also detected in respondents with lower levels of education. Our finding that COVID-19 vaccine hesitancy is affected by age and level of education is in line with other studies (2, 27–31). A greater acceptance of the COVID-19 vaccine among older people is usually explained by their greater perceived risk of being infected and developing serious forms of disease (30). COVID-19 vaccine hesitancy among individuals with lower levels of education can be potentially explained by lower health literacy and lower trust in healthcare system (31).

To our best knowledge, this is the first study attempting to develop and validate a scale for measuring the COVID-19 vaccine hesitancy based on the "3C" vaccine hesitancy model. Our scale is brief and consistent, maintaining good fit across four key socio-demographic subgroups (gender, age, region of living, level of education). However, our study has several limitations. First, we applied quota sampling and used an online survey platform, both of which could be sources of non-representativeness, which is tolerable given the exploratory nature of our study. However, the sample was adequate for the purpose of our study to validate the instrument. Second, Serbian population is mostly homogenous in terms of ethnic differences, since ethnic minorities accounted for less than 13% of the overall population according to the last census (15), implying that the scale should be tested in more diverse populations. It is recommendable to validate translated versions of the scale in other countries. Third, it would be valuable to expand our questionnaire and add more items to the Convenience section of the COVID-19 VHQ, to explore additional factors such as geographical accessibility, language barriers, quality, and cultural appropriateness of healthcare services, which could be of greater importance in other societies.

CONCLUSIONS

Although several vaccines have been proven to provide highly efficacious and safe protection from COVID-19 infection, vaccine hesitancy presents one of the main obstacles to achieving herd immunity and containing the disease, besides waning immunity. The COVID-19 Vaccine Hesitancy Questionnaire based on the "3C" vaccine hesitancy model can be used as a tool for a quick assessment of factors that contribute to COVID-19 vaccine hesitancy in target populations and national samples as well, with the aim to inform the COVID-19 vaccination campaigns and policies.

Conflicts of Interests

None declared

Adherence to Ethical Standards

The Ethics Committee of the Faculty of Medicine, the University of Belgrade, has approved the study protocol (approval number: 1322/ XII-7).

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