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Original article

Determinants of COVID-19 immunisation uptake in a country with high mortality and a low vaccination rate

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ABSTRACT

Background: Research concerned with attitudes towards COVID-19 vaccination in upper middle-income countries such as Bosnia and Herzegovina (B&H) is scarce. Currently, B&H has the lowest number of fully vaccinated adults in Europe, and the highest cumulative number of COVID-19 deaths and SARS-CoV-2 infected individuals. The aim of our study was to examine the factors associated with COVID-19 vaccination status in B&H.

Methods: An online survey among 1304 B&H adults was conducted in October 2021 evaluating vaccine acceptance, together with socio-demographic variables, attitudes and beliefs related to COVID-19 vaccination.

Results: The results from a binary logistic regression indicate that those who believed that the COVID-19 vaccine was effective were 45 times more likely to be vaccinated compared to those who did not. We also show that those who had received childhood immunisations were 41 times more likely to be vaccinated against COVID-19 compared to those who had never been previously immunised. Other significant factors were related to respondents' trust in government institutions and healthcare policymakers as well as trust in public healthcare workers.

Conclusion: We suggest that future vaccination campaigns should be aimed at educating the public regarding the importance and safety of vaccines, together with strengthening trust in the public health system.

Background

COVID-19 vaccines are intended to provide acquired immunity against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus that causes coronavirus disease 2019 (COVID-19). Development and widespread deployment of a safe and effective vaccine has been identified as a critical strategy to control the COVID-19 pandemic [1,2]. By June 2021, 23 vaccine candidates had progressed to Phase 3 clinical trials, and more than a dozen had been approved internationally (including ChAdOx1 nCoV-19 Oxford-AstraZeneca in 115 countries and BNT162b Pfizer-Biontech in 90 countries [3]). In many cases emergency use authorisation or temporary use authorisations were issued due to the gravity of the public health emergency [4]. Based on reports from national health agencies, as of 22 September 2022, 12.7 billion doses of COVID-19 vaccines have been administered worldwide [5].

Nevertheless, global vaccine distribution has remained highly unequal with much of the supply secured by high-income countries [3]. In addition to limited access to vaccines, a significant challenge has been ensuring their acceptance. Public trust in vaccines as well as the institutions that administer the COVID-19 immunisation programmes have been identified as crucial determinants of the success of the campaigns [4].

Academic interest in evaluating the factors associated with reduced uptake of, and/or hesitancy towards, vaccination has been on the rise, especially since the outbreak of the COVID-19 pandemic. Myriad of studies have examined COVID-19 vaccine acceptance in

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high-income countries [6–9]. However, there has been limited interest in exploring acceptance rates in middle- and lower-income countries [10,11].

Bosnia and Herzegovina (B&H) is a Southeast European country with a population of 3.27 million [12]. According to the World Bank [13] classification of countries, B&H is an upper middle-income country which continues to be affected by the significant economic, infrastructural, and human losses caused by the 1992–1995 Bosnian war. Under the General Framework Agreement for Peace in Bosnia and Herzegovina [14] B&H has a unique constitutional organisation consisting of 3 parts: Federation of B&H (FB&H), Republika Srpska (RS) and one district town of Brčko. Centralized B&H government institutions are responsible for matters such as monetary or customs policy. However, the remaining governance including the B&H national health service are the responsibility of the individual entities. The national health service is the most striking example of the complex and (dys)functioning governance and funding system in B&H [15], with 13 decision makers consisting of 11 decentralised health ministries in 10 cantons, FB&H healthcare fund as well as RS and Brčko District healthcare fund [15].

Despite global advances in vaccine development, B&H lagged in the procurement of vaccines against COVID-19, relying primarily on the COVID-19 Vaccines Global Access (COVAX) initiative for its distribution. COVAX, jointly led by the Coalition for Epidemic Preparedness Innovations (CEPI), Gavi, and the World Health Organization (WHO), was an international cooperation program for the efficient and just global distribution of COVID-19 vaccines. It advocated the proportional allocation scheme, aimed at providing COVID-19 vaccines for 20% of the total population in each country or region. After vaccinating 20% of the population in all countries and regions, vaccines were given as priority to vulnerable groups based on health status and demands for medical supplies. However, the COVAX initiative was considered inefficient by some as it had no enforcement power to make the governments or authorities take collective binding actions.

Hence, while COVAX aimed to ensure equitable access to COVID-19 vaccines by creating a global procurement mechanism, a number of shortcomings have been highlighted including a failure to recognise supply constraints as a major obstacle and the aid-finance approach leaving low- and middle- income countries at the mercy of wealthy nations and profit-driven companies [16,17].

Inefficient governance structure in B&H also gave rise to government-affiliated procurement affairs regarding the supply of ventilators, temporary COVID-19 hospitals and perhaps most crucially, COVID-19 vaccines [18]. In B&H, the health sector is financed through mandatory healthcare social security contributions (the Bismarck Model). Hence, vaccination costs did not influence vaccine uptake as the government secured additional financing for the supply of vaccines. Furthermore, the Institutes of Public Health of individual entities were required to prevent the spread of infectious diseases and to provide vaccines free of charge to the entire population. However, inefficient and lagged procurement affairs created negative public attitudes and mistrust in government management of the pandemic and triggered numerous anti-government protests. During this period, residents who wished to be vaccinated were reliant on personal arrangements in neighbouring countries, predominantly Serbia that invited all foreign citizens for a vaccination free of charge [19]. Nevertheless, early results from surveys conducted in 2020 indicate mistrust towards vaccination against COVID-19 among B&H citizens [20]. COVID-19 vaccines were made widely available in B&H by mid-2021, however public scepticism remained. COVID-19 vaccine hesitancy was preceded by increased mistrust and reduction in childhood immunisation uptake in B&H (i.e. measles-mumps-rubella vaccine and diphtheria-tetanus-pertussis) [21].

At the time of conducting this study and just prior to the largest SARS-CoV-2 infection wave to date which occurred in January 2022, B&H had the lowest number of fully vaccinated adults in Europe, and the highest cumulative number of COVID-19 deaths and SARS-CoV-2 infected individuals. By 31st October 2021 and at the time of the conducted study, the cumulative number of confirmed COVID-19 cases was 252,758, with 3555 deaths per million. Only 24.7% of the population was fully vaccinated and 1,307,890 COVID-19 tests had been conducted [12].

During the largest wave of infection in January 2022, there were 343,986 confirmed cases, with 4425 deaths per million, placing B&H at the top of the list for COVID-19 related deaths per capita. Nevertheless, even by the end of January 2022, the vaccination rate remained low with only 29.2% of the population fully vaccinated and 1,499,302 COVID-19 tests conducted [12]. At the time of the survey and prior to the third and largest COVID-19 wave in B&H, vaccination certificates for employment purposes were not mandated by the law or by governmental obligatory instructions, so the process relied largely on media promotion regarding the importance of immunisation. For comparison purposes, by the end of August 2021, 70% of the adult population in the European Union was fully vaccinated [12,22].

Society in B&H is highly polarized between pro-vaccination advocates and vaccine sceptics advocating mostly through online platforms. Therefore, the purpose of this research was to assess the factors affecting COVID-19 vaccination uptake or hesitancy in B&H.

The current situation in B&H was the prime motivation for the conducted study regarding factors, attitudes and opinions influencing COVID-19 vaccination uptake in this upper middle-income country. Employing an online nationwide survey approach, the study aims were to:

(1) Identify associations between socio-demographic characteristics of B&H adults and their COVID-19 vaccination status.
(2) Identify associations between the COVID-19 vaccination status of B&H adults and their attitudes and opinions.
(3) Determine the factors with the greatest influence on COVID-19 vaccination uptake or hesitancy among B&H adults, considering groups of questions relating to trust in the health system, attitudes towards vaccination and altruism.

Material and methods

Due to a legally binding B&H government decree restricting movement of individuals in B&H, and therefore preventing the survey being conducted in person, an online survey approach was adopted just prior to the largest wave of SARS-CoV-2 infection in B&H to date. Similar nationwide online-based studies regarding vaccine uptake and vaccine hesitancy have been employed extensively worldwide [23] including the REDCap online platform [24], the Dynata's U.S. panel [25], and SAHA and Qualtrics software [26]. Methods and research design follow corresponding methods for similar surveys previously described [23–25] particularly the use of regression analysis; we also apply multivariate binary logistic regression with variables such as sociodemographic factors together with attitudes and beliefs relating to COVID-19 vaccination.

Survey distribution and sample size estimation

The survey was distributed online, through Facebook in the period 23rd October – 30th October 2021, and was conducted in local languages in B&H. Prior to initiating the study, the questionnaire was piloted among adults from different socio-economic backgrounds (representing different ages, genders, educational levels and residences). Using an exponential non-discriminative snowball sampling technique, 1304 participants were recruited from the B&H adult population. Participant-inclusion criteria for targeting

through paid advertisements were location (B&H) and age (18 and over).

A total of 2918 individuals clicked on the survey link, of which 1304 completed the survey in full (response rate 44.7%). Sample size estimation was based on the methodology applied in [14]. Considering an estimated B&H population size of 3.27 million inhabitants [12], a minimum of 1067 survey participants were required to achieve 95% confidence level with a margin of error of 3%.

Survey design and variables

The survey included several groups of questions and statements (Table 1, Table 2) as independent variables that were selected based on results of a previous systematic review and meta-analysis of COVID-19 vaccination willingness and hesitancy [23].

The first set of questions related to the socio-demographic characteristics of respondents [23–25] and included standard factors such as age, sex, education, employment status, and area of residence. This set of variables was expanded to capture the respondents' political views, and whether the respondent was a chronic disease patient or social protection beneficiary. Since the survey was conducted online, respondents were also asked about their daily internet usage (from up to one hour to more than four hours per day).

The second set of variables were concerned with public trust in the health system, which is of particular interest in the case of B&H. The results that addressed the level of trust at a micro level were adapted from a three-section scale into eight public trust-related statements [27]. Given the complex organization of the health system in B&H, the questionnaire was expanded with policy-level statements regarding trust at the level of healthcare policy makers, trust in the efficiency of the healthcare system of B&H, and trust in the accuracy of information regarding COVID-19 vaccine safety. Additionally, respondents were asked about their overall trust in government institutions.

The five-point Likert scale whereby 1 = never and 5 = always was transformed into a dichotomous variable as follows: the answers "Never", "Rare" and "Sometimes" were coded as zero, and the answers "Often" and "Always" were coded as one [28].

The third set of variables was focussed on the altruism scale [29,30]. The initial nine-item scale was grouped into a second order model as two aspects of altruism: charity and helping people, and adjusted to B&H specifics. The variables were dichotomously coded in the same manner as the public trust in health system variables.

For the fourth set of variables, several adjusted sets of statements were included regarding respondents' attitudes towards vaccination more widely, such as whether they had previously received a vaccine against seasonal flu or had ever been vaccinated, in addition to a question regarding the respondents' belief in the effectiveness of the COVID-19 vaccine.

Statistical analysis

The data were presented as cross-tabulation. Chi-square tests with 95% confidence interval (CI) were used to analyse the association between prognostic factors and outcomes, followed by a multivariate binary logistic regression. A p-value of < 0.05 was considered significant. Stata version 13 was used for statistical analysis.

The suitability of the conducted regression specification was tested using the linktest and the Hosmer-Lemeshow test. The results of the linktest indicated that the selected model was well specified (LR chi2 [2] = 970.63; p-value < 0.001). Similarly, the results of the Hosmer-Lemeshow test indicated that the selected model fit the data well (HL chi2 [8] = 11.14; p-value = 0.194).

The results of estimates of the variance inflation factor (VIF) indicated that there were no variables that caused multicollinearity (VIF < 10). The average VIF value of all explanatory variables was 2.97.

Results

Descriptive statistics of the sample

In the sample surveyed, 53.3% of respondents had been (self-reportedly) vaccinated against COVID-19, most respondents were women (59%), 30% of respondents were in the age group 36–45, and a small majority had at least university-level education (52%), were in full time employment (55%), were married (54%) and had children (55%). The vast majority of respondents were living in urban areas (80%) and were not social protection beneficiaries (96%) or chronic patients (87%) (Table 1). Fig. 1 shows cross-tabulation results of interest between (self-reported) vaccination status and socio-demographic characteristics of the respondents, whereas the overall results of both significant and non-significant associations are presented in Table 1.

Association between COVID-19 vaccination status and socio-demographic characteristics

Given that at the time of the survey (October 2021) COVID-19 vaccines were widely available in B&H, we first evaluated associations between socio-demographic factors and COVID-19 vaccination status.

Full results are shown in Table 1. There was a significant association between a positive COVID-19 vaccination status and female sex ($p < 0.001$), age (where the age group 36–45 had the highest proportion of vaccinated respondents) ($p < 0.001$), level of education at university or higher ($p < 0.001$), full-time employment status ($p < 0.001$), having children ($p = 0.03$), not being a chronic patient ($p = 0.008$) and living in an urban area of residence ($p = 0.008$).

There was no significant relationship between COVID-19 vaccination status and marital status, self-reported income, social protection beneficiary status or internet usage (Table 1).

Association between COVID-19 vaccination status and attitudes and opinions

With regards to the attitudes and opinions of the respondents, a statistically significant association was also identified between COVID-19 vaccination status and all measures regarding public trust in the health system ($p < 0.001$), three out of eight measures regarding altruism (donated goods or clothes to charity ($p = 0.01$), helped carry a stranger's belongings ($p = 0.03$), and made a change for someone unknown ($p = 0.045$)), political ideology ($p < 0.001$), and all three measures of attitudes towards vaccination ($p < 0.001$) (Table 1 and Fig. 2).

There was no significant relationship between COVID-19 vaccination status and five out of eight measures regarding altruism (given money to charity, done volunteer work for charity, let a neighbour not known well to borrow an item of some value, offered to help a disabled or elderly stranger across a street, and offered a seat to a stranger who was standing) (Table 1).

Regression analysis highlights attitudes to vaccination as a critical determinant of COVID-19 vaccine uptake

The results of the binomial logistic regression model are presented in Table 2. The binomial logistic regression model was statistically significant ($\chi^2[52] = 970.58$, $p < 0.001$, Table 2), and explained 59.64% (Mc Fadden's R^2) of the variance in vaccination

Table 1
Results from Pearson Chi-square test.

Factor	Category	(%)	Vaccinated (self-reported) respondents (%)	Unvaccinated (self-reported) respondents (%)	Chi-squared test
Gender	0 = Male	41.18	35.97	47.13	chi2[1] = 16.6750,
	1 = Female	58.82	64.03	52.87	*p-value* < 0.001
Age	1 = 18–25	21.01	15.83	26.93	chi2[5] = 42.7234,
	2 = 26–35	22.47	20.58	24.63	*p-value* < 0.001
	3 = 36–45	29.75	33.96	24.96	
	4 = 46–55	20.17	20.72	19.54	
	5 = 56–65	5.67	7.63	3.45	
	6 = 65 +	0.92	1.29	0.49	
Education	0 = less than university education (bachelor)	47.55	41.01	55.01	chi2[1] = 25.5124,
	1 = university education or higher (bachelor, master, PhD)	52.45	58.99	44.99	*p-value* < 0.001
Employment status	1 = Full-time employed	55.06	62.59	46.47	chi2[8] = 63.1149,
	2 = Retired	3.37	4.6	1.97	*p-value* < 0.001
	3 = Student	15.64	12.95	18.72	
	4 = Currently unemployed but were previously employed	8.13	7.19	9.2	
	5 = Self-employed	7.90	4.03	12.32	
	6 = Housewife	2.76	2.59	2.96	
	7 = Part-time employed	2.38	2.45	2.3	
	8 = Unemployed (searching for job)	4.22	3.17	5.42	
	9 = Unable to work	0.54	0.43	0.66	
Marital status	1 = Married	54.29	56.98	51.23	chi2[4] = 8.1001,
	2 = Single	36.66	33.38	40.39	*p-value* = 0.088
	3 = Living with partner	2.91	2.73	3.12	
	4 = Divorced	4.45	4.89	3.94	
	5 = Widowed	1.69	2.01	1.31	
Self-reported income	1 = up to 1000 BAM	40.41	36.69	44.66	chi2[4] = 8.7589,
	2 = from 1000 to 1500 BAM	25.08	26.33	23.65	*p-value* = 0.067
	3 = from 1501 to 2001 BAM	14.65	15.54	13.63	
	4 = from 2000 to 2500 BAM	8.28	9.06	7.39	
	5 = more than 2500 BAM	11.58	12.37	10.67	
Area of residence	0 = rural	19.71	16.98	22.82	chi2[1] = 7.0097,
	1 = urban	80.29	83.02	77.18	*p-value* = 0.008
Children	0 = No	45.09	42.30	48.28	chi2[1] = 4.6782,
	1 = Yes	54.91	57.70	51.72	*p-value* = 0.031
Social protection beneficiary	0 = No	96.17	96.26	96.06	chi2[1] = 0.0352,
	1 = Yes	3.83	3.74	3.94	*p-value* = 0.851
Chronic patient	0 = No	87.04	84.60	89.82	chi2[1] = 7.8256,
	1 = Yes	12.96	15.40	10.18	*p-value* = 0.005
Self-reported internet daily use	1 = up to one hour	23.17	22.04	24.46	chi2[3] = 2.0127,
	2 = from one up to three hours	50.43	50.15	50.75	*p-value* = 0.570
	3 = from three up to five hours	18.85	19.67	17.92	
	4 = more than five hours	7.54	8.14	6.87	
Public trust in government: I trust the government institutions. (d1)	0 = No	60.35	46.04	76.68	chi2[1] = 127.35,
	1 = Yes	39.65	53.96	23.32	*p-value* < 0.001
Public trust in health system:	0 = No	89.88	83.02	97.70	chi2[1] = 76.88,
I trust health care policy makers. (d2)	1 = Yes	10.12	16.98	2.30	*p-value* < 0.001
Public trust in health system:	0 = No	88.42	84.89	92.45	chi2[1] = 18.09,
Focus of providers is patient centred. (d3)	1 = Yes	11.58	15.11	7.55	*p-value* < 0.001
Public trust in health system:	0 = No	71.40	64.03	79.80	chi2[1] = 39.55,
Health care providers are well-qualified. (d4)	1 = Yes	28.60	35.97	20.20	*p-value* < 0.001

(*continued on next page*)

Table 1 (*continued*)

Factor	Category	(%)	Vaccinated (self-reported) respondents (%)	Unvaccinated (self-reported) respondents (%)	Chi-squared test
Public trust in health system: Quality of health care is high. (d5)	0 = No	87.65	83.60	92.28	chi2[1] = 22.62,
	1 = Yes	12.35	16.40	7.72	*p-value* < 0.001
Public trust in health system: Health care workers communicate effectively and provide information provision. (d6)	0 = No	86.04	80.86	91.95	chi2[1] = 33.245,
	1 = Yes	13.96	19.14	8.05	*p-value* < 0.001
Public trust in health system: I trust health care workers' advice. (d7)	0 = No	69.33	56.69	83.74	chi2[1] = 111.71,
	1 = Yes	30.67	43.31	16.26	*p-value* < 0.001
Public trust in health system: Health system is efficient. (d8)	0 = No	93.71	90.94	96.88	chi2[1] = 19.47,
	1 = Yes	6.29	9.06	3.12	*p-value* < 0.001
Public trust in health system: I trust health care workers to provide accurate information regarding the safety of the vaccine against COVID-19. (d9)	0 = No	63.27	38.65	90.25	chi2[1] = 356.47,
	1 = Yes	36.73	61.35	9.75	*p-value* < 0.001
Altruism: Charity I have given money to a charity. (d10)	0 = No	61.89	62.16	61.58	chi2[1] = 0.05,
	1 = Yes	38.11	37.84	38.42	*p-value* = 0.829
Altruism: Charity I have donated goods or clothes to a charity. (d11)	0 = No	58.44	55.25	62.07	chi2[1] = 6.21,
	1 = Yes	41.56	44.75	37.93	*p-value* = 0.013
Altruism: Charity I have done volunteer work for a charity. (d12)	0 = No	81.29	80.58	82.10	chi2[1] = 0.4971,
	1 = Yes	18.71	19.42	17.90	*p-value* = 0.481
Altruism: Helping people I have helped carry a stranger's belongings. (d13)	0 = No	29.83	32.37	26.93	chi2[1] = 4.5968,
	1 = Yes	70.17	67.63	73.07	*p-value* = 0.032
Altruism: Helping people I have made change for someone I did not know. (d14)	0 = No	30.14	32.52	27.42	chi2[1] = 4.0034,
	1 = Yes	69.86	67.48	72.58	*p-value* = 0.045
Altruism: Helping people I have let a neighbour I did not know well borrow an item of some value to me. (d15)	0 = No	60.43	61.87	58.78	chi2[1] = 1.2924,
	1 = Yes	39.57	38.13	41.22	*p-value* = 0.256
Altruism: Helping people I have offered to help a disabled or elderly stranger across a street. (d16)	0 = No	31.52	31.37	31.69	chi2[1] = 0.0158,
	1 = Yes	68.48	68.63	68.31	*p-value* = 0.900
Altruism: Helping people I have offered my seat to a stranger who was standing. (d17)	0 = No	20.71	20.00	21.51	chi2[1] = 0.4512,
	1 = Yes	79.29	80.00	78.49	*p-value* = 0.502
Political views: I consider myself a conservative person. (d18)	0 = No	67.64	74.24	60.10	chi2[1] = 29.67,
	1 = Yes	32.36	25.76	39.90	*p-value* < 001
Attitudes towards vaccination: Ever been vaccinated (d19)	0 = No	10.42	0.58	21.72	chi2[1] = 154.31,
	1 = Yes	89.58	99.42	78.28	*p-value* < 001
Attitudes towards vaccination: Vaccinated against flu (d20)	0 = No	75.74	71.07	81.03	chi2[1] = 17.24,
	1 = Yes	24.26	28.93	18.97	*p-value* < 001
Attitudes towards vaccination: I believe that the vaccine is effective in preventing COVID-19. (d21)	0 = No	44.87	9.19	84.64	chi2[1] = 710.79,
	1 = Yes	55.13	90.81	15.36	*p-value* < 001

*fixed exchange rate 1 EURO= 1.98553 BAM bachelor'sχ^2bachelor's, master's$\chi^2\chi^2$
BAM = Bosnia and Herzegovina convertible mark.

Table 2
Results from binary logistic regression.

Variable	*OR (95% CI)*	*p-value*
Sex	*1.089 (0.683–1.734)*	*0.719*
Age		
1 = 18–25	*Ref.*	
2 = 26–35	*2.741 (0.998–7.526)*	0.050
3 = 36–45	*4.037 (1.364–11.949)*	*0.012**
4 = 46–55	*3.646 (1.143–11.630)*	*0.029**
5 = 56–65	*3.491 (0.861–14.151)*	*0.080*
6 = 65 +	*4.370 (0.178–107.330)*	*0.367*
Education	*1.540 (0.912–2.601)*	*0.106*
Employment status		
1 = Full-time employed	*Ref.*	
2 = Retired	*1.509 (0.416–5.476)*	*0.532*
3 = Student	*0.386 (0.130–1.148)*	*0.087*
4 = Currently unemployed but were previously employed	*0.475 (0.221–1.019)*	*0.056*
5 = Self-employed	*0.267 (0.104–0.683)*	*0.006***
6 = Housewife	*0.435 (0.115–1.639)*	*0.219*
7 = Part-time employed	*0.600 (0.152–2.375)*	*0.467*
8 = Unemployed (searching for job)	*0.266 (0.085–0.832)*	*0.023**
9 = Unable to work	*0.269 (0.017–4.224)*	*0.350*
Marital status		
1 = Married	*Ref.*	
2 = Single	*0.699 (0.272–1.799)*	*0.458*
3 = Living with partner	*0.645 (0.156–2.662)*	*0.544*
4 = Divorced	*1.130 (0.385–3.319)*	*0.824*
5 = Widowed	*1.086 (0.196–6.007)*	*0.925*
Children	*0.583 (0.245–1.388)*	*0.223*
Economic status		
1 = up to 1000 BAM	*Ref.*	
2 = from 1000 to 1500 BAM	*0.716 (0.389–1.318)*	*0.283*
3 = from 1501 to 2001 BAM	*0.739 (0.364–1.499)*	*0.402*
4 = from 2000 to 2500 BAM	*0.720 (0.292–1.777)*	*0.476*
5 = more than 2500 BAM	*0.621 (0.271–1.423)*	*0.260*
Area of residence	*1.201 (0.689–2.094)*	*0.518*
Social protection beneficiary	*1.075 (0.416–2.777)*	*0.882*
Chronic patient	*1.165 (0.592–2.294)*	*0.659*
Self-reported internet daily use		
1 = up to one hour	*Ref.*	
2 = from one up to three hours	*1.744 (1.019–2.984)*	*0.042**
3 = from three up to five hours	*2.231 (1.134–4.389)*	*0.020**
4 = more than five hours	*2.477 (0.993–6.182)*	*0.052*
Political views. (d18)	*0.605 (0.387–0.945)*	*0.027**
Attitudes towards vaccination: Ever been vaccinated. (d19)	*45.464 (12.364–167.179)*	*0.000***
Attitudes towards vaccination: Vaccinated against flu. (d20)	*1.498 (0.902–2.487)*	*0.118*
Attitudes towards vaccination: I believe that the vaccine is effective in preventing COVID-19. (d21)	*41.612 (25.315–68.403)*	*0.000***
Public trust in government: I trust the government institutions. (d1)	*1.670 (1.044–2.670)*	*0.032**
Public trust in health system: I trust health care policy makers. (d2)	*3.497 (1.428–8.565)*	*0.006***
Public trust in health system: Focus of providers is patient centred. (d3)	*0.543 (0.251–1.177)*	*0.122*
Public trust in health system: Health care providers are well-qualified. (d4)	*0.447 (0.233–0.857)*	*0.015**
Public trust in health system: Quality of health care is high. (d5)	*0.596 (0.257–1.380)*	*0.227*
Public trust in health system: Health care workers communicate effectively and provide information provision. (d6)	*1.928 (0.872–4.265)*	*0.105*
Public trust in health system: I trust health care workers' advice. (d7)	*1.099 (0.568–2.127)*	*0.780*
Public trust in health system: Health system is efficient. (d8)	*1.354 (0.504–3.637)*	*0.548*
Public trust in health system: I trust health care workers to provide accurate information regarding the safety of the vaccine against COVID-19. (d9)	*3.556 (2.041–6.196)*	*0.000***
Altruism: Charity I have given money to a charity. (d10)	*0.510 (0.311–0.838)*	*0.008***
Altruism: Charity I have donated goods or clothes to a charity. (d11)	*1.534 (0.918–2.564)*	*0.103*
Altruism: Charity I have done volunteer work for a charity. (d12)	*1.065 (0.604–1.879)*	*0.827*
Altruism: Helping people I have helped carry a stranger's belongings. (d13)	*0.954 (0.477–1.908)*	*0.895*

(*continued on next page*)

Table 2 (*continued*)

Variable	*OR (95% CI)*	*p-value*
Altruism: Helping people I have made change for someone I did not know. (d14)	*0.696 (0.345–1.403)*	*0.311*
Altruism: Helping people I have let a neighbour I did not know well borrow an item of some value to me. (d15)	*1.145 (0.708–1.852)*	*0.582*
Altruism: Helping people I have offered to help a disabled or elderly stranger across a street. (d16)	*1.818 (1.038–3.184)*	*0.037**
Altruism: Helping people I have offered my seat to a stranger who was standing. (d17)	*0.916(0.477–1.757)*	*0.791*

* $p < 0.05$, **$p < 0.01$, n = 1176, Mc Fadden's $R^2 = 0.5964$

against COVID-19 with 89.54% of cases correctly classified. At the 1% significance level, the significant variables as defined in Table 2 are: d19 (ever been vaccinated) (z = 5.75, p-value < 0.001), d21 (belief that the vaccine is effective in preventing COVID-19) (z = 14.70, p-value < 0.001), d2 (trust in healthcare policy makers) (z = 2.74, p-value = 0.006), d9 (trust in healthcare workers to provide accurate information regarding safety of the vaccine against COVID-19) (z = 4.48, p-value < 0.001) and d10 (have given money to charity) (z = −2.66, p-value = 0.008).

At the 5% significance level, significant variables are: d1 (trust in government institutions) (z = 2.14, p-value = 0.03), d4 (belief that healthcare providers are well-qualified) (z = −2.42, p-value = 0.02), d16 (have offered to help a disabled or elderly stranger across a street) (z = 2.09, p-value = 0.04) and d18 (political views) (z = −2.21, p-value = 0.03).

The regression analysis indicates that the attitudes of the respondents to vaccination as indicated by whether they had ever been vaccinated previously (d19) and their beliefs about the effectiveness of COVID-19 vaccines (d21) are critical determinants of COVID-19 vaccination status (Table 2). Those who received childhood immunisations were more likely to be vaccinated against COVID-19 compared to those who had never been vaccinated (OR = 45.46 [95% CI 12.36–167.18], p < 0.001). Furthermore, those who believed that the COVID-19 vaccines were effective had a higher likelihood of being vaccinated compared to those who thought they were not effective (OR = 41.61 [95% CI 25.31–68.40], p < 0.001). COVID-19 vaccine uptake was also significantly affected by trust in healthcare policy makers and trust in public healthcare staff in providing accurate information on the safety of the COVID-19 vaccine. Respondents who reported trust in healthcare policy makers had a higher likelihood of being vaccinated compared to those who did not (OR = 3.50 [95% CI 1.43–8.57], p = 0.006). Similarly, respondents who trusted healthcare workers to provide accurate information regarding the safety of the COVID-19 vaccine (d9) had a higher likelihood of being vaccinated compared to those who did not (OR = 3.56 [95% CI 2.04–6.20], p < 0.001) (Table 2).

A longer daily internet usage of up to 5 h was associated with increased uptake of COVID-19 vaccination. Respondents who reported trust in the institutions of the government (d1) were 67% more likely to be vaccinated against COVID-19 than those who did not (OR = 1.67 [95% CI 1.04–2.67], p = 0.03).

Altruism (by some of the measures assessed) also affected vaccine uptake rate: interestingly, respondents who reported they donate money to charity (d10) had a lower likelihood of being vaccinated against COVID-19 (OR = 0.51 [95% CI 0.31–0.84], p = 0.008), while respondents who have offered to help a disabled or

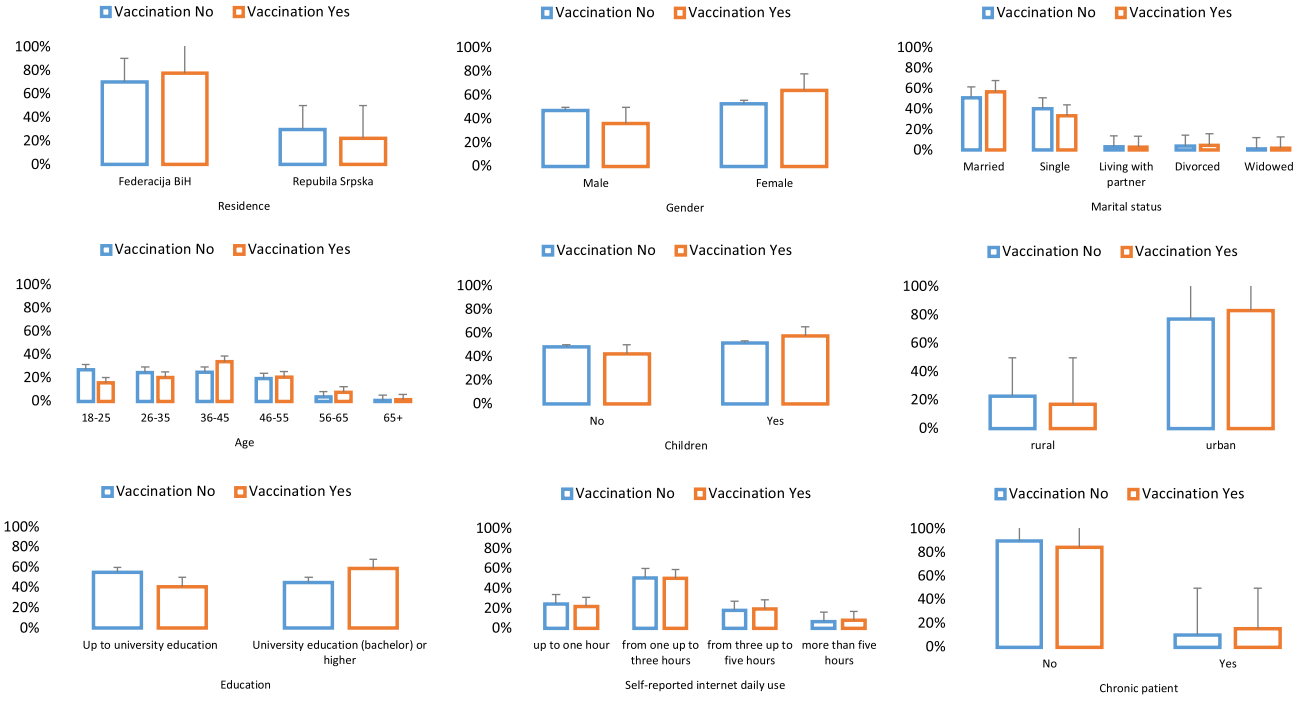

Fig. 1. Cross-tabulation of results between socio-demographic factors and vaccination status. N.B. Due to small number of surveyed residents of Brčko District, responses have been combined with those from RS.

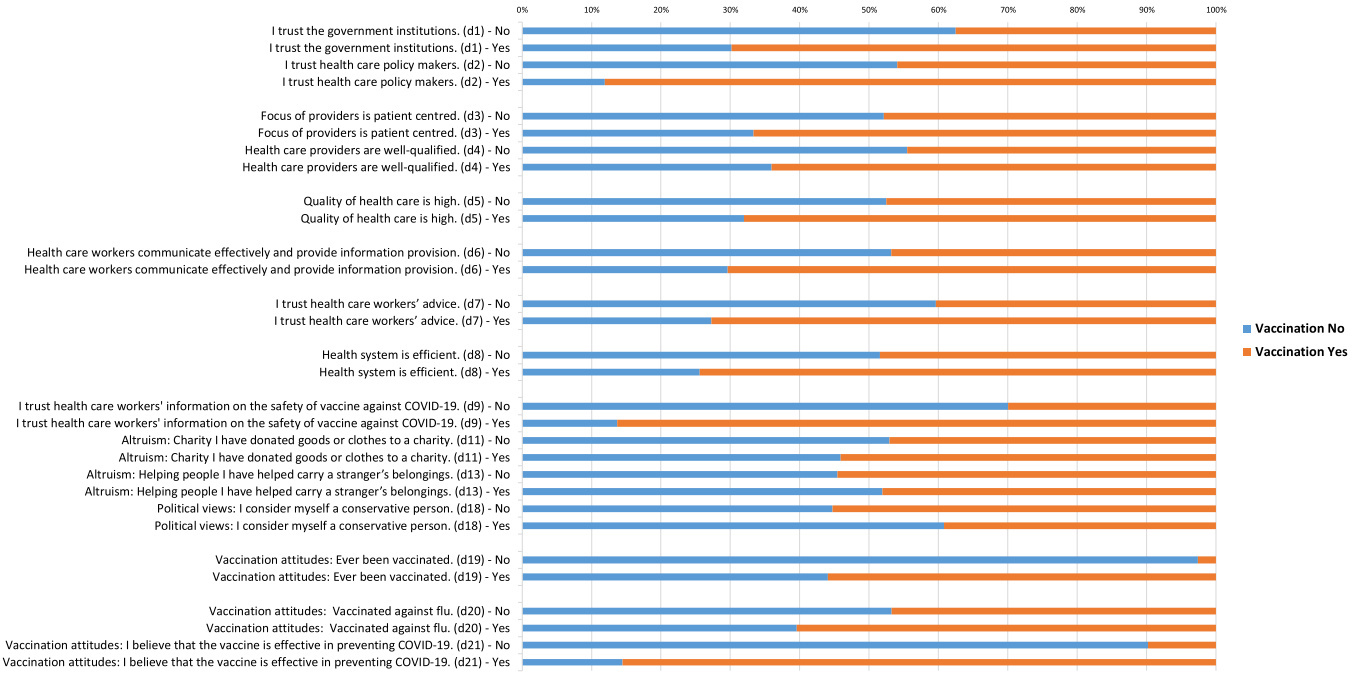

Fig. 2. Summary of responses regarding trust in health system, government, altruism and attitudes towards vaccination (cross tabulations for 15 variables used in the regression analysis).

elderly stranger across the street (d16) were more likely to be vaccinated against COVID-19 (OR = 1.82 [95% CI 1.04–3.18], p = 0.04) (Table 2).

Moreover, respondents who considered themselves conservative on the political spectrum (d18) had an almost 40% lower likelihood of COVID-19 vaccination uptake compared to those who did not (OR = 0.61 [95% CI 0.39–0.95], p = 0.03). The respondents who considered healthcare workers in B&H well-qualified (d4) were 55% less likely to be vaccinated against COVID-19 (OR = 0.45 [95% CI 0.23–0.86], p = 0.02). Finally, respondents who were unemployed or self-employed were less likely to be vaccinated against COVID-19 in comparison to those who were in full-time employment (OR = 0.27 [95% CI 0.08–0.83], p = 0.02; and OR = 0.27 [95% CI 0.10–0.68], p = 0.006, respectively, Table 2).

Discussion

Whilst a small number of previous studies evaluated vaccine acceptance and rejection among the B&H adult population [31], they were limited by the low number of individual determinants explored. Hence, since our study examines several groups of factors associated with vaccination uptake in B&H, it attempts to address this research gap. Although the Chi-squared analysis indicated several associations between COVID-19 vaccination and socio-demographic factors, the majority of these were not statistically significant variables in the binary logistic regression (with the exception of employment status and some age groups), which is in contrast to previous studies regarding vaccine hesitancy [23–25, 32].

The significance of employment status may be associated with concerns around requiring vaccination certificates for employment purposes in the future, even though at the time of the survey, employment vaccination certificates were not mandatory.

Currently, the most widely used method of evaluating the opinions of the general population regarding acceptance of, or hesitancy towards, vaccination has been through surveys. A Web of Science database search by title using the two keywords 'COVID-19 vaccine' and 'survey' returned a total of 116 results including 34 related to COVID-19 vaccine hesitancy.

The results represent a variety of survey-based methods deployed ranging from country-specific (among US citizens [24,25], among Japanese citizens [33], or among Italian citizens [34]); within-country ethnicity specific (for example among Arab Americans [26]); cross-country [35,36]; and cross-sectional analyses [37] of specific individual traits of respondents, primarily focusing on respondents with chronic diseases (for example, among haemodialysis patients [38] or among patients with cancer [39] or health care workers [40,41].

Our study highlights the importance of trust as a key determinant of COVID-19 vaccine uptake. Namely, the decline in trust in the healthcare system is a well-known phenomenon that is particularly well-researched in developed countries [27].

The health system in addition to the belief that healthcare providers always communicate effectively and provide accurate information to patients have previously proven to be important determinants [35]. Interpersonal trust [42,43] represented an important factor associated with COVID-19 vaccination status in our study. Perhaps counter-intuitively, respondents who believe that healthcare workers are well-qualified were less likely to be vaccinated against COVID-19. One possible explanation could lie in the respondents' trust in receiving adequate healthcare in the event of serious COVID-19 disease, and therefore believing a vaccination to be unnecessary. Given the complex B&H health system, the numerous problems that arose during the pandemic and a general decline in confidence in the health system (present in public discourse), a knock-on effect on vaccine uptake is perhaps not unexpected.

Another potential pathway to increase the percentage of the vaccinated population is through strengthening trust in the public health sector and institutions [27]. Namely, our study has suggested that trust in healthcare policy makers, the health system, but also in the qualification of doctors to provide good health services are significant factors associated with COVID-19 vaccination status. It may be necessary to implement reforms in the organization, management, and financing of healthcare, which could result in an improved

workforce and better technical equipment, and ultimately increase the quality of healthcare services provided. At this point, it is important to conduct campaigns to increase confidence in the public health system.

An additional finding was that participants' self-reported political views were associated with vaccine uptake, whereby those who consider themselves to be conservative are less likely to be vaccinated against COVID-19. This is in line with the results of other researchers who have shown a connection between political beliefs and attitudes to vaccination [25, 44, 45], and raises the possibility that campaigns may be targeted to specific subsets of the population.

The last set of variables analysed were concerned with altruism. The altruism assessment scale was included primarily because the current vaccination campaign is conducted under the slogan "Get vaccinated for those you love." Altruism is an important factor in vaccination decisions since economic theory regards vaccination as a merit good that is associated with a concept of paternalist altruism. Interestingly, we found that low commitment altruism is associated with a lower vaccination rate (those who donated money to charity, for example, were 49% less likely to be vaccinated against COVID-19).

However, altruistic behaviours that require a relatively high level of personal involvement (e.g., respondents who have offered to help a disabled or elderly stranger across the street) were 82% more likely to be vaccinated against COVID-19. Hence, in regards to altruism, our findings are broadly in concordance with those previously reported in a US cohort [25].

An additional factor that proved to be significant was the daily duration of internet usage. A longer daily internet usage was associated with an increased likelihood of having received a COVID-19 vaccine, up to a limit of more than 5 h/day. Given the findings of an association between the length of daily internet usage and vaccination status, and the importance, effectiveness and accessibility of digital tools, especially social media in spreading information, communication and creating awareness, such tools could be exploited for campaigns undertaken by the health sector and public health policy-makers [46–48]. Campaigns should be carefully crafted and targeted to specific groups, with appropriate messages and valuable content. In doing so, it may be preferable to use "informed inferences" rather than evidence-based recommendations [49,50], as current vaccine-promotion strategies largely fail to convince vaccine-hesitant individuals to reconsider their position [51]. It is also important that effective education and delivery of information related to vaccination does not cease after the end of the COVID-19 pandemic.

The results of the campaign to increase the percentage of the vaccinated population to date, as well as the results of our research, show that the current "altruism-based" broad-targeted campaign might not represent a sufficiently effective framework. Although socio-demographic factors were not found to be significant in our logistic regression analysis, associations identified during cross-tabulation of the socio-demographic characteristics of vaccinated compared with unvaccinated respondents might provide grounds for creating an ad-hoc (short-term) campaign with targeted messages and content to increase vaccination coverage. Targeted groups may include populations living in rural areas, politically conservative individuals, those with lower levels of education, lower incomes, and those aged 18–35 and over 45.

Our findings could be also applied in planning a long-term approach to gaining trust in the health system, improving education around COVID-19 and vaccination, and promotion of the importance of immunisation.

Although a large sample was surveyed, our research has several limitations. Due to financial constraints, the study focused only on B &H and was conducted online, which means that the (likely more elderly) population that lacks internet access or IT literacy was not captured. Additional limitations relate to the use of the exponential non-discriminative snowball sampling technique and the fact that vaccine status and some of the socio-demographic variables (e.g., income level) are self-reported and as such could be inaccurate/subjective. During the COVID-19 outbreak, the Institutes of Public Health of FB&H and RS issued a legally binding decree that PCR testing could only be performed in certified medical institutions in B &H. Inability to access such premises meant we were unable to sample PCR-tested individuals. A major advantage of our study is that a specific population in B&H was surveyed for the first time, providing data that can inform targeted campaigns that will have the greatest efficacy for that particular population. As our results indicate, further research regarding the impact of daily duration of internet usage on the uptake of vaccination is of specific interest.

Conclusion

The objective of this study was to examine the factors associated with COVID-19 vaccination status in B&H using an online survey approach with analysis by binary logistic regression.

We demonstrate a significant association between vaccination and a range of factors: respondents' socio-demographic characteristics, attitudes and estimates regarding personal risk, public trust in the health system and political ideology. We also highlight three important policy-level implications that should be reconsidered in the future: the importance of promoting awareness of the effectiveness and safety of vaccines, the significance of early childhood immunisations, and engendering trust in healthcare policy together with trust in healthcare staff. The results and stated conclusions are not only relevant to B&H decision makers, but also other upper-middle income countries with low vaccination and high mortality rates.

Ethical approval

The study was approved by the School of Economics and Business, University of Sarajevo on 4th October 2021 in accordance with the Article 17 of the Code of Ethics of the University of Sarajevo no. 01–38–1696–1/12.

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Declaration of Competing Interest

Dunja Aksentijevic, Lejla Lazović-Pita, Almir Peštek and Ademir Abdić declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Rachel Tanner is a contributor to intellectual property licensed by Oxford University Innovation to AstraZeneca.

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