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COVID-VAC: The second global study of COVID-19 vaccine acceptance

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Abstract (150/150 words)

This one-year follow-up study investigated COVID-19 vaccine acceptance in 23 countries. In June 2021, 75.2% of respondents reported to accept the vaccine, of which 49% had received at least one vaccine dose and 51% were willing to get it once available to them. Factors associated with COVID-19 vaccine acceptance include perceived safety and trust in science, as measured by a novel COVID-VAC score, and personal experience with COVID-19. Males, healthcare workers, well-to-do people, those with university degrees, and those whose physician recommended vaccination were more likely to accept it. Trust in governmental ability to address COVID-19 was weakly associated with vaccine acceptance. Respondents strongly supported vaccination to travel internationally, but weakly supported vaccinating children for school attendance. Hesitancy rates remain high in LMICs. Health policymakers should aggressively communicate vaccination need and inform accurately about efficacy and safety compared to disease risk, and healthcare workers need a greater vaccine communications role.

Keywords: COVID-19, disease control, SARS-CoV-2, vaccination

Introduction

Vaccine hesitancy is a global challenge, declared by the World Health Organization in 2019 as one of the ten greatest global health threats¹, and a vital concern since vaccination is the most effective intervention to control the ongoing COVID-19 pandemic. In June 2020, as most countries were experiencing a second wave of SARS-CoV-2 transmission, the authors of this study reported potentially low COVID-19 vaccine acceptance among more than 13,000 respondents in 19 of the hardest-hit countries.² As of 1 August 2021, 1.07 billion individuals globally had received one dose and another 1.14 billion received two doses of an available COVID-19 vaccine; however, more than 70% of the world (90% in low- and middle-income countries (LMIC)) remains unvaccinated.³

Globally, rates of COVID-19 vaccine acceptance vary. In a 2021 study of more than 30,000 respondents from eight countries, 27% of participants were hesitant, ranging from 9.6% in Brazil to 47.3% in France.⁴ Another survey of more than 18,000 respondents from 15 countries reported a range of 54% vaccine acceptance in France to 87% in India.⁵ A recent review of 15 peer-reviewed studies calculates a COVID-19 vaccine acceptance rate of 77.6% in the general population and 86.1% among students.⁶ Another study reported vaccine acceptance ranges from 23.6% in Kuwait to 97% in Ecuador.⁷ The lowest rates of acceptance to date are reported in the Middle East, Africa, and several European countries (notably France, Italy, Poland, and Russia).

The main causes of vaccine hesitancy in these studies included concerns about vaccine safety and efficacy, mistrust of governments and health and scientific institutions, individual religious and political beliefs, as well as misinformation and conspiracy theories.^{8–11} Most studies reported men to be more likely to accept COVID-19 vaccines than women.⁷ Other variables associated with lower vaccine acceptance include living in rural areas and lower income. Conversely, COVID-19 vaccine acceptance correlated strongly among those who reported greater concern about the effects of

COVID-19 disease and those previously vaccinated against influenza.⁴ Possessing accurate knowledge about COVID-19 disease transmissibility and prevention, fear of contracting COVID-19, and higher income all correlated positively with acceptance, but having a chronic disease and being female did not.¹² The association between age and vaccine acceptance varied geographically, with some studies showing greater acceptance among older (above 65 years)⁴ and others among younger (below 40 years) age groups.¹² A survey conducted in nine LMICs in Asia and Africa showed that vaccine acceptance increased with a higher perception of effectiveness; 76.4% accepting a hypothetical 90% effective vaccine increased to 88.8% accepting if 95% effective.¹²

Following a year of substantial but very uneven global availability, administration and acceptance of COVID-19 vaccines, further investigation is necessary to understand how knowledge, risk perception, trust, and other factors associated with acceptance continue to evolve. The present study was undertaken in June 2021 to assess vaccine acceptance and uptake among 23 countries that represent approximately 60% of the world's population. In addition, comparisons in acceptance rates among the 19 countries in our 2020 study were included. Novel investigations in this 2021 study include testing the predictive value of a new vaccine acceptance score (COVID-VAC), which represents perceptions of risk, trust, safety, equity, and efficacy; the impact of mental health on vaccine acceptance; and acceptance for a range of requirements for proof of vaccination, and vaccination for children.

Results

Sample characteristics

23,000 participants from 23 countries responded to the survey. Approximately half were female (50.2%), ages 30-59 (59.9%), and resided in LMICs (52.2%). One-fifth were university graduates (22.4%) (**Table 1**). Healthcare workers represented 10.8% of respondents. COVID-19 illness (self or

family) or loss of a family member to COVID-19 were most common in Ecuador (48.3% and 19.2%), Brazil (38.3% and 18.3) and Peru (35.5% and 34.7%), and least common in China (1.5% and 2%), Singapore (3.3% and 5.3%), South Korea (3.8% and 2.1%), Ghana (5.8% and 1.5%), and Nigeria (6% and 2.3%). Loss of income was highest in lower-middle and upper-middle income countries (range 31.7% in Germany to 95.1% in Ecuador). Reported anxiety prevalence ranged from 9.2% in Ghana to 44.7% in Turkey, and depression was lowest in China (12.6%) and Ghana (12.9%) and highest in Turkey (38.7%).

Vaccine acceptance, June 2021

In June 2021, global COVID-19 vaccine acceptance was 75.2%, of whom 49% reported having received at least one vaccine dose and 51% were willing to get it once available to them (**Figure 1**). Reported vaccine acceptance was highest in China (97.6% (of whom 91.9% had received at least one dose)), Canada (79.2% (86.3%)), and the UK (81.2% (82.6%)) and lowest in Russia (51.6% (30.4%)), Nigeria (57% (3.5%)), and Poland (59.3% (74.2%)) (**Figure 1**). The mean difference between these single-dose figures and official rates¹³ was 2.7%; reliable data for China are unavailable.

Compared to June 2020, vaccine acceptance in the 19 countries previously surveyed increased from 71.5% to 75.2%, though an opposite trend was observed in South Africa (-20.9%), the US (-8.8%), Nigeria (-8.2%), and Russia (-3.3%). Vaccine acceptance when recommended by employer increased in all countries (global average increased from 48.1% in 2020 to 64.2% in 2021), except in Germany (-3%) and South Korea (-0.2%). Vaccine acceptance when recommended by one's doctor (range 56.4% in Russia to 95.1% in China), was higher in all countries compared to one's employer (range 44.4% in Russia to 96.7% in China). Notably, among respondents unsure/unwilling to vaccinate, potential vaccine acceptance was most likely if recommended by one's doctor, particularly in India (63.5%), Kenya (38%), Brazil, (36.8%), Turkey(29.9%), South Korea (28.4%), and Russia (26.5%). Generally,

those unsure/unwilling to take the vaccine were more likely to follow their doctors' recommendation (21.9% +/- 12.3%) than employers' recommendation (13.2% +/- 7.7%; $p=0.006$) (**Figure 1**).

Vaccine acceptance correlated highly with perceptions of risk, trust, safety, equity, and efficacy, measured using COVID-VAC (June 2021: $r=0.85$, $p<0.001$). In validation analyses, COVID-VAC was unidimensional with a Cronbach's alpha of 0.86. Vaccine acceptance weakly correlated with countries' current COVID-19 case burden ($r=-0.13$, $p>0.05$), mortality ($r=-0.25$, $p>0.05$), and approval of government responses to the pandemic in June 2020, measured using COVID-SCORE-10¹¹ ($r=0.25$, $p>0.05$) (**Figure 2**).

Countries' vaccination rates¹³ and hesitancy showed moderate negative association ($r=0.45$, $p=0.034$) (**Figure 2**). Generally, countries in Africa had low vaccination uptake and high hesitancy; whereas India, South Korea, and countries in South America had higher uptake and lower hesitancy. Countries with 40%+ uptake had similar hesitancy to the latter group, with the exception of Poland, France and the US, which had high hesitancy.

Parents' willingness to vaccinate children was highest in China (95%), Brazil (91.3%), Ecuador (85.9%), Peru (85.1%) and lowest in Russia (35.5%), Poland (46.3%) and France (48.5%). In all countries, willingness to vaccinate one's children was significantly greater among parents who accepted the vaccine ($p<0.001$) (**Figure 3**).

Correlates of vaccine acceptance June 2021

In multivariable models, vaccine acceptance was associated with older respondents in Canada, France, Germany, South Korea, Sweden, UK, and US (aOR range, 1.02-1.04) (**Figure 4**) and younger

ones in Nigeria (aOR=0.89) and Ghana (aOR=0.93). Male gender was significantly positively correlated in Ghana, Nigeria, South Africa, and the US (aOR range 1.51-8.84) and female gender in Kenya and Peru (aOR=0.39 and aOR=0.32). Having a university degree was significantly associated with vaccine acceptance in France, Mexico, South Africa, and the US (aOR range, 1.75-5.55). Personal or family COVID-19 illness or death of a family member due to COVID-19 was strongly associated with vaccine acceptance, with statistically significant associations with personal or family illness in Germany, Peru, Poland, Turkey, Singapore, UK (aOR range 1.89-5.72) and with loss of a family member in Brazil, France, Germany, Ghana, Mexico, Peru, Poland, Sweden, Turkey and the UK (aOR range 2.75-9.25). Having low or no income was associated with less vaccine acceptance in Brazil, France, Germany, Nigeria, Peru, Russia, South Korea, Spain, Turkey, and the US (aOR range 0.08-0.55). Moderate or severe income loss due to the pandemic was positively associated with vaccine acceptance in Ghana, Nigeria, Poland, and the US (aOR range 2.01-6.27).

Adjusted for socio-demographic factors and COVID-19 experience, the COVID-VAC score was the most salient and consistent positive correlate of vaccine acceptance in all countries (aOR range, 1.41-3.44) (**Figure 5**). The strongest correlation was with “I trust the science behind the COVID-19 vaccines” and “safety of the vaccines.” The lowest correlation was with “I trust my government is able to deliver the vaccine to everyone and everywhere in my country” (**Supplemental Table 1**). In univariable analyses, vaccine acceptance was significantly higher among respondents who reported that they trust their central and/or local government. This finding was not universal, however, and was not found in Brazil, China, Ecuador, and Peru (**Supplemental Figure 1**). After adjustment, trust in central government had a significantly positive association in Russia and Singapore (aOR=2.05 and aOR=5.28) and trust in local government had a negative association in South Africa (aOR=0.44). In Poland, vaccine acceptance was negatively correlated with trust in central government (aOR=.48) and positively correlated with trust in local government (aOR=2.9). Finally, vaccine acceptance positively correlated with anxiety in Canada (aOR=4.59) and Peru (aOR=3.64) and negatively

correlated in South Korea (aOR=.43) and the US (aOR=.31), while depression was a negative factor in Canada (aOR=.21) and South Africa (aOR=.53) (**Figure 5**).

Healthcare workers (HCW)

Vaccine acceptance was significantly higher among HCWs globally compared to non-HCWs (91.8% vs. 83%, $p<0.001$, aOR=1.72, 95%CI [1.38, 2.13]) (**Table 2**). Vaccine hesitancy was significantly lower among physicians (3.1%) followed by nurses (6.5%), community health workers (7.8%), and other HCWs (14.0%).

Proof of vaccination requirements

Support for requiring vaccines was highest in China, India, Peru and South Korea and lowest in Poland, Russia and Germany. Strong support was reported globally (74.4%) for proof of vaccination to travel internationally, particularly in China (93.3%), South Korea (87.8%), India (87.7%), Brazil (86.4%), and Ecuador (83%), with less support in Poland (52.7%) and Russia (52.5%). Overall support was 63.3% and 63.1% for vaccination to attend university and indoor activities, respectively. These ranged from lows in Russia of 33.1% for university and 37.6% for indoor activities to highs in China of 95.4% and 89.7%. Support for governments or employers to require vaccination followed similar trends. Agreement with mandates to vaccinate school children received the lowest support overall (58.2%), ranging from 24.4% in Russia to 86.6% in China (**Figure 6**).

Discussion

Reported COVID-19 vaccine acceptance, measured by intention to get vaccinated or having received at least one dose of an available vaccine, increased over the last year in 15 of the 19 countries studied both years and was 75.2% for the 23 countries studied in 2021, still below what is needed to

achieve global herd immunity (80-85%). Among the six-item COVID-VAC score, positive perceptions of safety and trust in the science behind vaccine development were the strongest predictors of acceptance, while perceptions of efficacy, benefit, and equity also held strong associations. Other determinants of vaccine acceptance varied by country; personal experience with COVID-19 (e.g. sickness or loss of a family member) predominated, but other demographic characteristics (e.g. gender, education and income) showed varying degrees of association, and government trust was associated with vaccine acceptance in a few countries.

In order to improve the global vaccination rate, some countries may require people to present proof of vaccination to attend work, school, or indoor activities and events. Our results found the strongest support for requirements targeting international travellers and support was weakest for requirements for school children. Importantly, vaccine acceptance improves among those indicating unwillingness to vaccinate if it is recommended by a doctor, and to a lesser extent by an employer.

Misperceptions of vaccines as having high risks and low benefits drive vaccine hesitancy,¹⁴ which may also be influenced by lower trust in the science behind vaccine research and production.^{15–19} In late 2019 and early 2020 the majority of people in most countries perceived the importance of science and trust in scientists positively.²⁰ Our results corroborate these findings where perceptions of trust in science and vaccine safety were most predictive of vaccine acceptance.

Healthcare workers are in a privileged position of trust and are therefore important sources of reliable and accurate vaccine information.^{21–24} Among HCWs, COVID-19 vaccine hesitancy ranged between 4.3% and 72%, with an average of 22.5%.²⁵ Similar to the general population, the main reasons for vaccine hesitancy among HCWs were concerns about efficacy, safety, and potential side-effects. Demographic factors among HCWs such as male gender, older age and holding a doctoral degree were positively associated with acceptance of COVID-19 vaccines.²⁵ Our study aligns with

similarly recorded trends of higher rates of vaccination acceptance among physicians compared to nurses.^{26–29} Among hesitant respondents in this survey, the advice of their physician was the factor most likely to change their minds, followed by the recommendation of their employer. This effect could be amplified if the physician had personally received the vaccine.

In June 2020, trust in government to successfully address unexpected health threats, including the COVID-19 pandemic, was one of the strongest factors associated with acceptance of an (at that time) unavailable vaccine.² A 2020 study in Portugal, where 56% reported they would wait to take the COVID-19 vaccine and 9% would refuse, showed that vaccine hesitancy was related to a poor perception of government and health service response as well as a lack of trust in the information provided,³⁰ which is consistent with previous pandemic research.³¹ Yet, after accounting for socio-demographic, vaccine-specific, and COVID-19 experience variables, our study found trust in central government to be significantly associated with vaccine acceptance only in Russia and Singapore and for local government in only Poland. It is notable also that Nigeria reported low vaccine acceptance and high distrust in governmental ability to respond to COVID-19,³² but the association was not significant. This dissonance between trust in government and vaccine acceptance in our study could be related to the population's general dissatisfaction with government responses to the pandemic and its economic consequences, with vaccine acceptance being independent of such sentiments and more a reflection of personal experiences with COVID-19 illness or loss of life and livelihood. Our results confirm that direct experience for self or family with the illness, and/or loss of a family member to the disease are independently associated with vaccine acceptance.

As health systems in LMICs struggle to address COVID-19,³³ vaccine access has become cause for national frustrations. Most LMICs have been slow to receive and distribute vaccines, which are significantly more available in high-income countries, prompting critiques of global vaccine inequity.³⁴

Most recent studies do not investigate income as a potential influencer on vaccine acceptance. A study conducted in Portugal found people who lost income during the pandemic were more hesitant.³⁰ An Irish study showed that people with lower income were also more vaccine hesitant.³⁵ In China, loss of income was greater among residents of areas with more severe COVID-19 transmission and magnified existing social and economic disparities.³⁶ In the US, having lower income was associated with higher risk of depression during the pandemic.³⁷ Our results show a seemingly paradox where lower household income is associated with a greater level of hesitance, while loss of income due to the pandemic is associated with greater likelihood of vaccine acceptance. We suspect the perceived association between vaccination and return to normalcy is stronger among people who lost socioeconomic status due to pandemic-related job loss, while people whose income was low before the pandemic may not perceive a vaccine as making much of a difference in their lives.

Globally, anxiety and depression increased during the pandemic while positive feelings such as happiness and life satisfaction decreased.³⁸ A global review of COVID-19 related mental health found anxiety levels of 26.5%-44.6%, depression rates of 8.1%-25% and insomnia levels of 38%.³⁹ Stress levels were found to greatly differ (3.8% and 68.3%). In several countries such as Bangladesh, India, and Pakistan cases of suicide as a result of COVID-19 fear have been reported.³⁸ Across a range of timepoints and geographies, people who had COVID-19 report more symptoms of anxiety, depression, and post-traumatic stress disorder than people without a COVID-19 diagnosis.³⁸ Similarly, people with pre-existing psychiatric conditions reported worsening of their psychiatric symptoms during the pandemic.⁴⁰

Mental illness has been associated with a higher risk of COVID-19 related mortality and morbidity,⁴¹ yet studies examining the impact of mental health on vaccine hesitancy are scarce. One German

study did not show a relation between depression or anxiety and vaccine hesitancy.⁴² This is in line with a Danish study showing that, although people previously diagnosed with mental illnesses reported slightly lower vaccine acceptance compared to the general population (84.8% versus 89.5%), vaccine hesitancy among people with mental illnesses does not seem to be a deterrent to reaching herd immunity.⁴³ In Ireland, by contrast, people who had received treatment for a mental health problem were more accepting of a vaccine, unlike UK respondents who showed no association.³⁵ Our study results suggest that the effects of depression and anxiety are far from universal, with divergent associations between anxiety and depression and vaccine acceptance reported across the 23 countries. A deeper examination of cultural influences should be explored in future research.

Increased vaccine scepticism may result from the dissemination of erroneous or inaccurate, and often politicized,^{17,44} information. Misinformation drives vaccine hesitancy, undermining confidence in vaccine safety and efficacy, as well as in equity of availability and access to COVID-19 vaccines.⁴⁵ For example, over two-thirds of vaccine videos on YouTube that were analyzed for content accuracy in May 2019 were found to have presented unreliable safety and efficacy information.⁴⁶ However, in mid-February 2021, despite only 46% of Twitter poll respondents agreeing that all COVID-19 vaccines are safe, 83% indicated they would accept a vaccine, while only 2% would only agree to accept one if it were mandatory to do so.⁴⁷ Our results indicate that respondents are willing to trust their doctors' advice. HCWs should play a more direct role in disseminating clear and credible information whenever possible.

To control the COVID-19 pandemic, requirements for proof of vaccination, or vaccine mandates, are being considered, for example, to travel internationally or to attend work, school, or indoor events. A 2020 study surveying 1,200 Australians found that 73% of the respondents agreed with vaccine mandates for work, travel, and study.⁴⁸ In line with our results, a US September 2020 study found

that approximately half of the general population considered mandatory COVID-19 vaccination for children attending school acceptable, a perspective that remains universally low in our sample.

Mandates for adults by state governments were considered acceptable by 40.9% of the US population, whereas 47.7% accepted mandates by their employer to attend work.⁴⁹ However, our 2020 global study showed that people were potentially more likely to accept voluntary over employer-mandated vaccination.² “Choice architecture” that frames vaccination requirements as effective public health and disease prevention and control tools, which one chooses to accept in order to fully participate in society, as opposed to a violation of the individual’s right to select medical treatment, may promote incremental vaccine uptake.⁵⁰ As vaccines receive full approval from regulatory agencies, this may lead to improved perspectives on safety and efficacy, and vaccination campaigns based on such choice framing could convince more unvaccinated adults and young adults to accept vaccination and increase parental acceptance of vaccination for their children.

One limitation of correlation analyses using actual vaccination rates is that countries with low vaccine access may produce unreliable results given this extrinsic factor. Additionally, our questionnaire asked about a general COVID-19 vaccine, whereas several COVID-19 vaccines, each with different efficacy results and targeted misinformation, are being distributed globally. This study is strengthened by maintaining a sampling methodology that ensures population representativeness between iterations.

As COVID-19 vaccination campaigns continue and coverage improves, further challenges will include increasing vaccination among those reporting lower vaccine confidence in addition to expanding equitable vaccine access to low- and middle-income countries. Validation of COVID-VAC confirms the importance of positive perception of vaccine safety, efficacy and equity for vaccine acceptance. Vaccine uptake may be improved through targeted requirements for vaccination in order to

participate in certain activities. Misinformation may have greater opportunity to spread in settings where access to COVID-19 vaccination is low, so accurate COVID-19 vaccine communication should be delivered by trusted sources, like doctors, to promote vaccination and clearly explain its safety and benefits to individuals, families, and communities.

Methods

Study participants

Participants were recruited by Consensus Strategies using multiple international online panel providers to avoid coverage bias: Dynata provided 22,500 respondents across all 23 countries; and Consensus Strategies provided 500 respondents from Ghana. Respondents' identities were verified using IP addresses and mobile phone numbers. Participants were recruited for the panels via a variety of methods, including online, telephone, and direct mail solicitation and equitably compensated in compliance with ethical standards, varying by country and not exceeding USD 3 per completed survey. No personally identifiable information was collected or stored.

Sampling

Strata included age (18–29, 30–39, 40–49, 50–59 and 60 years and older); gender (male, female, prefer not to say, and “other”); statistical regions (usually province or state, varies by country); and level of education (based on each country's educational system⁵¹), using global data from UNESCO the Organisation for Economic Co-operation and Development, and country data from Sweden, the United Kingdom, and the United States. Educational level was coded into two groups, those who had or had not completed a university degree. The number of participants who could enrol in each of

these strata was calculated to reflect the distribution in the general population based on census/survey estimates provided by the World Bank and CIA World Factbook. Data were weighted by strata with each stratum requiring a minimum of 50 participants. Sampling was random and is described in detail elsewhere.⁵¹

Data collection

Survey data were collected between 25-30 June 2021, from an online panel of 23,000 respondents aged ≥ 18 years from 23 countries (n=1,000 per country), comprised of those countries included in the 2020 study² (n=19) , augmented by four additional countries with high disease incidence⁵² and representing regions not represented in the previous study. The 23 countries are: Brazil, Canada, China, Ecuador, France, Germany, Ghana, India, Italy, Kenya, Mexico, Nigeria, Peru, Poland, Russia, Singapore, South Africa, South Korea, Spain, Sweden, Turkey, the United Kingdom (UK) and the United States (US). This study was approved and the survey administered by Emerson College, Boston, USA (institutional review board protocol no. 20-023-F-E-6/12-[R1] updated April 12, 2021).

Survey Instrument

The instrument was developed by an expert panel following a comprehensive literature review of COVID-19 vaccine acceptance studies and the authors' earlier studies of pandemic control measures^{51,53,54} and vaccination intent.^{14,55-60} The instrument included 1) a 6-item COVID-VAC score representing perceptions of risk, trust, safety, equity, and efficacy, identified via the literature review as important determinants of acceptance of a COVID-19 vaccine and of routine immunization, 2) vaccination acceptance for self (whether respondent received at least one dose of a COVID-19 vaccine and if not, whether he/she will take the COVID-19 vaccine when it is available for them) and vaccination acceptance for their children, 3) vaccination acceptance if recommended by

one's employer or doctor, 4) COVID-19 mandate acceptance (required by: (a) employers and (b) the government and for (c) university students, (d) school children, and (e) indoor activities like auditoriums, concerts, sports events, and (f) international travel), 5) trust in central and local government, 6) experience of anxiety and depression (moderate; 3-4 days per week, or most or all of the time; 5-7 days), 7) COVID-19 experience (self or a family member became ill with COVID-19, lost a family member to COVID-19), and 8) demographic variables (age, gender, education, income, loss of income due to COVID-19 (self-reported as "moderate" or "severe"), and health care worker (HCW) status (**Supplemental Information 1**).

Data analysis

This study documents vaccine acceptance globally and by country at a point in time approximately six months after the first vaccine was authorized and made available for emergency use. First, vaccine acceptance was assessed using descriptive statistics. The association between a country's vaccine acceptance and current COVID-19 cases and mortality (per million population), COVID-SCORE-10 (June 2020),⁵¹ COVID-VAC score (June 2021), and vaccine hesitancy were each assessed using Pearson correlations. We also compared the acceptance of a hypothetical vaccine described in our June 2020 study and current COVID-19 vaccine acceptance now that vaccines are available. Weighted multivariable logistic regressions were used to assess the relationship between vaccine acceptance and socio-demographic variables, COVID-19 illness experience (personally or a family member), COVID-VAC score, trust in central and local government, and mental health. In addition to adult vaccine acceptance, we investigated attitudes regarding vaccination of children and requirements for proof of vaccination to travel internationally or to attend work, school, or indoor events using descriptive statistics. Finally, vaccine acceptance among HCWs was assessed across all countries combined. Statistical significance was set at $\alpha=0.05$. Analyses were conducted in SAS 9.4.

Author Contributions

JVL, SCR and AEM conceived the study. PFF collected the data. KW was responsible for coding and data analyses with input from TMW. JVL, TMW, CAP and AEM wrote the first draft of the paper. JVL, AEM, TMW, CAP, KW, KR, SCR, JPL, and JH edited subsequent revisions of the draft and approved the final manuscript.

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Competing Interests Statement

The authors declare no competing interests.

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Tables and figures

Table 1. Sample characteristics

Country	Brazil	Canada	China	Ecuador	France	Germany	Ghana	India	Italy	Kenya	Mexico	Nigeria	Peru	Poland	Russia	South Africa	South Korea	Singapore	Spain	Sweden	Turkey	United Kingdom	United States	Global average
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
<i>Age Groups</i>																								
18-29	19	16.5	16.5	23.5	16.5	14.1	35.6	24.2	18.5	37.9	23.5	31.9	23.3	16	15.8	25	18.4	20.7	15.5	15.7	22.1	16.6	17.1	21.0
30-39	20.3	17.7	22.4	22.1	15.2	15.3	64.4	21.2	20	20.7	22.1	68.1	21.5	17.3	17.7	23.4	21.3	20.7	17.4	16.3	20.6	17.2	15.8	23.4
40-49	19	16.5	23.5	22.1	16.5	16.5		21.2	20	18.9	20.6		20.6	18.5	19	20.3	19.9	22	18.6	17.6	20.6	17.8	17.1	19.3
50-59	24.1	16.5	16.5	14.7	17.7	17.6		16.7	16.9	13.8	16.2		16.5	17.3	18.7	17.2	18.4	17.1	17.4	15.7	17.6	16.6	18.4	17.2
60+	17.7	32.9	21.2	17.6	34.2	36.5		16.7	24.6	8.8	17.6		18	30.9	28.8	14.1	22	19.5	31.1	34.7	19.1	31.8	31.6	24.3
<i>Sex</i>																								
Male	49.1	49.3	51.5	49.7	49.2	48.9	50.6	50.4	48.7	49.3	49.8	50.5	49.4	48.1	46.2	48.9	49.8	49.3	48.9	49.6	48.7	49.1	48.9	49.3
Female	50.9	50.1	48.5	49.7	50.7	50.5	49.2	48	51	49.9	50.1	49.2	49.9	51.5	53.2	50.6	49.7	50.2	50.7	49.6	49.9	50.4	51	50.2
Prefer not to say/Other		0.6		0.6	0.1	0.6	0.2	1.6	0.3	0.8	0.1	0.3	0.7	0.4	0.6	0.5	0.4	0.5	0.4	0.7	1.4	0.5	0.1	0.54
<i>Education (university degree)</i>																								
No	82.6	73.8	88	88	82	75	85	91	85.6	97	84	91.5	84	75	45	92.5	44.9	67.8	67	75.7	79	65.6	64.3	77.6
Yes	17.4	26.2	12	12	18	25	15	9	14.4	3	16	8.5	16	25	55	7.5	55.1	32.2	33	24.3	21	34.4	35.7	38.7
<i>Income (country median)</i>																								
More than Median	32.1	39.8	65.9	30.3	39.6	30.2	17.7	66.6	29.8	36.1	49.6	17.9	40.7	40.2	24.4	65.6	50.4	35.4	37.6	22.6	32.3	43	42	38.7

Less than Median	58.2	53	29.3	36.7	53.2	61.1	42.8	19.4	57.8	28.2	42.4	48	38.9	53.4	69.3	18.9	37.4	54.1	52.3	68.8	56.9	49	46.1	46.7
No income	9.7	7.2	4.9	33	7.2	8.7	39.5	14	12.4	35.7	8	34.1	20.3	6.4	6.3	15.5	12.2	10.4	10	8.6	10.8	8	11.9	14.6
<i>Have you or anyone else in your household experienced a loss in income due to the COVID-19 pandemic?</i>																								
Severe loss	29.7	16.7	14.4	58.9	14.5	13.7	43.4	57.5	14.9	59.9	33.1	56.2	37.3	10.8	24.9	40.1	19.5	23.2	16.4	13.1	38.4	11.9	17.9	29.0
Moderate loss	42.2	24.8	51.5	36.2	23.1	18	25.9	27.2	41.2	29.3	45.2	20.6	50	16.6	36.2	39.7	40.7	39.2	34.6	23.4	37	24.7	18.2	32.4
No	28.2	58.5	34.1	5	62.5	68.2	30.7	15.2	43.9	10.7	21.7	23.2	12.6	72.5	38.9	20.2	39.9	37.6	49.1	63.5	24.6	63.4	63.8	38.6
<i>COVID-19 experience</i>																								
None	43.3	84.9	96.5	32.4	68.8	85.7	92.7	70.3	73.2	78	50.4	91.7	29.8	52.2	53.1	58.5	94.1	91.4	72.5	67.4	60.1	73.6	71	69.2
Self/family member sick	38.3	11	1.5	48.3	25.4	9.4	5.8	8.7	20.1	15.2	28.2	6	35.5	41.4	42.8	25.1	3.8	3.3	19.6	27.3	31.3	17.8	17.7	21.0
Lost family member	18.3	4.1	2	19.2	5.8	4.9	1.5	20.9	6.7	6.8	21.4	2.3	34.7	6.4	4.1	16.5	2.1	5.3	7.8	5.3	8.6	8.6	11.3	9.8
<i>Health care worker</i>																								
Yes	5.5	9.8	9	7.7	10.8	12	20.6	25.4	5.6	10.9	8.9	19.4	8.2	4.7	2.9	6.7	11.2	7.7	7.8	13.8	9.3	14.8	16.5	10.8
No	94.5	90.2	91	92.3	89.2	88	79.4	74.6	94.4	89.1	91.1	80.6	91.8	95.3	97.1	93.3	88.8	92.3	92.2	86.2	90.7	85.2	83.5	89.2
<i>Mental health</i>																								
Anxiety	25.1	24.9	12.3	21.7	28.7	20.6	9.2	26.7	26.1	24.4	29.4	13.3	39.3	20.6	36.6	37	22.7	20.8	24.4	24.1	44.7	27.6	21.9	25.3
Depression	25.3	23.1	12.6	23.1	23.1	19.2	12.9	15	22.4	32.5	23.8	25.1	28.8	20.3	27.2	30.9	21.1	21.6	22.2	23.8	38.7	25.9	23.2	23.6

Note: Anxiety and depression defined as symptoms moderate amount of time (3-4 days) or most or all of the time (5-7 days).

Figure 1. Vaccine acceptance in June 2020 and June 2021

Panel a. Vaccine acceptance overall

Panel b. Vaccine acceptance if recommended by employer or one's doctor.

Panel c. Vaccine acceptance if recommended by employer or one's doctor among 1) willing to get vaccinated, 2) unsure/unwilling to get vaccinated.

Figure 2. Vaccine acceptance by current cases and mortality

Panel a. Vaccine acceptance and COVID-19 cases

Panel b. Vaccine acceptance and COVID-19 mortality

Panel c. Vaccine acceptance and COVID-SCORE-10 (June 2020)

Panel d. Vaccine acceptance and COVID-VAC

Panel e. Vaccination rates and hesitancy

Figure 3. Vaccine acceptance for children among parents

Panel a. Overall

Panel b. By respondent's willingness to vaccinate self.

Figure 4. Correlates of vaccine acceptance-sociodemographic factors and COVID-19 experience.

Adjusted odds ratios (aOR) and 95%CI (log scale) from weighted multivariable logistic regression; reference categories: Female, No university degree, More than median income, No COVID-19 sickness/death, No loss of income.

Figure 5. Correlates of vaccine acceptance-COVID-VAC score, trust in government, anxiety and depression.

Adjusted odds ratios (aOR) and 95%CI (log scale) from weighted multivariable logistic regression, adjusted for socio-demographic factors and COVID-19 experience.

Table 2. Vaccine acceptance by HCW status.

		At least one dose received	Will take when available	At least one dose received or will receive when available	Unsure or not willing to take		
	n	%	%	%	%	p-value	aOR(95%CI)
Not HCW	19840	52	31	83	17		
All HCW	3295	72.4	19.4	91.8	8.1	<.001	1.72(1.38, 2.13)
Physician	891	85.6 ^a	11.2 ^a	96.9 ^a	3.1 ^a	<.001	
Nurse	619	74.5 ^b	19.1 ^b	93.5 ^b	6.5 ^b		
Community Health Worker	790	69.6 ^b	22.5 ^b	92.2 ^b	7.8 ^b		
Other healthcare worker	995	61.6 ^c	24.5 ^b	86.1 ^c	13.9 ^c		

p-value based on Chi-squared tests. Different subscripts denote statistically significant pairwise differences. aOR from multivariate logistic model after adjusting for demographic variables, COVID-19 experience and clustering of HWC in countries.

Figure 6. Vaccine mandates acceptance.

Supplementary Files

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