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ORIGINAL RESEARCH ARTICLE

Jumping the Queue:Willingness to Pay for Faster Access to COVID-19 Vaccines in Seven European Countries

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Abstract

Introduction Given the initial shortage of vaccines to protect against coronavirus disease 2019 (COVID-19), many countries set up priority lists, implying that large parts of the population had to wait. We therefore elicited the willingness to pay (WTP) for access to two hypothetical COVID-19 vaccines.

Methods Respondents were asked how much they would be willing to pay to get an immediate COVID-19 vaccination rather than waiting for one through the public system. We report data collected in January/February 2021 from the European COVID Survey (ECOS) comprising representative samples of the population in Denmark, France, Germany, Italy, Portugal, the Netherlands, and the UK ($N = 7068$).

Results In total, 73% (68.5%) of respondents were willing to pay for immediate access to a 100% (60%) effective vaccine, ranging from 66.4% (59.4%) in the Netherlands to 83.3% (81.1%) in Portugal. We found a mean WTP of 54.36 euros (median 37 euros) for immediate access to the 100% effective COVID-19 vaccine and 43.83 euros (median 31 euros) for the 60% effective vaccine. The vaccines' effectiveness, respondents' age, country of residence, income, health state and well-being were significant determinants of WTP. Willingness to be vaccinated (WTV) was also strongly associated with WTP, with lower WTV being associated with lower WTP. A higher perceived risk of infection, higher health risk, more trust in the safety of vaccines, and higher expected waiting time for the free vaccination were all associated with a higher WTP.

Conclusion We find that most respondents would have been willing to pay for faster access to COVID vaccines (jumping the queue), suggesting welfare gains from quicker access to these vaccines. This is an important result in light of potential future outbreaks and vaccines.

Abbreviations

EU	European Union
WTP	Willingness to Pay
WTP100	Willingness to Pay for 100% effective vaccine.
WTP60	Willingness to Pay for 60% effective vaccine.
WTV	Willingness to be vaccinated
ECOS	European COVID Survey
5C	Confidence, Complacency, Calculation, Collective Responsibility & Constraints
GBB	British Pound
DKK	Danish Krone
DK	Denmark
IT	Italy
FR	France
DE	Germany
PT	Portugal
NL	The Netherlands
M	Mean
SD	Standard deviation
MED	Median
CI	Confidence interval

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ICECAP-A The ICEpop CAPability measure for adults is a measure of well-being used in economic evaluation.

EQ-5D Standardised measure of 5-dimension health related quality of life, developed by EuroQol group.

Key Points for Decision Makers

We find that 73% of respondents in seven European countries would have been willing to pay out of pocket for faster access to a 100% effective coronavirus disease 2019 (COVID-19) vaccination in January 2021.

The mean willingness to pay for immediate access to a 100% effective COVID-19 vaccine was 54.36 euros (median 37 euros) and 43.83 euros (median 31 euros) for one with an effectiveness of 60%.

Our results highlight the value of providing quick(er) access to vaccines in the context of outbreaks.

1 Introduction

From 2020 onwards, several coronavirus disease 2019 (COVID-19) vaccines were developed, passed clinical trials, and were approved for use. In January 2021, three COVID-19 vaccines were approved for use by the European Medicines Agency. One was a viral vector vaccine, and two were RNA-based vaccines with different efficacies. However, the vaccine demand outweighed the available supply in early 2021 [1]. Due to this scarcity of vaccines and organisational restrictions on upscaling, the vaccination campaigns in the European Union (EU) prioritised vaccinations for those with the highest infection and health risk related to COVID-19, mainly the elderly, residents in long-term care facilities and healthcare workers [2]. These prioritisations also implied that many people willing to be vaccinated had to wait, sometimes for a considerable time. This paper reports a study focussing on the willingness to pay (WTP) for faster access to these vaccines amongst European citizens, observed in representative samples of the general public from seven European countries in January 2021, when COVID-19 vaccines were available but still scarce. Studying the WTP of individuals for quicker access to COVID-19 vaccines, in relation to a broad array of background characteristics, including risk perceptions and general willingness to be vaccinated, provides insight into the (differences in) valuation of quicker access. It furthermore provides evidence for decision makers about the value of quicker access to vaccines. This may be relevant in circumstances where the height of expenditures on vaccines is questioned and criticised, as was the case for COVID-19 [3]. While WTP, due to distributional and equity concerns which are central in societal decisions regarding health and healthcare [4], may not be used to guide decisions regarding individual access, a better understanding of the (average) value of (quicker) access to vaccines may still relevantly inform such debates and general allocation decisions.

WTP is a well-established instrument to estimate valuations of (especially non-marketed) goods and services [5]. It has been used to obtain relative valuations for informal care [6], quality-adjusted life-years (QALYs) [7–9], different treatment options for medical conditions [10], health care priority setting [11] and vaccines [12, 13]. Obtained WTP valuations are typically influenced by the good on offer, respondents' characteristics, and methodological choices. These factors are also relevant in valuing (quicker access to) COVID-19 vaccines. In the context of vaccines, income and education [14], perceived severity of the disease avoided [12], risk perceptions regarding infection either of oneself [15] or family members [14], as well as disease-related knowledge [16, 17], were associated with WTP in previous studies. Regarding gender, the evidence is mixed, with some studies reporting no significant associations with WTP for a hypothetical COVID-19 vaccine [15, 18], but others reporting significant ones, e.g. for hepatitis B vaccinations [19].

A crucial issue in valuing quicker access to COVID-19 vaccines is individuals' general willingness to be vaccinated (WTV). Indeed, it needs to be noted that many European citizens were hesitant or even unwilling to be vaccinated. Results from the European COVID survey (ECOS) in January 2021 show that 68% of respondents were willing to be vaccinated, 17% were unsure, and 15% stated to be unwilling to be vaccinated against COVID-19. Interestingly, these figures on the willingness to be vaccinated were below the levels reported for April 2020, potentially due to debates about the safety and necessity of vaccinations [20]. So-called 'vaccine hesitancy' [21], i.e. refusing or delaying a vaccination despite its availability, has been and remains an important issue, especially in the context of COVID-19. WTV may be strongly related to WTP for (quicker access to) vaccines, but this relation remains understudied. One would, however, expect respondents who indicate being unwilling to be vaccinated also to be unwilling to pay for (quicker) access. Otherwise, this would constitute an 'irrational' preference reversal between WTV and WTP [22].

To investigate these issues further, we use the European COVID Survey (ECOS), a unique, multi-country survey explicitly designed in the context of COVID-19 [20, 23, 24]. ECOS elicited the WTV against COVID-19, risk

perceptions, and the WTP for quicker access to such vaccines with two levels of effectiveness, i.e. 100% and 60%, and various relevant background characteristics of respondents. This allowed us to investigate how WTP for quicker access to COVID-19 vaccines is associated with these variables. The insights presented in this analysis are important from a scientific viewpoint and for decision-makers who have to decide on priorities and investments in production and distribution capacities (in future waves or outbreaks).

2 Methods

ECOS collected data from representative adult population samples in seven European countries: Denmark, France, Germany, Italy, Portugal, the Netherlands, and the UK. The data presented here were obtained in the fifth data collection, conducted from 19 January until 1 February 2021, using the market research company Dynata [25]. The total sample consisted of 7068 responses representative of each country's population regarding age, gender, region and education.

Respondents were asked to state their WTP for access to a hypothetical COVID-19 vaccine using the following question:

'*Suppose a highly effective vaccine for COVID-19 becomes available, meaning that 100 persons out of every 100 cases become immune (are able to resist COVID-19).*

The Ministry of Health has decided to vaccinate high-risk groups first, and you have been informed that you will not be vaccinated through the public health care system yet. Some private clinics are offering the vaccination, and you could get it immediately, but you would have to pay for it out of your pocket, and it would not be reimbursed later.

What is the maximum amount you would be willing to pay out of your pocket for a highly effective COVID-19 vaccine?'

We, therefore, constructed a scenario in which respondents would not yet be vaccinated through the public health care system, resembling the actual circumstances. Subsequently, respondents were asked what they would be willing to pay for immediate access to a 100% effective vaccine (WTP 100) or a 60% effective vaccine (WTP 60), the latter based on the average effectiveness of the influenza vaccine in adults aged 18–65 years [26]. We described the efficacy using natural frequencies to avoid presenting probabilities [27]. The implied trade-off in our scenario between waiting in the public system or paying for quicker access was partly chosen to avoid a more extreme (and unrealistic) 'no treatment' scenario [28]. We also asked respondents in how many months they expected to be vaccinated through the public vaccination programs, as a shorter expected waiting time implies a lower benefit from quicker access, ceteris paribus.

WTP was elicited with a modified version of the payment scale [29] using a slider ranging from 0 to 150 euros (or the equivalent in GBP/DKK), with increases in increments of 1€. Respondents could also select the option 'more than 150 Euros' to provide their WTP in an open text field, which less than 4% of respondents did. This approach combined the advantages of a payment scale without restricting expressed WTP figures. A detailed discussion of the relative strengths and weaknesses of response formats in WTP can be found elsewhere [30, 31].

We converted all responses to euros and adjusted them with the country-specific purchasing powers using the Harmonised Indices of Consumer Prices [32]. We applied common numeracy and understanding exclusion criteria [33]. First, as a quality control [34], respondents who completed the questionnaire in less than a third of the median survey duration per country, so-called 'speeders' and multiple responses by the same individual, were excluded. After excluding them, using the same quality checks, the sample was increased again to meet the criteria for representativeness. Second, to reduce the influence of outliers, we trimmed the tail of the distribution [30] based on a cut-off point of all values above the 99th percentile for each subsample (WTP100 and WTP60) by recoding these outliers as missing.

Protest responses are common in WTP studies [35–37]. For different reasons, respondents may indicate a WTP of zero but still have a positive valuation of the good on offer [38]. To identify protest answers, we asked each respondent who provided zero valuation why they did so, basing answering categories on previous studies [35–37]. Responses such as 'To me, a vaccination is worth nothing' and 'It's worth nothing to me because of the potential side effects' were categorised as 'true' zeros. In contrast, motivations such as 'Vaccinations should be paid by the government' were treated as a protest response.

We used two measures to investigate the relationship between WTP and vaccination hesitancy. The first was WTV, where respondents could answer on a three-point scale if they would be willing to get vaccinated against COVID-19 (yes/unsure/no). To decompose which aspects of vaccine hesitancy are most relevant for WTP, we used the COVID-19-specific version of the 5C [39], a validated measure to explain causes for vaccination hesitancy [40]. The 5C is composed of questions relating to Confidence, Complacency, Calculation, Collective Responsibility and Constraints; the complete 5C questions can be found in the electronic supplementary material.

We used the ICECAP-A and EQ-5D-5L [36, 37] to measure well-being and health. Given the lack of country-specific tariffs for the EQ-5D-5L and ICECAP-A for some countries in our sample, we used summary scores ('misery indices') of the respective indices to indicate well-being (ICECAP-A) and health (EQ-5D-5L) problems. We expected a positive association between well-being and the WTP, since

respondents with a higher well-being stand to lose more utility in case of an infection, severe illness, or premature death than those with lower well-being.

2.1 Regression Models

We developed three regression models based on previous literature on the WTP for vaccines [18, 41, 42] and used dominance analysis [33] to determine the importance of independent variables. The base model included sociodemographic aspects, well-being, the expected waiting time for a vaccine through the public system, the health problem index, the perceived severity of COVID-19 and a dummy variable indicating whether a respondent had ever been diagnosed with COVID-19. We tested both measures of vaccination hesitancy separately, first WTV in model 2 and then the 5C psychological antecedents of vaccination [39, 40] as an alternative in model 3.

We expected a higher WTP among people who expect to wait longer for the vaccine (ceteris paribus) as the protective benefit from immediate access to a vaccine increases with the waiting time the respondent expects. Most European countries used a prioritisation mechanism based on age and, in some cases, occupation or health condition [2], so we expected most respondents would have knowledge about the waiting time that applied to them.

Evidence from Australia [43], Kenya [44] and the United States of America [45, 46] suggests that, unsurprisingly, the efficacy of a vaccine is a relevant property for WTP. Discrete choice experiments in Canada [47] and China [48] listed effectiveness as one of the main properties respondents considered desirable in a vaccine against COVID-19. Currently, no evidence from Europe exists, but we expected respondents to show a higher WTP for a more effective vaccine, as this again increases the expected health benefits from vaccination.

Based on WTP response formats, different techniques for statistical analysis are suggested in the literature [49]. We ran two robustness checks to address concerns related to the continuous, non-negative nature of the dependent variable and a potentially larger than usual number of zeros. First, we used log-transformed WTP values so that the dependent variable followed a normal distribution. Second, we used a two-part model, using logistic regression to model the probability of WTP being positive (WTP > 0) in the first part and estimating the WTP conditional on being positive using a gamma distribution and a log-link function in the second part [50]. For a better interpretation and comparison, we calculated the average marginal effects (AME) of the two-part model results in one estimate and contrasted them with the log-transformed and OLS results in the electronic supplementary material. The analysis was conducted using the "twopm" command [51] in STATA 17.

3 Results

3.1 Descriptive Results

The sample comprises 7067 respondents, about 1000 from each of the seven ECOS countries. While the dataset largely represents the population, older age groups are underrepresented in some countries (especially in Portugal), which is a known limitation of online panels. We show the sample characteristics and the differences in WTP and WTV by country in Table 1. Overall, 73% of respondents were willing to pay for faster access to a 100% effective vaccine and 68.5% for a 60% effective vaccine. Regarding vaccine hesitancy, we find that 68.2% of respondents were willing to be vaccinated (WTV) in January 2021 as opposed to those who were unwilling (14.5%) or unsure (17.3%), which differed between countries with the lowest willingness to be vaccinated in France (47.6%) and the highest in the UK (80.2%).

Similarly, the levels of agreement with the 5C statements differed between countries; the overall 5C results can be found in Fig. 3 in the electronic supplementary material. In some countries, like France, the share of respondents who were willing to pay for faster access exceeded the share of those who indicated being willing to be vaccinated. This could be due to a preference reversal between WTV and WTP but could also signal that respondents who were still unsure about whether they wanted to be vaccinated were willing to pay for quicker access when asked this question. However, interestingly, 6% of respondents were unwilling to be vaccinated (answering 'no' to the WTV question) but indicated to be willing to pay a positive amount for immediate access to a vaccine. This constitutes a preference reversal, a common phenomenon in health state elicitation [22].

On average, respondents expected to wait 6 months for vaccination against COVID-19 through the public system, with the shortest expected waiting time in the UK (5.3 months) and the longest in Portugal (7.9 months).

Including protest zeros, mean (*M*) WTP100 was 42.83 euros [standard deviation (SD) 49.26, median (MED) 27.00] and WTP60 32.95 euros (SD 40.15, MED 18.9). Excluding protest zeros, WTP100 was 54.36 euros (SD 49.53, MED 37.00), and WTP60 was 43.83 euros (SD 40.83, MED 31.00).[1] WTP values differ between countries for

[1] The mean WTP100 including outliers ($N = 78$) would be 69.25 euros with the average WTP amount of the outliers being 1119.66 euros. For WTP60 the mean including outliers would be 53.82 euros with the average amount of the outliers being 664.33 euros. Seven respondents who stated a very high amount for WTP100 gave a protest zero for WTP60. Due to the impact of this small group of respondents on the results, and the sometimes implausibly high estimates, we decided to remain with our ex-ante decision to remove the extreme values.

Table 1 Sample characteristics

Country	DE	UK	DK	NL	FR	PT	IT
N	1007	1016	1012	1006	1012	1005	1009
Gender (%)							
Male	48.8	49.1	47.7	48	47	49.9	47.8
Female	51.2	50.9	52.3	52	53	50.2	52.2
Age cat. (%)							
18–24	8.0	10.93	8.8	10.14	9.49	10.65	7.93
25–34	13.7	16.34	14	13.62	15.42	19.9	14.37
35–44	17.1	18.21	18	19.18	18.68	24.28	19.52
45–54	18.5	18.11	19.1	19.28	18.28	19.5	18.33
55–64	16.9	15.55	17.3	16.9	15.91	16.62	15.36
65+	25.8	20.87	22.8	20.87	22.23	9.05	24.48
Income (%) (make ends meet)							
With great difficulty	4.97	6.79	6.13	8.25	11.07	8.06	10.21
With some difficulty	37.74	28.64	31.03	33.7	44.07	28.96	48.66
Fairly easily	42.70	40.75	42.98	38.27	36.46	53.93	33.20
Easily	14.60	23.82	19.86	19.78	8.40	9.05	7.93
WTV (%)	61.97	80.22	79.45	68.79	47.63	69.35	69.87
Unsure (%)	20.75	11.52	11.96	16.70	21.44	21.00	17.84
Unwilling (%)	17.28	8.27	8.60	14.51	30.93	9.65	12.29
WTP (100) (%)	69.81	73.13	72.23	66.4	70.36	83.28	76.71
WTP (60) (%)	63.4	70.2	67.7	59.4	65.7	81.1	71.9

N number of observations, *age cat.* age category, *WTV* willingness to be vaccinated, *WTP (100)* willingness to pay for 100% effective vaccine, *WTP (60)* willingness to pay for 60% effective vaccine, *DE* Germany, *UK* United Kingdom, *DK* Denmark, *NL* The Netherlands, *FR* France, *PT* Portugal, *IT* Italy

Table 2 Further summary statistics

Country	DE		UK		DK		NL		FR		PT		IT	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Well-being (5–20)	14.55	3.04	14.93	3.36	15.59	3.00	15.41	2.91	15.13	3.09	14.47	3.15	14.43	3.18
Health problem index (5–25)	8.01	3.45	7.91	3.44	8.11	3.41	7.69	3.27	7.61	3.12	6.96	2.29	7.32	2.85
WTP100	46.98	54.89	53.96	56.09	47.89	51.67	46.12	57.63	32.63	39.96	33.28	35.81	39.08	39.97
WTP100—no protest	62.89	55.07	68.54	54.74	58.86	51.34	64.55	58.81	41.90	40.76	38.37	35.82	48.44	39.07
WTP60	35.90	44.26	42.48	46.79	38.26	45.21	31.39	42.81	26.07	33.04	25.42	26.70	31.22	35.16
WTP60—no protest	51.26	44.83	55.08	46.31	49.51	45.69	47.32	44.82	34.95	33.96	29.92	26.53	41.11	34.94
Waiting time (months)	6.2	3.6	5.3	3.6	6.1	3.7	5.3	3.5	6.9	4.3	7.9	4.1	6.5	3.7
Level of agreement with 5C statements														
Confidence	0.57	0.49	0.69	0.46	0.68	0.47	0.64	0.48	0.43	0.50	0.64	0.48	0.62	0.48
Complacency	0.14	0.35	0.18	0.39	0.15	0.35	0.15	0.36	0.18	0.38	0.12	0.33	0.19	0.39
Calculation	0.55	0.50	0.57	0.50	0.51	0.50	0.59	0.49	0.53	0.50	0.71	0.45	0.58	0.49
Collective resp.	0.14	0.35	0.17	0.38	0.12	0.33	0.16	0.37	0.23	0.42	0.15	0.36	0.21	0.41
Constraints	0.12	0.32	0.19	0.39	0.09	0.29	0.11	0.31	0.17	0.38	0.09	0.29	0.14	0.35

both vaccines (Table 2). Furthermore, we find a significant difference between WTP100 and WTP60 [$t(10561) = 9.95$, $p < 0.001$]. This suggests that respondents took the effectiveness of the vaccines in the two proposed scenarios into account, valuing the more effective vaccine higher. The relationship between WTP and the vaccine's effectiveness was not proportional, however, as the WTP for the 60% effective vaccine was 'only' 19% lower than that of a 100% effective one. We furthermore investigated the relationship between WTP and both measures of vaccination hesitancy. Respondents willing to be vaccinated (measured using the WTV question) (*M* 61.33, SD 50.61) were also

Table 3 Share of zero WTP responses in % and decomposition into protest and true zeros

	WTP for a 100% effective vaccine			WTP for a 60% effective vaccine		
	Total share of zeros	True zeros	Protest zeros	Total share of zeros	True zeros	Protest zeros
Netherlands	33.60%	5.27%	28.33%	40.6%	7.3%	33.3%
Germany	30.19%	5.16%	25.02%	36.6%	7.0%	29.7%
France	29.64%	7.61%	22.04%	34.3%	9.0%	25.3%
UK	26.87%	5.81%	21.06%	29.8%	7.3%	22.5%
Italy	23.29%	4.06%	19.23%	28.1%	4.2%	24.0%
Denmark	27.77%	9.78%	17.98%	32.3%	10.1%	22.2%
Portugal	16.72%	3.48%	13.23%	18.9%	4.0%	14.9%
Total	26.87%	5.89%	20.98%	31.5%	7.0%	24.6%

UK United Kingdom, *WTP* willingness to pay

willing to pay significantly ($p < 0.001$) more for early access (WTP100) than those who were unsure (*M* 38.40, SD 37.79) or unwilling (*M* 34.68, SD 46.37). For WTP60, we find similar results, those willing to be vaccinated (*M* 48.70, SD 41.46) were also willing to pay more than those who were unsure (*M* 32.10, SD 32.47) and unwilling (*M* 30.62, SD 32.46), both with $p < 0.001$). We also investigated whether agreeing or disagreeing with the 5C statements (Table 5 in the electronic supplementary material) was associated with observed WTP. Except for the domain calculation, we find significant differences in WTP100 values in all 5C domains.

In our scenario, we asked for the WTP for a swifter vaccination. The obtained WTP values were quite comparable to an approximation of the actual immunisation costs, consisting of payments to the physician [52] and the costs for the vaccine [53, 54], faced by the respective governments (see the electronic supplementary material). For example, costs to the UK Government per vaccination were estimated to be about 72 euros, which is comparable to the WTP100 in the UK of 68.54 euros. The costs to the Italian government were 47 euros, while WTP100 in Italy was 48.44 euros.

When analysing the number of zero responses (Table 3), we observed that for WTP100, 26.9% of responses were zeros, the majority being protest zeros (i.e. 21.0%). We observed a larger share of zeros (31.5%) for WTP60, with a slightly larger share of protest zeros (24.6%) than for WTP100; this difference was mainly driven by more respondents stating they are unable to pay more than 0 euros for WTP60 and more respondents stating 'other reason'. The share of protest zeros between countries differed. This may reflect differences in the use and acceptance of private payments in the different healthcare systems to gain quicker access to care.

When analysing the characteristics of the respondents who gave protest answers in Table 4, we observed that these respondents had similar health levels as other respondents, while well-being levels did not differ significantly either, although they were slightly older and more often male. These respondents may have viewed the risk that COVID-19 posed to themselves, their family, and their community as lower than the rest of the sample. Respondents giving protest answers moreover showed lower levels of trust regarding COVID-related information from different sources. Finally, fewer protest responders were willing to be vaccinated and fewer stated to have been previously infected with COVID-19.

Younger age groups appeared to have a higher WTP than older groups, except in the UK (Fig. 8 in the electronic supplementary material), which may also be related to expected waiting time. Indeed, as shown in Fig. 1, younger respondents expected to wait longer for the vaccination through the public system. Figure 2 highlights the relationship between waiting time and WTP (WTP100), as observed in our sample. WTP60 showed a similar pattern (not shown here).

3.2 Regression analysis

Table 5 shows the results of the stepwise OLS regression analyses with robust standard errors to adjust for heteroscedasticity for WTP100 and WTP60. Note that WTP values were skewed and did not follow a normal distribution (Fig. 4 in the electronic supplementary material), although the amount of (true) zeros does not seem excessive (5.9%/4.2%). Log-transformed WTP and the AME calculated from a two-part model were used as a robustness check. Since the results of the robustness checks (see the electronic supplementary material) were similar to the OLS results, we report the latter here, also for ease of interpretation.

Our results suggest that being in age groups above 44 years is associated with a lower WTP; sex has no significant impact, while living with a partner is associated with a higher WTP. Similarly, having a middle or high income and a high formal education was associated with a higher WTP. Respondents with worse health states had a higher WTP for access to vaccination, as well as those who experienced higher well-being. Compared with Germany (base), on

Table 4 Comparison of protest responses and the main sample

WTP100	Overall sample	Non-protest	Protest	*t*-Test *p* value
Observations	7067	5584	1483	
in %	100%	79.0%	21.0%	
Female (%)	51.7%	52.4%	49.0%	0.0214
Age (years)	47.8	47.2	50.3	< 0.0001
Average health problem index score	7.6	7.7	7.6	0.3981
Average wellbeing score	14.9	15.0	14.8	0.0834
Severity assessments, share that stated (very) high risk				
Risk of getting infected themselves	26.2%	27.5%	21.3%	< 0.0001
Risk of COVID-19 for own health	34.7%	35.4%	31.8%	0.0094
Risk of COVID-19 for health of family	44.9%	46.3%	39.6%	< 0.0001
Risk of COVID-19 for health of community	38.1%	40.6%	32.1%	< 0.0001
Trust in COVID-related information from				
National government (1–5)	3.2	3.3	2.8	< 0.0001
Major national media outlets (1–5)	3.1	3.2	2.8	< 0.0001
General practitioner (1–5)	3.8	3.8	3.6	< 0.0001
Share already infected with COVID-19	7.9%	8.8%	4.6%	< 0.0001
Share willing to be vaccinated	68.2%	71.9%	54.2%	< 0.0001

WTP100 willingness to pay for 100% effective vaccine

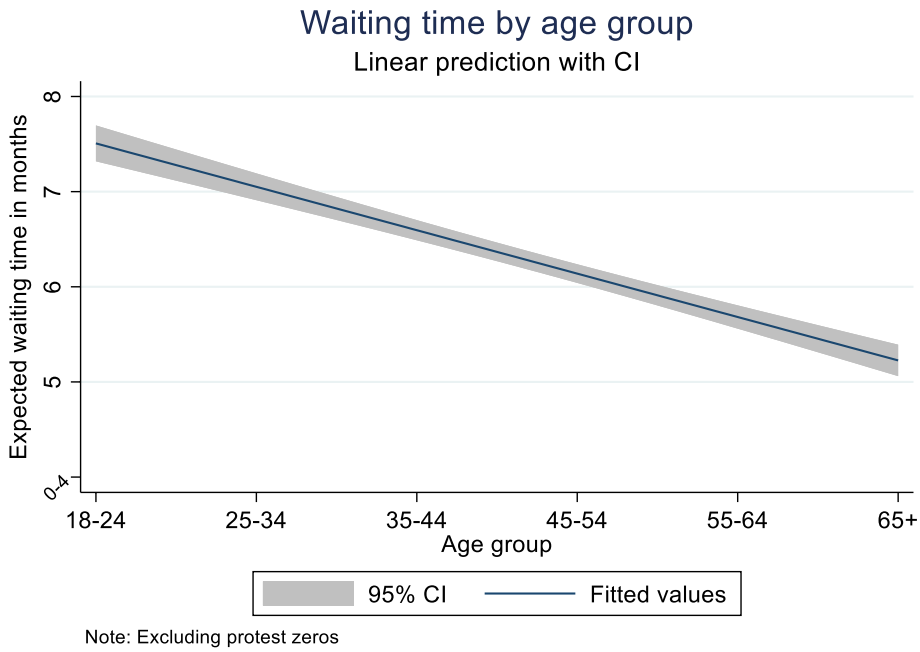

Fig. 1 Relationship between waiting time and age category

average, respondents from Denmark, Italy, France, and Portugal reported a significantly lower WTP for quicker access to the vaccines. Having had a prior infection with COVID-19 was associated with a higher WTP. This may suggest that respondents who had already experienced a confirmed or suspected infection wanted to mitigate the consequences of a new infection. Perceived increases in the risk of infection and a higher health risk due to COVID-19 were also associated with an increased WTP. Furthermore, a higher perceived risk of COVID-19 for the community was also associated with a higher WTP, while the risk for the family was only significantly associated with WTP100 at lower levels of significance. An increase in the subjective stringency of measures was positively associated with the willingness to pay in model III and only for WTP60 in model II.

In line with expectations, the expected waiting time was significantly associated with WTP100 throughout the models. Model II shows that WTV was significantly associated

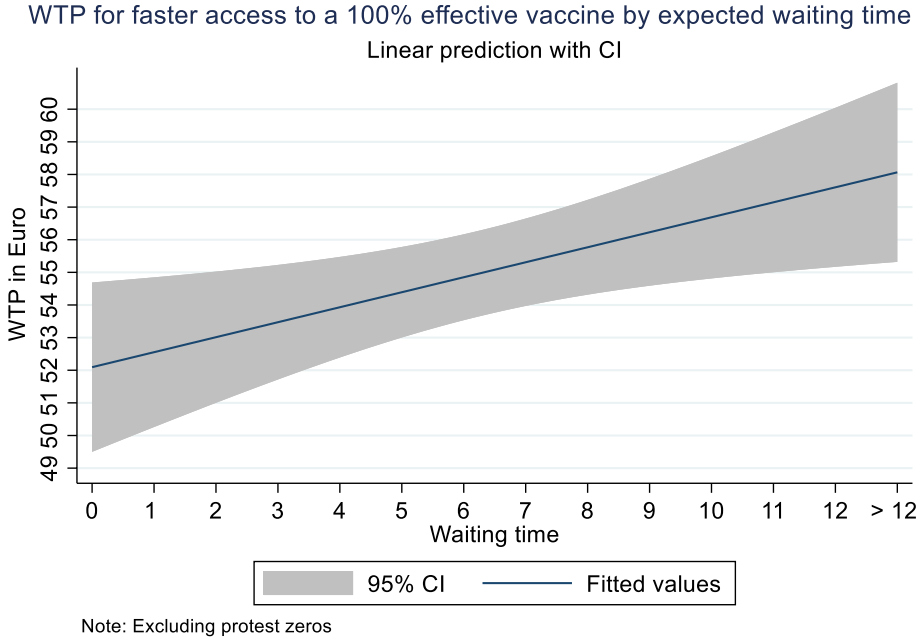

Fig. 2 Relationship between WTP and expected waiting time

Note: Excluding protest zeros

with WTP. Respondents who were unwilling to be vaccinated had a lower WTP than those who were unsure about this, which is intuitive. Using model III, we found that three elements of the 5C were significantly associated with WTP. Confidence in vaccine safety was associated with a higher WTP100, while calculation (carefully weighting the risks and benefits of the vaccination) was associated with a lower WTP100. Agreeing that everyday stress prevents the respondent from vaccinating against COVID-19 (constraints) was positively associated with WTP100. This may signal that respondents who believe everyday stress would prevent them from getting vaccinated at some point could be enticed to pay out of pocket to 'jump the queue' and get an appointment immediately.

Similar effects for waiting time and both measures of vaccination hesitancy were observed between WTP60 and WTP100. For WTP60, respondents above the age of 34 and those from The Netherlands showed a significantly lower WTP. Furthermore, the risk of COVID-19 to the family's health was significantly associated with WTP100, but not with WTP60. We tested all models in terms of sensitivity to outliers. While our main results remained similar, the results did appear to be affected by outliers.

When looking at the country-specific results for model II/III (electronic supplementary material), we observed that waiting time was significantly positively associated with WTP100 in all countries except Denmark. We find a similar effect for waiting time for WTP60 in most countries. Furthermore, both measures of vaccination hesitancy were significantly associated with WTP in the country-specific results. WTV was significantly associated with WTP100 and WTP60 in all countries. Similar to the results in our primary analysis, elements of the 5C were significantly associated with WTP100 and WTP60 in most countries, e.g. confidence in all countries and constraints in most countries. We conclude that despite a more limited sample size per country, respondents' expected waiting time, as well as WTV and elements of the 5C, were significantly associated with the willingness to pay for earlier access to both vaccinations in the included countries.

4 Discussion

We reported on a study into WTP for faster access to vaccination against COVID-19 in seven European countries, as observed in January 2021 when vaccines against COVID-19 were still scarce. Our findings suggest that 73% of respondents were willing to pay for immediate access to a 100% effective vaccine and 68.5% for one with an effectiveness of 60%. This is comparable to previously reported percentages, i.e. 73% in Bangladesh [55] and 85% in India [56], observed in the same period. A study from the USA found that 60% of respondents were willing to pay for the vaccine, while 14% would only accept the vaccine if they were paid for it [45].

On average, respondents would have been willing to pay 54.36 euros for immediate access to a 100% effective vaccine and 43.83 euros for a 60% effective vaccine. In line with expectations, we observed that respondents were willing to pay more when they anticipated waiting longer for vaccination through the public system (e.g., because of their age). Waiting time may have served as a reference point [57, 58] against which respondents evaluated the faster access, since

Table 5 Comparison of Regression results, WTP for access to a 100% and 60% effective COVID-19 vaccine

Model	I	I	II	II	III	III
Effectiveness	100 %	60 %	100 %	60 %	100 %	60 %
Age category						
18–24	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)
25–34	−1.97	−2.44	−2.12	−2.88	−1.56	−2.21
35–44	−2.69	−5.16*	−2.79	−5.12*	−2.03	−4.86*
45–54	−7.43**	−11.18***	−8.18***	−10.54***	−8.27***	−11.97***
55–64	−7.01**	−8.94***	−8.71***	−8.78***	−9.26***	−10.59***
65+	−9.48**	−10.85***	−11.50***	−10.84***	−11.74***	−12.67***
Characteristic						
Female	−1.29	−1.18	−0.15	0.34	0.27	−0.01
Married or living together	5.92***	4.97***	5.65***	4.57***	5.52***	4.63***
Pensioner	1.19	−0.87	0.79	−0.63	0.63	−1.39
Education level						
Low	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)
Middle	3.51	1.11	3.55	1.51	2.79	0.65
High	9.28***	5.44**	8.03***	4.69**	7.33***	4.08*
Health and well-being						
Health problem index—sum of EQ-5D	1.27***	1.43***	1.24***	1.25***	1.23***	1.42***
Well-being index based on ICECAP-A	1.39***	1.49***	1.19***	1.21***	1.28***	1.43***
HH income						
Very low	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)
Low	0.38	0.43	0.40	0.59	−0.15	−0.23
Middle	11.76***	7.42***	11.26***	7.73***	9.61***	5.62**
High	23.49***	14.78***	21.70***	14.27***	20.27***	12.28***
Country of residence						
Germany	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)
United Kingdom	1.23	−0.26	−0.23	−1.54	−1.06	−1.81
Denmark	−6.77*	−3.78	−7.02**	−3.61	−8.98***	−5.32*
Netherlands	0.64	−5.39*	0.17	−5.24*	−0.69	−6.14**
France	−21.81***	−17.02***	−19.94***	−16.51***	−18.40***	−14.41***
Portugal	−27.37***	−23.06***	−27.37***	−21.87***	−29.11***	−24.28***
Italy	−12.19***	−8.95***	−13.25***	−10.01***	−14.40***	−10.55***
Diagnosed COVID-19 infection						
No	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)
Yes, confirmed	9.89***	14.04***	9.61***	11.97***	8.80***	13.13***
Yes, but not yet confirmed	20.18***	18.18***	21.80***	17.49***	22.50***	19.71***
Don't know	−4.17	−4.42*	−3.74	−3.88*	−3.34	−3.92*
Risk						
Risk infection	6.09***	6.39***	5.48**	5.53***	5.21**	5.67***
Risk own health	7.63***	6.19***	7.07***	5.68***	7.01***	5.73***
Risk family health	4.99**	0.98	3.69*	0.59	3.63*	0.10
Risk community health	4.22**	5.56***	3.77*	5.29***	3.09*	4.71***
Stringency, COVID-19 regulations	0.03	0.07**	0.03	0.05*	0.06*	0.09***
Waiting time	0.86***	0.66***	1.05***	0.80***	1.17***	0.87***
5C						
Confidence			15.12***	9.98***		
Complacency			−2.83	1.84		
Calculation			−4.93***	−7.60***		
Collective responsibility			−1.83	1.76		
Constraints			10.90***	13.77***		

Table 5 (continued)

Model	I	I	II	II	III	III
Willingness to vaccinate						
Yes					(Base)	(Base)
No					− 24.44***	−18.17***
Not sure					−18.37***	−12.85***
Constant	5.23	−0.03	2.42	1.41	15.04*	6.92
N	5502	5259	5502	5259	5502	5259
r2_a	0.14	0.15	0.16	0.18	0.17	0.17

WTP = Willingness to Pay; EQ-5D = standardized measure of 5-dimension health related quality of life, developed by EuroQol group; ICECAP-A = the ICEpop CAPability measure for Adults is a measure of well-being used in economic evaluations; HH = Household; N = number of observations; r2_a = adjusted R2

* p<0.05; ** p<0.01; *** p<0.001

they have been shown to influence evaluations of health and wealth [59] but also purchasing decisions [60].

Respondents, on average, were prepared to pay more for a vaccine when its effectiveness was higher, similar to findings from other regions [43–47]. The relationship between effectiveness and WTP was not proportional, however. In line with previous findings, we found a positive relationship between income, education [18, 44, 45, 55, 56, 61, 62] and a prior infection of oneself or family members with COVID-19 [18], and the WTP for (earlier access to) a COVID vaccine. The perceived risk of COVID-19 (infection, own health and family health) had a significant positive association with the WTP for faster access to a vaccine in our study. This relates to a finding from an Indonesian study [15] identifying the perceived risk of contracting COVID-19 as one of the important determinants associated with the WTP for a COVID vaccine. Furthermore, in accordance with recent findings [62, 63], we found that some behavioural aspects of vaccination hesitancy, captured by the 5C [40], also play a role in the WTP for access to vaccines.

Some limitations of this study need to be emphasised. First, strictly speaking, we did not elicit the WTP for COVID vaccines, but for immediate and hence quicker access to vaccination. In contrast to previous studies in countries such as Chile [18], Ecuador [42], or Indonesia [15], we considered it to be less realistic to investigate the general WTP for a COVID-19 vaccination, given that in the European context general public provision of vaccinations was commonly expected at the time of the study. Indeed, in the included countries, vaccinations were later covered by governments or health systems. We therefore constructed a scenario with regulated access to vaccinations and a prioritisation mechanism like those used throughout Europe. We elicited the value of immediate access to a vaccine or, colloquially, of jumping the queue. Therefore, the WTP values in this study reflect how much value people attach to immediate, and hence quicker, access to a COVID-19 vaccine with different levels of efficacy. This provides interesting and policy-relevant insights but the specific setup needs to be taken into consideration when comparing our estimates to those of other studies.

Second, related to the hypothetical scenario, we observed stated rather than revealed preferences. In our dataset there was no way of confirming whether respondents, in real life, would actually pay the amounts they indicated to be willing to pay. Hausman, for example, argues that this hypothetical response bias leads to overstatements of the value [64] and argues against the use of contingent valuation to inform policy decisions. While it is clear that caution is required, because of this hypothetical nature of the questions, as well as the general setup of the study, especially in the health domain in which some non-marketed goods exist, hypothetical valuations are sometimes difficult to avoid. Previous studies have used such an approach to, for instance, value early warning systems for infectious diseases [36], estimate the willingness to pay for reductions in risk from heart attacks using mobile coronary care units [65] or estimate the value of a quality adjusted life year [66]. While firmly acknowledging the limitations and potential biases, we would agree with Kling et al. [67], that results based on stated preferences are more useful than having no numbers to inform policy makers. Still, more research is needed to improve elicitation procedures in contingent valuation studies and to validate stated preferences in this context remains warranted.

Third, some respondents were unwilling to pay for immediate access, which could be seen as protest zeros. While protest responses are common in WTP studies in healthcare, there is no consensus about how to deal with them. Depending on how WTP was elicited, different methods were used to handle protest responses [49, 68, 69]. We would be hesitant to use imputation for protest answers [69] because of the context of this study. Protest zeros, in some ways, provide valuable insight into a general attitude/preference regarding

privately paying for healthcare. Here, we opted for the consensus view [37] to exclude protest responses from the regression analysis, while reporting WTP estimates with and without protest responses. The share of protest zeros (which were mostly related to the idea that the government should pay for vaccinations) indicates that some respondents were not willing to pay for (quicker access to) COVID vaccinations, or not used to the idea of paying themselves. Furthermore, the category 'other reason' may have captured reservations concerning the vaccinations we did not elicit, leading to a zero valuation. In this context, it would also have been helpful to elicit the expected severity of side effects to control for this, similar to the expected waiting time.

Another attention point are outliers. Our WTP estimates were influenced by the trimming procedure applied. While we applied a common procedure in contingent valuation [30], and some very high numbers might be simply errors or noise, one could also see them as another type of strategic or protest response, or simply a sign that respondents need more assistance in valuation tasks [22].

Fourth, the data presented in this paper is cross-sectional and collected in January 2021; it can provide important insights into the determinants of the WTP for faster access but only captures one point in time. In all three regression models we observe significant associations, but a relatively low (adjusted) R^2, indicating that we are only able to explain part of the variation. While we included common explanatory variables in WTP for vaccine studies, the decision appears to be complex and includes factors we were unable to observe. Future studies may use longitudinal analysis of data.

Finally, obtaining valuations from individuals about a good, such as a vaccine, requires the assumption that these individuals are capable of correctly estimating the (costs and) benefits of (quicker access to) a vaccine. In a recent US study it was suggested that respondents may undervalue the worth of the COVID vaccines [70]. In any case, meaningful WTP estimates require sufficient knowledge about the risk and consequences of infection.

Our findings are also relevant in the context of health policy, but do deserve careful consideration, because of the limitations highlighted above, as well as other issues. First, while jumping the queue using private facilities offering vaccination may free public capacity [71], which therefore may also benefit people depending on public provision, important equity questions are associated with such a scenario. It is likely to be perceived as unjust, although paying for faster access is not uncommon in health care, e.g. voluntary health insurance may allow patients faster access to health care [72]. Rejecting our scenario of paying for faster access was more common in the health insurance countries (NL, GE, FR) than in the NHS countries (DK, IT, PT, UK). Such differences may partly relate to differences between countries in how common or acceptable private payments are considered to be, which are also used to bypass the waiting line in the public system. This also highlights that the estimated value of quicker access to healthcare may depend on context as well as study design (including payment vehicle).

Paying for access to the COVID-19 vaccine was also suggested as a strategy in lower-income countries that cannot finance vaccinations for the whole population [61]. In this context, governments could fund the vaccine only for people with a lower income. In contrast, others would have to pay for the vaccine themselves, lowering the collective financial costs while aiming to improve the equity of the vaccination campaign. The (short- and long-term) costs, benefits and equity implications of such strategies need to be carefully considered.

In particular, and in general, prioritisation based on the ability to pay needs to be avoided, as this goes against common ethical principles for distributing health(care). Here, we therefore do not suggest that vaccines should be distributed within the population based on WTP estimates. Our results do suggest that large parts of the European population appear to place a high value on faster access to the COVID-19 vaccines. This could inform general investments in vaccine availability, benefitting all in society. It needs to be noted that distributional concerns do not only exist within countries but also between them; country and regional differences in the ability to pay have indeed impacted the (speed of) availability of vaccines [73].

Another observation is that while the amounts spent on COVID-19 vaccines in Europe have been criticized [3], our results suggest that, notwithstanding high costs, many European citizens seemingly also highly valued the protection offered by them. The WTP of 54.36 euros estimated in this study (which was 'only' for quicker access) was higher than the 15.50 euros per dose (or 31 euros for a full course) of BioNTech/Pfizer supposedly paid in the EU in January 2021 [54]. Nevertheless, while this may be encouraging to learn, lower prices paid to producers do still imply lower collective costs and profit margins, and arguably, a more favourable division of total surplus.

In this context, WTP valuations may also be informative for policymakers in price negotiations (as setting an upper limit) and in deciding on optimal procurement strategies (e.g. paying more for additional production capacity, resulting in quicker availability of a vaccine). Moreover, recognition of the value attached to health protection may stimulate preventative actions and investments in pandemic preparedness and sound WTP estimates may help to justify the associated costs.

Finally, the European Commission recently reported that 81.4% of Europeans had been vaccinated twice against COVID-19 [74]. Currently, there is no scarcity of appointments to receive a vaccination in the countries covered in

this study and we hope such a situation will not occur again – for COVID or another pandemic. Nonetheless, if it does, understanding and quantifying the value of adequate and timely protection remains highly important.

5 Conclusion

When the COVID-19 vaccines became available, a large initial demand for vaccines was met with a limited supply of vaccines, highlighting the need for an efficient distribution of scarce vaccines. We explored how much value respondents attach to early access to vaccines and which characteristics are associated with their valuation. The analysis showed that respondents had a higher value for access to more effective vaccines, and highlighted clear differences in the valuations between the included countries. We overall found that the majority of respondents in seven European countries would have been willing to pay out of pocket for quicker access to COVID-19 vaccines, suggesting potential welfare gains from quicker access to these vaccines.

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Author contributions All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by SN-B and IS. The first draft of the manuscript was written by SN-B, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data availability The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest All authors declare that they have no conflicts of interest.

Ethics approval Ethics approval was obtained by the University of Hamburg Social Science (WiSo) Research Laboratory for the complete ECOS study in April 2020. There were no privacy concerns since no personal or identifiable information was recorded. The study is in compliance with the terms of use of the WiSo Laboratory the guidelines for safeguarding good scientific practice and avoiding scientific misconduct at the University of Hamburg, as well as the RESPECT code of practice released by the RESPECT project by order of the European Commission. All authors of the study declared to follow and uphold these scientific and ethical standards.

Informed consent All participants provided their informed consent before starting the survey.

Consent to participate Informed consent was obtained from all participants prior to commencing the survey.

Consent for publication All authors provide this consent.

Code availability Please contact the corresponding author for any requests for any study materials including codes.

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