Stability of Stated Preferences: Vaccine Priority Setting before and during the First COVID-19 Lockdown

Brief Report

Medical Decision Making

Medical Decision Making
2023, Vol. 43(4) 521–529

DOI: 10.1177/0272989X221150185
journals.sagepub.com/home/mdm
SAGE

Stability of Stated Preferences: Vaccine Priority Setting before and during the First COVID-19 Lockdown

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Background. Discrete choice experiments (DCEs) are frequently used to study preferences and quantify tradeoffs in decision making. It is important to understand how stable their results are. **Objective.** To investigate to what extent an extreme change in context, the COVID-19 pandemic, affected preferences for vaccine priority setting, as observed in an earlier DCE. **Methods.** We replicated a DCE in which participants had to prioritize vaccination programs for public funding. The initial DCE was executed in Flanders (Belgium) right before the onset of the SARS-CoV-2 pandemic (December 2019, $N = 1,636$). The replicated DCE was executed 6 months later when the population was in lockdown (April 2020, $N = 1,127$). A total of 612 respondents participated in both waves of the DCE. We used panel mixed logit models to quantify attribute and level importance and compared utility estimates for consistency. **Results.** The number of vaccine-preventable deaths became less important during the pandemic than before, whereas the influential attributes, the vaccine's contribution to disease eradication and certainty about vaccine effectiveness became even more important. Respondents attached equal importance to the number of patients with transient or permanent morbidity, to the disease's economic impact as well as to its equity profile. **Conclusion.** Different preferences for vaccine priority setting were observed during the first COVID-19 lockdown as compared with before, although these differences were, given the extreme nature of the changing circumstances, relatively small.

Highlights

- We replicated a discrete choice experiment (DCE) about vaccine priority setting during the first COVID-19 lockdown and compared results with those from the original setting.
- The major attributes, contribution to disease eradication, and scientific certainty about vaccine effectiveness became even more important than they already were, whereas avoidable mortality became less important.
- Respondents attached equal importance to the number of patients with transient or permanent morbidity, to the disease's economic impact as well as to its equity profile.
- An extreme change in directly related context to the choice assignment led to changes in stated preferences, although these changes were relatively small, given the extreme change in context.
- Priorities in the second DCE were even less aligned with cost-effectiveness analysis than those observed initially.

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Keywords
infectious diseases, priority setting, cost-effectiveness, preference stability, test-retest study, discrete choice experiments, COVID-19 pandemic

Date received: December 13, 2021; accepted: December 19, 2022

Preferences regarding how to make policy tradeoffs are often elicited through stated or discrete choice experiments (DCEs).[1,2] It is important to understand how stable these stated preferences are across time and circumstance. Several studies, almost exclusively in the domain of environmental policy, have repeated DCEs, either in the same sample or in different samples of the same population and across time lags ranging from minutes to years. These test-retest studies found mostly similar results and provided evidence of temporal stability of stated preferences.[3–13] Only a handful of studies investigated preference stability when the circumstances had radically changed. Brouwer reexamined DCE inferred willingness-to-pay (WTP) values for water quality improvements 8 months later, in a time when there was extremely hot, dry weather.[14] Metcalf and Baker[15] compared WTP for a permanent water service and environmental improvements before and during the 2008 economic crisis. Hynes et al.[16] compared preferences for environmental management plans to protect ecosystem benefits before and during the first COVID-19 wave. These studies observed stable preferences.

In this study, we also investigated how stable stated preferences were under changing circumstances. We did so in the health policy domain, using a radical change in context that was directly related to the subject of the DCE. In an initial DCE, performed in December 2019, right before media reported on SARS-CoV-2 transmission, respondents were asked to set priorities between vaccines competing for public funding.[17] We repeated this DCE 6 months later (in April 2020), about 2 months after the first SARS-CoV-2 infection was reported in Belgium. At this time, the entire country was in its first lockdown, a draconic public health measure and an extreme circumstance that had not occurred in Belgium since World War II.[18] All Belgian borders were closed; all flights from and to Belgium were canceled; all bars, restaurants, and nonessential shops were closed; group gatherings (>2 persons) were prohibited; teleworking was the norm; and media were continuously reporting and discussing infectious diseases.

Our objective was to investigate to what extent the earlier observed preferences for vaccine priority setting remained stable during the exceptional circumstances of the pandemic. The above-mentioned studies suggest that we find stable preferences here as well. However, one could also expect to see different results. The increased familiarity of the respondents with the choices that needed to be made in the DCE (i.e., to set infectious disease prevention priorities) might lead to more clearly pronounced preferences and hence sharper distinctions between the attribute weights as compared with those observed in the earlier DCE. People's preferences might have changed too, given the exceptional change in the context of our study. On an individual attribute level, one could, for instance, speculate that a widely shared sense of emergency might lead to stronger uncertainty avoidance and time preference and a more outspoken focus on avoiding the worst disease outcomes first.

Methods

Samples

We used the Belgian panel of market research company Dynata, which consists of 5,500 representative members of the Belgian population. From those panel members living in the Flemish region (about 57% of the Belgian population), 2 samples were drawn, fulfilling predetermined quota in line with the Flemish population for age, gender, province, and level of education. The first sample (N = 2,724) completed the DCE in December 2019, right before media started reporting on SARS-Cov-2. The second sample (N = 1,536) completed the DCE in April 2020, when stringent containment measures were in place. In total, 838 respondents (31% of wave 1; 55% of wave 2) completed both DCE waves. All respondents were sent an online invitation to participate but did not know the study subject beforehand. After agreeing to participate, all respondents received an email with a link to the survey.

DCE

Full details on the original DCE are published elsewhere.[17] After sociodemographic questions, respondents

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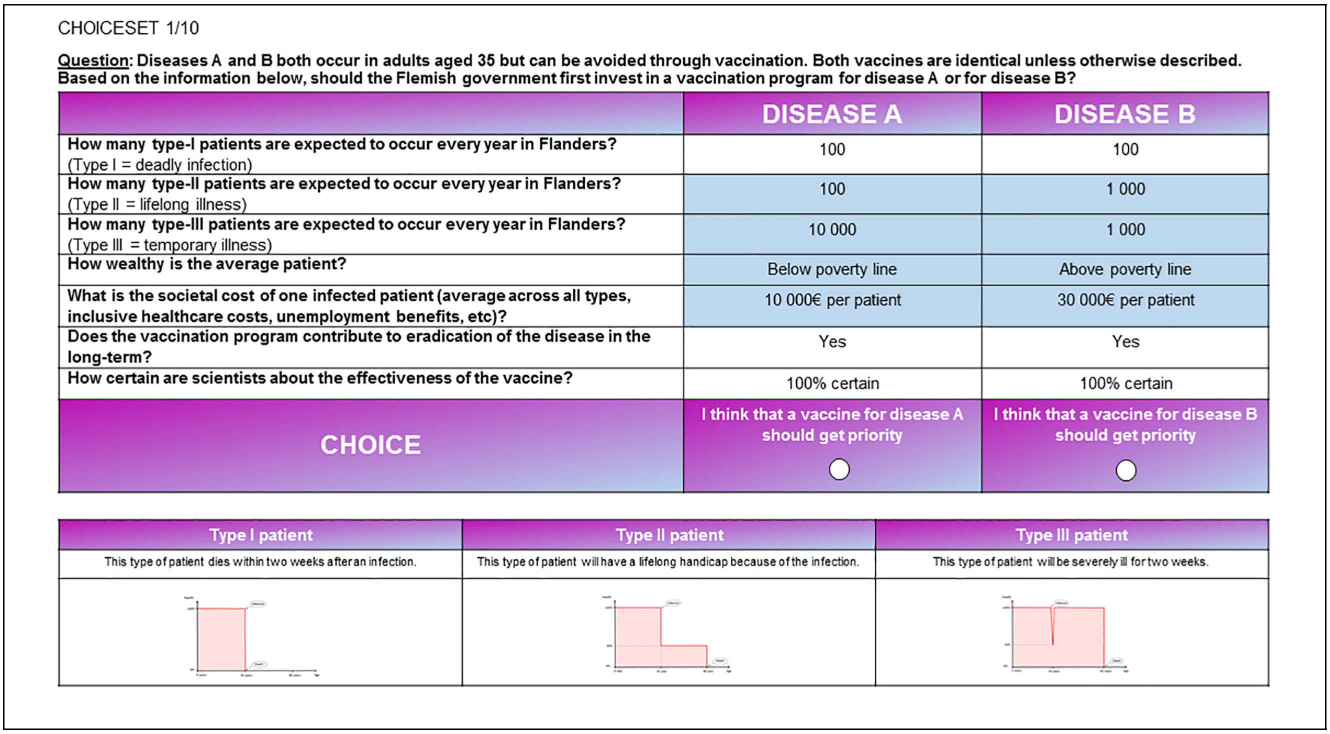

CHOICESET 1/10

Question: Diseases A and B both occur in adults aged 35 but can be avoided through vaccination. Both vaccines are identical unless otherwise described. Based on the information below, should the Flemish government first invest in a vaccination program for disease A or for disease B?

	DISEASE A	DISEASE B
How many type-I patients are expected to occur every year in Flanders? (Type I = deadly infection)	100	100
How many type-II patients are expected to occur every year in Flanders? (Type II = lifelong illness)	100	1 000
How many type-III patients are expected to occur every year in Flanders? (Type III = temporary illness)	10 000	1 000
How wealthy is the average patient?	Below poverty line	Above poverty line
What is the societal cost of one infected patient (average across all types, inclusive healthcare costs, unemployment benefits, etc)?	10 000€ per patient	30 000€ per patient
Does the vaccination program contribute to eradication of the disease in the long-term?	Yes	Yes
How certain are scientists about the effectiveness of the vaccine?	100% certain	100% certain
CHOICE	I think that a vaccine for disease A should get priority	I think that a vaccine for disease B should get priority

Type I patient	Type II patient	Type III patient
This type of patient dies within two weeks after an infection.	This type of patient will have a lifelong handicap because of the infection.	This type of patient will be severely ill for two weeks.

Figure 1 Example choice set (translated from Dutch).

were informed about the need to set vaccine priorities and the study objective (for the full survey, see Appendix A). We then asked respondents to make 10 choices between 2 competing vaccination programs (see Figure 1). Both were described as being equally costly and safe, but they differed in terms of their impact: preventable cases for 3 severities of illness (deadly infections, serious illness that is lasting or transient), impact on health inequities, avoidable treatment and productivity costs, certainty about vaccine effectiveness, and contribution to disease eradication. Before the DCE started, all attributes were explained in detail one-by-one on a separate page (see Appendix B), which respondents could skip only after 10 seconds per page. The 3 possible severities of illness were presented both graphically (using a quality-adjusted life-year diagram) and textually. These diagrams were shown once more at the bottom of each choice set (see Figure 1). We developed the DCE for 3 age groups: vaccines for young children 3 years old, for adults 35 years old, and for elderly people 70 years old. The surveys used in both waves were identical, but some respondent background questions of the first wave were replaced with questions about how the COVID-19 pandemic had affected people's lives.

To enable exclusion of low-quality responders during data cleaning, in both waves, 3 "exercise" choice sets were added before the 10 "real" ones. The first 2 consisted of a "dominant" vaccine profile that scored better on each varying dimension. A third choice set was identical to the 10th (and final) real choice set.

The main result of the first DCE was that the disease's economic impact was irrelevant, whereas all other attributes mattered.[17] In terms of relative weight (see Figure 2 and Table 1), contribution to disease eradication and certainty about vaccine effectiveness were most important. Least important was the disease's equity profile. A main conclusion of the DCE was that priorities were not determined by cost-effectiveness.

Data Analysis

We estimated panel mixed logit (PML) models using the hierarchical Bayes technique. In these models, random normal coefficients are used to model the correlation structure of choices from the same respondent.[19] Repeated choices from the same respondent are therefore grouped together across 1 or both waves. We calculated the significance of the attributes using likelihood ratio (LR) or plausibility tests and the relative importance of the attributes using the LogWorth statistic (defined as $-\log_{10}$[*P* value of the LR test]). We analyzed the data sets by estimating an initial PML model that included all main and all 2-way interaction effects. We

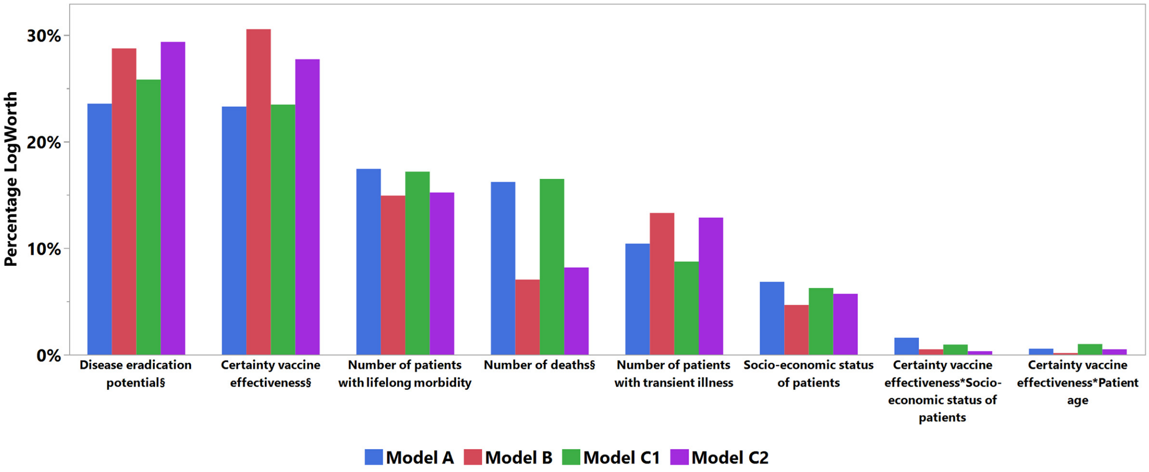

Figure 2 Importance of all significant ($P < 0.05$) attribute effects in DCEs from wave 1 (model A), wave 2 (model B), and the subset of respondents included in both waves (model C1 = wave 1, model C2 = wave 2). Attributes indicated by the § symbol (i.e., disease eradication potential, certainty of vaccine effectiveness, and number of deaths) show significant differences in their percentage LogWorth between models A and B. This applies to models C1 and C2 for the number of deaths only. All other differences in the attributes' LogWorth between models A and B and models C1 and C2 are not significant.

then deleted the nonsignificant terms to arrive at final models in which all effects had significant explanatory value at the 5% level. We performed the Bayesian estimations in the JMP Pro 16 Choice platform (based on 10,000 iterations, the last 5,000 of which have been used for the actual estimation; SAS Institute Inc, Cary, NC, USA).

Because we analyzed and compared data from 2 different waves, we first looked into a possible difference in scale or choice consistency between the data sets.[20] Appendix D contains a discussion on the separation of scale from preference heterogeneity between the 2 waves, showing that the scale difference was only minor.

Differences in attribute weights between both DCE waves were then assessed in 2 ways: 1) by analyzing wave 1 and 2 separately and comparing the percentages LogWorth of each attribute (i.e., the attribute's LogWorth relative to the LogWorth of all attributes) and 2) by pooling all data and estimating an overall model in which wave number was included as an interaction term with each attribute.

Lastly, we used chi-square tests to investigate whether the respondent distribution across sample characteristics differed between the 2 samples.

Results

Thirty-five percent of all respondents ($N = 1,497$ in total, $N = 1,088$ for wave 1 and $N = 409$ for wave 2) were excluded based on the predetermined quality criteria: those who gave nonsensical answers in comment boxes, incorrect responses to the 2 warm-up choice sets with a dominant profile, "speeders" (i.e., answering the survey in less than one-third of the median time to completion), and "straightliners" (consistently giving the same answer to the 10 choice sets). A final sample of 2,763 responses met all quality criteria: 1,636 (60%) of the wave 1 total and 1,127 (73%) of the wave 2 total. Within this final sample, 612 respondents (37% of wave 1 and 54% of wave 2) completed both DCEs. Table 2 presents the demographic characteristics of the final samples, and a comparison with the Flemish population appears in Appendix C. The final samples were sufficiently representative in terms of age, gender, and province, but respondents with low educational attainment were underrepresented. As shown in Table 2, there were no statistically significant differences between both samples in terms of distribution across sample characteristics, except for the experienced difficulties with monthly expenses, which showed improvement in the second wave. However, this difference is likely to be a result of the COVID-19 lockdown and the implemented financial protection measures at that time, rather than that it signals a different sample constitution.

Models A and B summarize the results of waves 1 and 2, respectively. Also in wave 2, the cost attribute had no explanatory power, whereas the other attributes were

Table 1 Panel Mixed Logit Model Estimates (Means and Standard Deviations) and Likelihood Ratio (LR) Chi-Square Statistics of the Significant Attribute Effects[a]

	Model A (Wave 1: $N = 1{,}636$)		Model B (Wave 2: $N = 1{,}127$)		Model C1 (Wave 1: $N = 612$)		Model C2 (Wave 2: $N = 612$)	
Model Term	**Mean (*s*; Subject *s*)**	**LR χ^2**	**Mean (*s*; Subject *s*)**	**LR χ^2**	**Mean (*s*; Subject *s*)**	**LR χ^2**	**Mean (*s*; Subject *s*)**	**LR χ^2**
Number of type I patients (expected mortality)	0.794 (0.026; 1.032)	562.816	0.544 (0.029; 1.024)	188.732	0.924 (0.042; 1.044)	278.545	0.642 (0.045; 0.983)	137.241
Number of type II patients (expected lifelong morbidity)	0.067 (0.002; 0.096)	606.226	0.077 (0.003; 0.106)	405.201	0.082 (0.004; 0.103)	290.371	0.089 (0.005; 0.111)	259.371
Number of type III patients (expected short-term morbidity)	0.007 (0.000; 0.014)	359.953	0.008 (0.000; 0.014)	360.557	0.007 (0.000; 0.015)	145.384	0.009 (0.000; 0.015)	218.585
Socioeconomic status of those infected								
Below poverty line	14.760 (0.690; 26.981)	234.201	14.924 (0.975; 30.270)	123.328	17.375 (1.110; 28.194)	102.765	17.468 (1.165; 31.530)	94.630
Above poverty line	−14.760		−14.924		−17.375		−17.468	
Disease eradication potential								
Yes	29.006 (0.879; 40.018)	820.857	37.836 (1.098; 42.906)	785.501	36.633 (1.551; 43.578)	439.222	42.064 (1.581; 41.514)	505.236
No	−29.006		−37.836		−36.633		−42.064	
Scientific certainty around vaccine effectiveness								
100%	29.552 (0.781; 31.195)	811.203	39.547 (1.088; 37.211)	835.429	35.973 (1.521; 31.299)	398.765	41.313 (1.573; 33.842)	476.961
75%	−29.552		−39.547		−35.973		−41.313	
Scientific certainty around vaccine effectiveness, b socioeconomic status of those infected								
100% Below poverty line	10.829 (0.749; 22.708)	51.374	6.098 (1.163; 30.537)	10.849	9.067 (1.465; 23.047)	13.290	6.018 (1.519; 32.868)	3.619
100% Above poverty line	−10.829		−6.098		−9.067		−6.018	
75% Below poverty line	−10.829		−6.098		−9.067		−6.018	
75% Above poverty line	10.829		6.098		9.067		6.018	
Scientific certainty around vaccine effectiveness, by patient age								
100% 3 y	−2.900 (0.427; 0.171)	19.898	−2.983 (0.691; 0.221)	4.239	−3.491 (0.912; 0.427)	17.277	−4.974 (2.120; 0.311)	8.755
100% 35 y	−0.603 (0.692; 0.775)		0.508 (0.659; 0.292)		−0.079 (0.566; 0.221)		−1.357 (1.397; 0.237)	
100% 70 y	3.503 (0.472; 0.322)		2.475 (0.675; 0.243)		3.569 (0.792; 0.753)		6.332 (2.306; 0.394)	
75% 3 y	2.900		2.983		3.491		4.974	
75% 35 y	0.603		−0.508		0.079		1.357	
75% 70 y	−3.503		−2.475		−3.569		−6.332	

[a] *s* is the standard deviation of the posterior distribution in the Bayesian estimation, also called the posterior standard deviation of the mean or the posterior standard error. It is a measure of the uncertainty of the posterior distribution. Subject *s* is the standard deviation of the subject-specific preference estimates and hence a measure of the heterogeneity in individuals preferences. All model terms are significant at $P < 0.05$.

Table 2 Final Sample Characteristics

Characteristic		Pooled Respondents DCE 1–2		DCE 1		DCE 2		χ^2 Test (Comparing Sample DCE 1 with DCE 2)	Identical Respondents DCE 1–2	
		N = 2,151	100%	N = 1,636	100%	N = 1,127	100%	P Value	N = 612	100%
Gender	Male	1006	47%	755	46%	531	47%	0.6165	280	46%
	Female	1145	53%	881	54%	596	53%		332	54%
Age, years	18–24	256	12%	182	11%	116	10%	0.0646	42	7%
	25–34	366	17%	272	17%	184	16%		90	15%
	35–44	382	18%	293	18%	189	17%		100	16%
	45–54	409	19%	328	20%	221	20%		140	23%
	55–64	355	17%	292	18%	179	16%		16	19%
	65–80	383	18%	269	16%	238	21%		124	20%
Province	Antwerp	632	29%	498	30%	319	28%	0.5969	185	30%
	Limburg	283	13%	210	13%	150	13%		77	13%
	East-Flanders	495	23%	384	23%	254	23%		143	23%
	Flemish-Brabant	358	17%	258	16%	195	17%		95	16%
	West-Flanders	383	18%	286	18%	209	19%		112	18%
Education	None	3	0%	2	0%	1	0%	0.1719	0	0%
	Primary school	67	3%	56	3%	26	2%		15	2%
	First-degree secondary school	141	7%	110	7%	66	6%		35	6%
	Second-degree secondary school	129	6%	104	6%	53	5%		28	5%
	Third-degree secondary school	837	39%	592	36%	450	40%		205	33%
	Higher, nonuniversity	647	30%	517	32%	348	31%		218	36%
	University or postuniversity	315	15%	246	15%	174	15%		105	17%
	PhD	12	1%	9	1%	9	1%		6	1%
Number of children	0	805	37%	589	36%	433	39%	0.6440	217	35%
	1	416	19%	312	19%	218	19%		114	19%
	2	631	29%	505	31%	320	28%		194	32%
	3	186	9%	144	9%	99	9%		57	9%
	>3	113	5%	86	5%	7	5%		30	5%

(continued)

Table 2. (continued)

Characteristic		Pooled Respondents DCE 1–2		DCE 1		DCE 2		χ^2 Test (Comparing Sample DCE 1 with DCE 2)	Identical Respondents DCE 1–2	
		N = 2,151	100%	*N* = 1,636	100%	*N* = 1,127	100%	*P* Value	*N* = 612	100%
Profession	Working	1166	54%	912	56%	584	52%	0.2814	330	54%
	Homemaker	91	4%	73	4%	49	4%		31	5%
	Student	187	9%	129	8%	91	8%		33	5%
	Unemployed	68	3%	43	3%	35	3%		10	2%
	Disabled	143	7%	112	7%	74	7%		43	7%
	Retired	496	23%	367	22%	294	26%		165	27%
Difficulties with monthly expenses	Never	773	36%	564	34%	437	39%	0.0060	228	37%
	Once a year	671	31%	514	31%	354	31%		197	32%
	Once every 3 mo	488	23%	368	23%	246	22%		126	21%
	Every month	219	10%	190	12%	90	8%		61	10%

significant with mostly the same ranking of importance. However, respondents to wave 2 attached higher importance to the vaccine's contribution to disease eradication and effectiveness certainty while the number of preventable deaths received lower weight. When we pooled all data and estimated an overall model (model D, see Appendix E) in which the wave number was introduced as an interaction term with all attributes, the interactions with these 3 attributes were statistically significant.

Models C1 and C2 examine the choices of the 612 respondents who completed both waves of the DCE (model C1 for wave 1, model C2 for wave 2). The relative importance of the attributes was similar in both waves, except for the preventable mortality attribute, which became less important in wave 2. This was noticeable when we analyzed the choices all together (2 recordings per respondent) but added an interaction effect for the wave number (see model E in Appendix E). The increase in importance of contribution to disease eradication and effectiveness certainty in wave 2, which was observed in model B (or model D) was not observed in model C2 (or model E).

We also investigated whether different responses to the questions on personal experiences with COVID-19 were associated with different preferences in wave 2. Respondents who thought the government had handled the crisis well ($N = 722$; 64%) considered the number of patients with lifelong morbidity (type II patients) more important and certainty about vaccine effectiveness less important compared with the others. Also, respondents who had been anxious or gloomy during the crisis ($N = 492$; 44%) attached more weight to the disease's equity profile and to the effectiveness certainty attribute.

Discussion

This study was a test-retest study of a DCE about vaccine priority setting, in which we used the exceptional circumstances of the COVID-19 pandemic to investigate how stable stated preferences for vaccine priority setting were. People were more than ever forced to think about infectious disease prevention, and all media were continuously evaluating policy measures in terms of the attributes that were investigated in this DCE. The weight associated with 3 attributes changed: contribution to disease eradication, effectiveness certainty (both more important), and number of vaccine-preventable deaths (less important), although only the change of the latter attribute was observed in all models.

The results of the first wave showed that people did not set vaccine priorities aligned with cost-effectiveness analysis (CEA), as several attributes that do not receive a prominent place in CEA (contribution to eradication objectives, effectiveness certainty) were considered highly valuable whereas others that are important in CEA (economic impact) were of no influence. During the pandemic, this divergence became even bigger, particularly as also the number of preventable deaths (a major source of quality-adjusted life-years) became less important.

These observations were partly in line with our a priori beliefs. We expected to find sharper distinctions in the attribute weights between waves 1 and 2, as in wave 2 respondents became more familiar with vaccine priority setting, which would lead to clearer choice patterns. Indeed, wave 2 results were similar to those of wave 1 but more outspoken. We also expected to find more uncertainty avoidance, which was reflected in the increased weight of the effectiveness uncertainty attribute. However, we foresaw an increased focus on avoiding deaths during an emergency, but people seemed to care less about deaths. Furthermore, we projected a stronger time preference and increased focus on the present, suggesting a lower focus on the long-term goal of disease eradication, while we observed the opposite. As an explanation for the changes that we observed, one could speculate that there was an increased insensitivity toward deaths from infectious diseases, induced by the daily COVID-19 death toll in the news at the time of executing the second DCE. There was also a widespread hope in popular media that a vaccine would become available soon, but the key question in all debates was how effective it would be. In the best case, the vaccine would be able to eradicate COVID-19. The additional focus on these attributes may have influenced how people prioritized vaccines in our DCE.

Our results seem to contrast with the stable preferences that were observed in 3 earlier test-retest studies that also exploited radically changing circumstances to investigate preference stability.[14–16] However, given that most attribute weights remained constant and as there was only a limited change in the ranking of the attributes importance, we consider the changes observed in our study as relatively small, given the enormous change in the directly relevant context. One other test-retest study under extreme circumstances also reported changing preferences. Wunsch et al.[21] investigated preferences for investments in large infrastructure projects such as coastal adaptation for climate change during different waves of the COVID-19 pandemic. However, these results compare preferences measured twice during the COVID-19 pandemic and hence investigate preference stability during extreme circumstances.

The following are important study limitations. The DCE evaluated vaccines on 8 criteria but excluded many others. An important one was the risk of side effects. It would have been interesting to investigate whether or not side effects became more important during the pandemic. Also, we chose levels that were realistic for infectious diseases in Flanders; therefore, our attribute about economic impact did not include a very low cost level, which would have allowed more variation. Furthermore, we used an online panel in which membership may be associated with unobserved characteristics (e.g., Internet access). Lastly, there may have been some selection bias in the sense that respondents who were excluded in the final sample of wave 1 were probably also excluded in the final sample of wave 2. However, in the initial DCE, the inclusion of excluded respondents did not meaningfully affect the results.[17]

Acknowledgments

We thank the members of the infectious disease unit of the Agency of Health and Care (Flemish Government) for their financial support to conduct the initial wave of this study and prof. Philippe Beutels and prof. Corinne Vandermeulen for their input in the development of the DCE. Also, dr. Kessels acknowledges the JMP division of SAS Institute for financial support.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Ethical Approval

The Social and Societal Ethics Committee (SMEC) of KU Leuven decided that this study did not fall under the Belgian law on experiments as pseudonymized data collected by a third party were analyzed. No ethics approval was deemed necessary.

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Supplemental Material

Supplemental material for this article is available online.

Data-Sharing Statement

Data can be accessed upon reasonable request from the authors.

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