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ORIGINAL RESEARCH ARTICLE

Public Preferences for Introducing a COVID-19 Certificate: A Discrete Choice Experiment in the Netherlands

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Abstract

Objective Here we investigate public preferences for coronavirus disease 2019 (COVID-19) certificates in the Netherlands, and whether these preferences differ between subgroups in the population.

Methods A survey including a discrete choice experiment was administered to 1500 members of the adult population of the Netherlands. Each participant was asked to choose between hypothetical COVID-19 certificates that differed in seven attributes: the starting date, and whether the certificate allowed gathering with multiple people, shopping without appointment, visiting bars and restaurants, visiting cinemas and theatres, attending events, and practising indoor sports. Latent class models (LCMs) were used to determine the attribute relative importance and predicted acceptance rate of hypothetical certificates.

Results Three classes of preference patterns were identified in the LCM. One class a priori opposed a certificate (only two attributes influencing preferences), another class was relatively neutral and included all attributes in their decision making, and the final class was positive towards a certificate. Respondents aged > 65 years and those who plan to get vaccinated were more likely to belong to the latter two classes. Being allowed to shop without appointment and to visit bars and restaurants was most important to all respondents, increasing predicted acceptance rate by 12 percentage points.

Conclusions Preferences for introduction of a COVID-19 certificate are mixed. A certificate that allows for shopping without appointment and visiting bars and restaurants is likely to increase acceptance. The support of younger citizens and those who plan to get vaccinated seems most sensitive to the specific freedoms granted by a COVID-19 certificate.

1 Introduction

The COVID-19 pandemic has forced governments around the world to implement far-reaching policies restricting individual freedom of citizens to mitigate the spread of the virus, including for example public venue closures, limitations on social contacts, and travel restrictions. The situation changed considerably at the end of 2020, when the first vaccines were approved for use on the basis of their safety

Key Points for Decision-Makers

Public support for COVID-19 certificates remains unclear, with some indications that in public debates a vocal minority against or in favour of certificates is outvoicing the silent majority.

This study showed three groups in the population with different opinions on the desirability of a COVID-19 certificate; approximately 1/3 was generally against, 1/3 was generally in favour and for 1/3 desirability depended on the characteristics of the certificate.

If the government introduced a COVID-19 certificate, public support could significantly increase when holders of the certificate are allowed to shop without appointment and visit bars and restaurants. Demographic characteristics impacted preferences [e.g. elderly citizens were more likely to favour, while respondents who did not (plan to) get vaccinated were more likely to oppose].

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and effectiveness and the first vaccination programmes were launched. Because vaccination rates remained insufficient for protection against the virus at the population level, many countries have introduced a (digital) COVID-19 certificate that provides proof that a person has been vaccinated against COVID-19, received a negative test result or recovered from a COVID-19 infection. Certification has, for example, been introduced for international travel. The scope of application of certificates has differed between countries and within countries over time but has foremost been applied to regulate access to settings where larger groups of people gather and it is difficult to keep sufficient distance, such as public transport, bars and restaurants, museums, theatres and large events, such as concerts, festivals and sports. Advocates of the introduction of certificates have emphasized their potential to help control the spread of the virus while, unlike lockdowns, enabling a part of economic and social life to continue [1]. Previous studies showed that vaccination certificates can also be an effective measure to stimulate vaccine uptake [2–6], especially in countries with below-average vaccination coverage and in younger age groups. Despite these advantages of introducing a COVID-19 certificate, there also has been strong opposition. Besides discussions on whether COVID-19 certificates indeed are more effective than other measures such as wearing masks or social distancing, opponents have, for instance, argued that certification restricts people's freedom of choice and, therefore, could be seen as a policy measure that exacerbates inequalities and leads to discrimination [5–10]. Hence, in many countries the public debate on introducing a COVID-19 certificate has been emotional and morally challenging [11–14].

Meanwhile, it remains unclear what the public support is for such certificates, with some indications that in these public debates a vocal minority against or in favour may be outvoicing the silent majority. This also seems to be the case in the Netherlands, where the introduction of the CoronaCheck app [15] resulted in large demonstrations by opponents. At the same time, a study showed strong support for a COVID-19 certificate in the population, albeit much stronger among those who were (planning to get) vaccinated than among those who did not want to get vaccinated or were still in doubt [16]. Another study from the Netherlands also found strong support among citizens and established that a COVID-19 certificate was the preferred policy from a range of alternative policies aiming to promote COVID-19 vaccination [17]. The present study aims to shed further light on the preferences of the public in the Netherlands for a COVID-19 certificate, and whether these preferences differ between subgroups in the population.

2 Methods

2.1 Attributes, Attribute Levels and Experimental Design

The discrete choice experiment (DCE) developed as part of this study followed guidelines of good research practice [18, 19]. Attributes and attribute levels were selected on the basis of literature review [2–10, 17, 20–23] and policy documents on current developments around COVID-19 strategies in the Netherlands [24, 25]. The research team selected attributes and levels to reflect the ongoing policy in the Netherlands related to COVID-19 restrictions so that displayed alternatives would reflect realistic potential policy measures in the Netherlands. Graphics were used to illustrate the attributes and their levels, corresponding to those used on official governmental information leaflets about COVID-19 in the Netherlands [24]. A final list of attributes and their levels as well as the graphics used for each is presented in Table 1.

A Bayesian D-efficient design using 300 Halton draws and 1000 repetitions was developed using NGene (version 1.2.1). No interactions between attributes were anticipated. Choice tasks were optimized for level balance. Best guess estimates based on prior publications [17, 20–23] were used as prior information for the design. Taking statistical requirements and respondent burden into account, a total of 36 unique choice tasks were generated which were divided over three blocks of 12 choice tasks. Respondents were randomized to one of these three blocks.

2.2 Survey Development and Pilot Testing

The complete survey was web-based, constructed in Sawtooth Software SSI Web 9.13.0 and consisted of four parts. First, after providing informed consent, respondents were asked to complete a series of background questions (e.g. age, gender and educational level). Second, respondents answered questions related to their vaccination status and intentions, their household and their occupational situation. Third, respondents were provided with information on COVID-19 certificates (i.e. that it will be provided to everyone who has either been vaccinated, received a negative test result or recently recovered from infection) and all attributes and levels of the DCE. This included an example choice task and three comprehension questions. Thereafter, respondents were asked to complete 13 choice tasks. These included the 12 choice tasks of the block they were assigned to as well as one repeated choice task to test for consistency in choice (see Fig. 1 for example choice task). The choice context presented to respondents was: '*imagine that the government decides to implement a COVID-19 certificate and people with the certificate are allowed more*

Table 1 Attributes and levels included in the discrete choice experiment

Attributes	Levels
Start date of the certificate in 2021[a]: 	1 May 1 June 1 July 1 August
Gathering with multiple people: 	Allowed Allowed outside only Not allowed
Shopping without appointment: 	Allowed Not allowed
Visiting bars and restaurants: 	Allowed Allowed only outside Not allowed
Visiting cinemas and theatres: 	Allowed Not allowed
Attending events: 	Allowed Not allowed
Practising indoor sports: 	Allowed Not allowed

[a]This attribute refers to the national wide launch of the potential COVID-19 certification across the country; the dates were chosen so that by the first date not everyone who wanted to get vaccinated would have had the chance to do so, while by the last date everyone who wanted to get vaccinated would have had the opportunity

activities and/or freedom compared to people without the certificate. Which certificate would you advise the government to implement, Certificate A or Certificate B?' After each choice task, respondents were offered the opportunity to indicate whether they would or would not advise the government to implement the COVID-19 certificate they preferred (i.e. to opt-in or opt-out). Considering the controversiality of the topic and the expectation that a significant proportion of respondents might select the opt-out without carefully considering the alternatives, the opt-out was included as separate follow-up question after the choice task. Fourth, respondents were asked to complete questions about self-perceived risk of COVID-19 infection, compliance and opinion regarding the COVID-19 regulations, their perseverance time in the current situation [26] (a measure asking how long respondents thought they would be able to persevere financially and mentally under the current policy regulations, with six time intervals as answering option), the 7-item Consideration Of Others (COO) scale [27] (a measure used to capture altruistic motives; a sub-scale of the self-restraint scale from the Weinberger Adjustment Inventory, with scores theoretically ranging from 5 to 35 and higher scores indicating stronger altruistic preferences), the 6-item health risk attitude scale (HRAS) [28, 29] (with scores theoretically ranging from 6 to 42 and higher scores indicating stronger risk aversion) and feedback questions about the survey.

The draft survey was pre-tested in a convenience sample of the target population to assess clarity throughout the survey and flag any issues with the DCE design, wording or graphics used. After small corrections in wording throughout the survey, a pilot test ($N = 100$) was conducted among the target population. Data gathered from this pilot were analysed using a multinominal logit model [19], and its parameter estimations were used as prior input for the final DCE design.

2.3 Participants, Recruitment and Ethics

Respondents (for pilot and main survey) were recruited between March and April 2021, via a vendor company (Dynata). During that time the first vaccines became available, but the Netherlands was still in partial lockdown. Specifically, schools were open with restrictions, and the number of clients that could visit shops was restricted. Sectors like the hospitality and entertainment industry were fully closed, and the group size for sports activities was limited. There was also a curfew starting 9:00 PM.

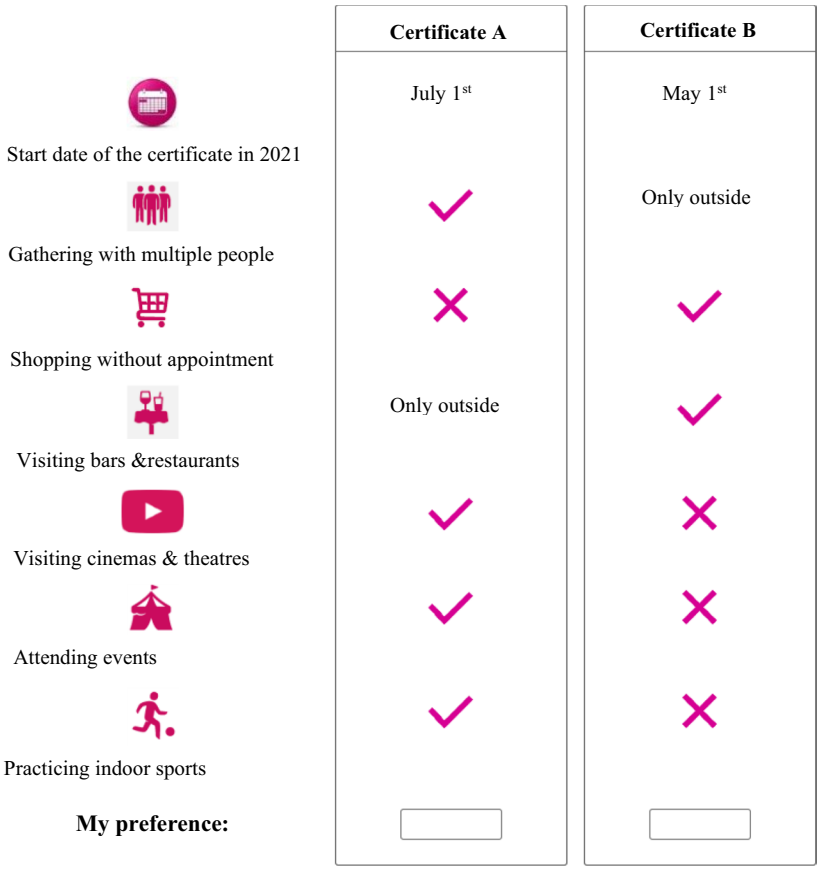
A total of 1500 respondents was recruited reflecting quota on gender (49.3% male), age group (18–24 years: 10.9%, 25–34 years: 15.8%, 35–44 years: 14.8%, 45–54 years: 18.0%, 55–64 years: 16.7%, 65–74 years: 13.7% and > 75 years 10.1%) and educational level (low: 28.5%, middle: 36,8% and high: 34.6%) so that the final sample would be representative of the general population of the Netherlands aged between 18 and 80 years. Ethical approval for this study was granted by Delft University of Technology (Nr. 1487). Data are available upon request to the authors.

2.4 Statistical Analysis

Analyses were conducted in SPSS 27 (IBM corporation) and NLogit 6.0 (Econometric software Inc.). Only complete surveys were included in the analysis. Results were considered statistically significant if $p < 0.05$.

Descriptive statistics (means and frequencies) are presented including responses to questions about vaccination status, self-perceived risk of COVID-19 infection,

Fig. 1 Example choice task



compliance and opinion regarding the COVID-19 regulations, and attitude towards vaccination as well as HRAS and COO.

Panel latent class models (LCMs) were applied to determine attribute level estimates. Such models account for the multilevel structure of the data and allow the detection of preference heterogeneity [30]. All attributes were considered non-linear and were therefore effects coded [19, 31]. On the basis of model fit tests (Akaike information criterion, log likelihood), the model most suitable for the data was selected (models ranging from one to six classes were tested). The final utility equation is shown below.

$V_{\text{rta|c}} = \beta_{0|c} + \beta_{1|c}$ Start date $_{\text{June rta|c}} + \beta_{2|c}$ Start date $_{\text{July rta|c}} + \beta_{3|c}$ Start date $_{\text{August rta|c}} + \beta_{4|c}$ Gathering with others $_{\text{Allowed outside rta |c}} + \beta_{5|c}$ Gathering with others $_{\text{Allowed rta|c}} + \beta_{6|c}$ Shopping $_{\text{Allowed rta|c}} + \beta_{7|c}$ Visiting bars and restaurants $_{\text{Allowed outside rta |c}} + \beta_{8|c}$ Visiting bars and restaurants $_{\text{Allowed rta|c}} + \beta_{9|c}$ Visiting cinema and theatres $_{\text{Allowed rta|c}} + \beta_{10|c}$ Visiting events $_{\text{Allowed rta|c}} + \beta_{11|c}$ Practising indoor sports $_{\text{Allowed rta|c}}$

$V_{\text{rtb|c}} = \beta_{1|c}$ Start date $_{\text{June rtb|c}} + \beta_{2|c}$ Start date $_{\text{July rtb|c}} + \beta_{3|c}$ Start date $_{\text{August rtb|c}} + \beta_{4|c}$ Gathering with others $_{\text{Allowed outside rtb|c}} + \beta_{5|c}$ Gathering with others $_{\text{Allowed rtb|c}} + \beta_{6|c}$ Shopping $_{\text{Allowed rtb|c}} + \beta_{7|c}$ Visiting bars and restaurants $_{\text{Allowed outside rtb|c}} + \beta_{8|c}$ Visiting bars and restaurants $_{\text{Allowed rtb|c}} + \beta_{9|c}$ Visiting cinema and theatres $_{\text{Allowed rtb|c}} + \beta_{10|c}$ Visiting events $_{\text{Allowed rtb|c}} + \beta_{11|c}$ Practising indoor sports $_{\text{Allowed rtb|c}}$

$V_{\text{opt-out|c}} = \beta_{12|c}$

The systematic utility component (V) describes the observable utility that participant 'r' belonging to class 'c' reported for alternative 'a' in choice task 't'. β_0 and β_{12} represent the alternative specific constant for alternative A and no COVID-19 certificate respectively, while β_1–β_{11} are the attribute level estimates.

In addition to the above-specified utility function, a class assignment model was fitted to each of the LCMs. On the basis of previous research [17, 20, 32, 33], demographic variables (age, gender and educational level), vaccination status, HRAS and COO were included to test if these variables impacted class membership and thereby explain heterogeneity in preferences.

2.5 Attribute Relative Importance

Importance scores (i.e. part-worth utility) for the attributes relative to the most important attribute were calculated on the basis of the results of the LCMs, separately for each

class. The difference between the highest and lowest attribute level estimate was calculated for each attribute. The largest difference value received an importance score of 1, representing the attribute that was deemed most important by participants. The other difference values were divided by the largest difference value, resulting in a relative distance between all other attributes and the most important attribute. The class-adjusted relative importance scores were calculated by weighting the relative importance score of all attributes in each class according to class assignment probability.

2.6 Predicted Uptake Rates

Within each class the predicted uptake of a base-case COVID-19 certificate was calculated against the opt-out on the basis of the standard logit rule [19]. The base-case certificate was represented by the following attribute levels: certificate starts in May 2021, all further activities (gathering with multiple people, shopping without appointment, visiting bars and restaurants, visiting theatres and cinemas, attending events, practising indoor sports) were not allowed. Subsequently, the relative impact of attribute level changes on the total predicted uptake was calculated. On top of the class specific calculations, a class-adjusted predicted update was determined, which adjusts the class-specific predictions on the basis of average class membership probabilities.

3 Results

A total of 1516 completed surveys were gathered. Respondents were excluded if they completed the survey in less than 10 min and had a positive score on two or more exclusion criteria (i.e. dominant alternative selection, wrong answer on two or three out of the three comprehension questions, inconsistent answer on the repeated choice task). This resulted in a total sample of 1309 respondents for the final data analyses. Respondents were relatively equally divided over age groups between 18 and 80 years (Table 2), 47.4% of the respondents were male and 27.9%, 45.8% and 26.2% of respondents had a low, medium or high educational level, respectively, making it representative of the general Dutch population. Of all respondents, 3.9% were vaccinated and 70.4% planned to get vaccinated when they received their invitation.

Less than 25% of respondents perceived themselves as being at (extremely) high risk of getting infected with COVID-19 or becoming seriously ill, being hospitalized or dying from a COVID-19 infection (Table 2). Considering the governmental measures to mitigate the spread of COVID-19 in place at the time of data collection, 71.7% of respondents reported a financial perseverance time of 6 months or more, while 40.5% of respondents reported a mental perseverance time of 6 months or more.

In total, 40.4% of respondents (completely) agreed with implementing a COVID-19 certificate (Fig. 2a). At the same time, over 56.7% of respondents indicated they believed that such a certificate would lead to division in society and would force people to get vaccinated, while 17.9% of respondents thought a certificate would lead to people purposively getting themselves infected with COVID-19. About 50% of respondents thought the European Union should decide that all people with a certificate can travel abroad. Over 60% of respondents indicated to (always or mostly) still comply with the governmental measures to mitigate the spread of COVID-19 such as washing hands and keeping social distance (Fig. 2b).

In total, 62.2% of respondents found the survey (very) easy to complete and 81.4% deemed the length of the survey acceptable or just right. In addition, 76.9% answered the repeated choice task consistently with their initial choice and 58.0% answered at least one or more of the comprehension questions correctly.

3.1 Preferences for a COVID-19 Certificate

A three-class latent class model showed best model fit to the data. The average class probability for the respective classes was 33.4%, 29.3% and 37.3% (Table 3). Across all classes, respondents significantly preferred shopping without appointment and visiting bars and restaurants to be allowed for holders of a COVID-19 certificate.

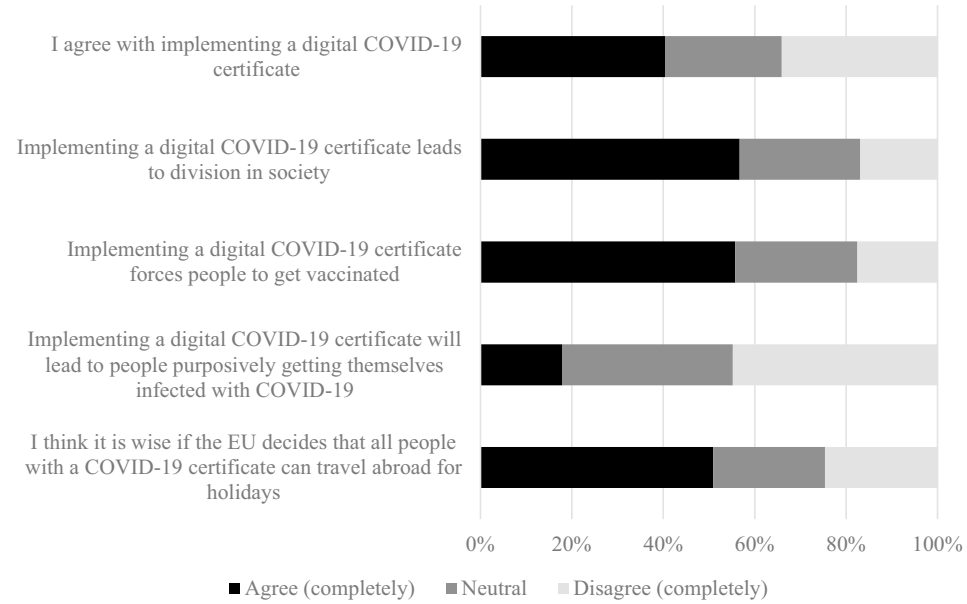
A priori, respondents in class one showed a strong disutility regarding the certificate (i.e. a large and significant positive estimate for the opt-out). Preferences for a certificate in this class were impacted by whether or not a COVID-19 certificate allows holders to shop without an appointment or to visit bars and restaurants. Class 2 also showed a positive estimate for the opt-out (i.e. indicating an a priori disutility from a certificate), although relatively small as compared with class 1. In this class all attributes included in the design showed significant coefficients impacting the overall utility of a COVID-19 certificate. Respondents in this class also preferred gathering with multiple people and visiting cinemas and theatres as well as practising indoor sports to be allowed. Respondents in this class were the only ones who also preferred the certificate to start in June, so not immediately in May, and reported a disutility for a certificate to start in August. Finally, respondents in class 3, a priori preferred a certificate (i.e. sizeable and significant negative estimate for the opt-out); their preferences were further influenced by all attributes except for the starting date.

Of all tested variables in the class assignment model, only age and vaccination status significantly impacted class

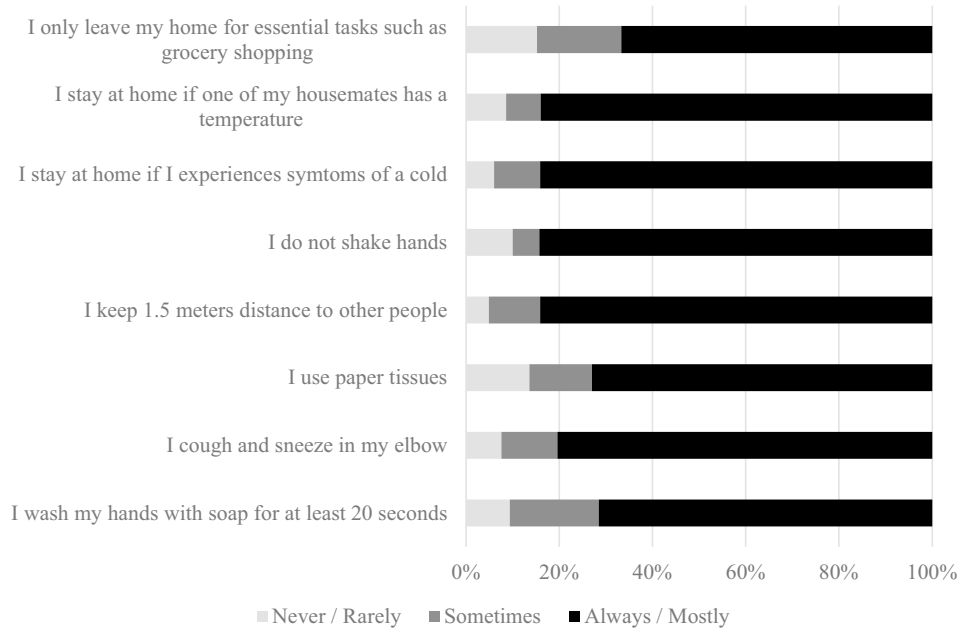
Table 2 Description of the respondents ($N = 1309$)

		Frequency (%)
Age, years		
18–29		13.7
30–39		14.7
40–49		17.6
50–59		17.3
60–69		23.1
70–79		13.5
Gender		
Male		47.4
Educational level[a]		
Low		27.9
Medium		45.8
High		26.2
	Min–max	Mean (SD)
Health risk attitude scale	6.0–42.0	15.5 (6.0)
Consideration of others	7.0–35.0	26.1 (4.5)
		Frequency (%)
Vaccination		
Vaccinated		3.9
Planned to get vaccinated		70.4
Had doubts about vaccination		12.8
Planned not to get vaccinated		11.9
Agree to implement COVID-19 certificate		
Agree (completely)		40.4
Neutral		25.5
Disagree (completely)		34.1
Perceived to be at (extreme) high risk of:		
Getting infected with COVID-19		14.9
Becoming seriously ill after COVID-19 infection		23.5
Being hospitalized after COVID-19 infection		17.9
Dying from COVID-19 infection		12.9
Perceived ability to financially maintain		
Less than 3 months		18.0
Less than 6 months		10.2
More than 6 months		71.7
Perceived ability to mentally maintain		
Less than 3 months		38.2
Less than 6 months		21.3
More than 6 months		40.5

[a]Low: primary school, lower secondary education; medium: lower tertiary education, higher secondary education; high: higher tertiary education, university



a.



b.

Fig. 2 Responses to statements related to digital COVID certificates (**a**) and respondents' perceptions on their compliance with current COVID-19 measures (**b**)

assignment. Respondents who were not vaccinated or had doubts about vaccination were more likely to belong to class 1 as compared with class 3, while respondents aged over 65 years were less likely to belong to class 2 as compared with class 3.

3.2 Attribute Relative Importance

Visiting bars and restaurants was the most important attribute explaining preferences in all classes, followed by shopping without appointment. The relative importance of the

Table 3 Preferences of the Dutch population for characteristics of a COVID-19 certificate based on a latent class model

	Class 1		Class 2		Class 3	
	Coef.[$]	Std.Err.[$]	Coef.	Std.Err.	Coef.	Std.Err.
Start date in 2021						
May (ref)	0.34		0.10		–0.04	
June	0.03	0.17	0.17***	0.04	0.03	0.03
July	–0.30	0.19	–0.05	0.04	0.06	0.03
August	–0.07	0.17	–0.22***	0.04	–0.05	0.03
Gathering with multiple people						
Allowed	0.06	0.17	0.24***	0.03	0.18***	0.02
Allowed only outside	0.17	0.15	0.11***	0.04	0.02	0.02
Not allowed (ref)	–0.23		–0.35		–0.20	
Shopping without appointment						
Allowed	0.45***	0.10	0.31***	0.02	0.27***	0.01
Not allowed (ref)	–0.45		–0.31		–0.27	
Visiting bars and restaurants						
Allowed	0.24**	0.11	0.47***	0.03	0.33***	0.02
Allowed only outside	0.36***	0.12	0.28***	0.03	0.05**	0.02
Not allowed (ref)	–0.60		–0.75		–0.38	
Visiting cinemas and theatres						
Allowed	–0.01	0.09	0.18***	0.02	0.16***	0.01
Not allowed (ref)	0.01		–0.18		–0.16	
Attending events						
Allowed	0.05	0.09	0.17***	0.02	0.13***	0.01
Not allowed (ref)	–0.05		–0.17		–0.13	
Practising indoor sports						
Allowed	0.20	0.11	0.16***	0.02	0.14***	0.01
Not allowed (ref)	–0.20		–0.16		–0.14	
Opt-out	4.48***	0.14	0.71***	0.04	–2.56***	0.07
Alternative Specific Constant Alternative A	0.36	0.19	0.05	0.04	0.14***	0.03
Class share	0.334		0.293		0.373	
Class membership model						
Constant	–0.51***	0.11	0.03	0.10	–	–
Aged over 65	–0.25	0.16	–0.61***	0.15	–	–
Not being vaccinated	2.02***	0.25	–	–	–	–

**$P < 0.05$

***$P < 0.001$

[$]Coefficient and standard error

other attributes differed across the classes (Fig. 3), with start date and visiting cinemas and theatres showing largest variability of importance across classes.

3.3 Predicted Uptake Rate

Preferences and relative importance results were reflected in predicted uptake rates (Fig. 4). Compared with the base-case certificate that starts in May and does not allow any activities (class-adjusted uptake rate 31.0%), the uptake increased most if having a COVID-19 certificate allows visiting bars and restaurants (7.9% class adjusted) or shopping without appointment (4.7% class adjusted).

4 Discussion

This study has investigated the preferences of the adult general public in the Netherlands for the introduction of a COVID-19 certificate based on vaccination, a negative test or recent infection, and whether preferences differed between subgroups in the population. The DCE results showed that

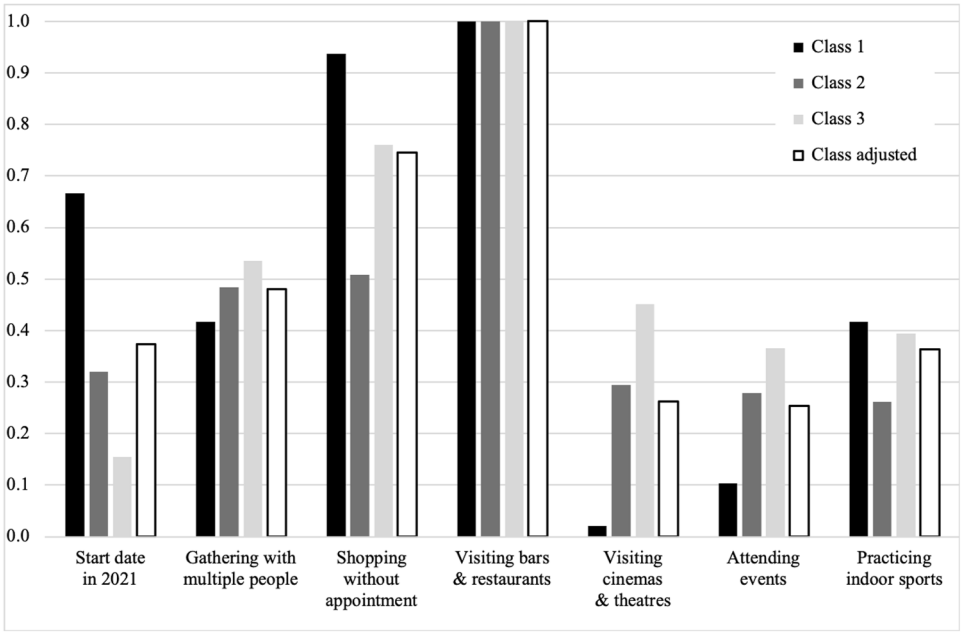


Fig. 3 Relative importance of COVID certificate's attributes separate for each class of the LCA as well as the class-adjusted outcome

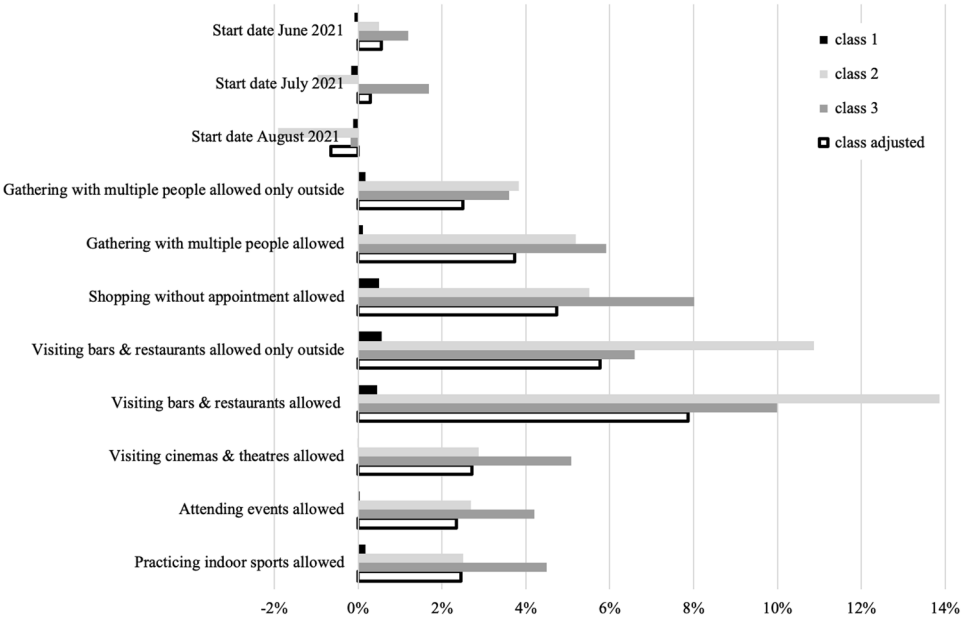


Fig. 4 Change in predicted uptake of certificates based on changes in each attribute level relative to the base case (certificate starting in May 2021 and all activities not allowed). The uptake rates are shown separately for each class as well as adjusted for class probability

the population was divided regarding the desirability of a COVID-19 certificate; 33% were generally against, 37% were generally in favour and for 29% it depended on the characteristics of the certificate. If the government introduced a COVID-19 certificate, public support could significantly increase when holders of the certificate are allowed to shop without appointment and visit bars and restaurants. In support of these results, survey responses showed that about 40% of respondents (completely) agreed with the statement that a COVID-19 certificate should be introduced, but, at the same time, over 40% of respondents expressed concerns that a certificate would contribute to division in society and that some might feel forced to get vaccinated in order to be able to keep participating in society. These findings deviate from previous studies in the Netherlands that showed a somewhat higher level of support for a COVID-19 certificate [16, 17], but are in line with those from previous studies indicating that vaccination certificates may result in unfair and inequitable health and social outcomes in the population and might induce social divisions [5, 6, 10, 14]. The strong heterogeneity in citizens' preferences for COVID-19 policies is found in various studies that were conducted after the

first wave of the COVID-19 pandemic (e.g. [34, 35]), which contrasts with the results of studies conducted during the first wave of the pandemic in which a large majority of citizens prioritized health outcomes over other societal impacts (e.g. [36, 37]) Elderly citizens were more likely to favour a COVID-19 certificate, while respondents who did not (plan to) get vaccinated were more likely not to support a certificate. Younger people and those (planning to get) vaccinated were more likely to prefer a certificate depending on the additional freedoms a certificate would provide. The result that elderly more strongly support COVID-19 measures than younger people is in line with several previous studies that investigated people's preferences for COVID-19 measures (e.g. [34, 38]).To increase public support, the Dutch government could target communication about the benefits of a COVID-19 certificate towards this group, particularly also because previous research showed that uptake of vaccination was highest among younger people after the introduction of a COVID-19 certificate in France and Italy [3].

This study is subject to some limitations. First, even though quotas were applied to ensure the respondents match the adult general population of the Netherlands regarding age, gender, educational level, and vaccination status and vaccination intention, participation in COVID-19-related studies may be sensitive to peoples' views. In the introduction to the experiment, we emphasized that we were interested in all views in the public on the introduction of a COVID-19 certificate, so that the results would be most useful to advise the government. Nonetheless, our study may have suffered from selection bias, with people less engaged with or tired of the COVID-19 situation – or with low trust in government – less likely to participate in this study. For that reason, it might be of particular interest to repeat studies like these in subgroups of the population that deny the importance of COVID-19 as a public health crisis or do not get vaccinated. Secondly, this study was conducted in a time where the Netherlands was in (partial) lockdown due to COVID-19; preferences of respondents for a certificate might depend on the policy measures in place and the upcoming vaccination campaign. It would, therefore, be of interest to repeat this study during a period with no (or few) governmental measures to mitigate COVID-19 infections and all members of the population have had the chance to get vaccinated. Thirdly, in line with the available information about governmental plans to introduce a COVID-19 certificate at the time of data collection, respondents were told that a certificate would be provided to everyone who got vaccinated, had a negative test result or recently recovered from a COVID-19 infection. The preferences observed in this study can therefore not be easily generalized to public support for certificates with stricter or more lenient rules for granting them (e.g. only those who got vaccinated). This also applies to the freedoms a certificate would provide, as different attributes might have led to other observed preferences, and to other countries, where different measures may be in place, the thinking about certificates may be in a different stage and – at least in part – different attributes may be more relevant. Further studies in these areas are therefore warranted. Fourthly, as with any DCE study, this study is likely to suffer from hypothetical bias. The impact of this bias on results is unclear. Previous research showed good external validity of well-designed preference studies [39, 40]. Given this study was conducted according to guidelines for good research practice and respondents indicated the survey was understandable and not too lengthy, the impact of hypothetical bias is anticipated to be low.

In conclusion, this study showed that the adult population of the Netherlands is divided regarding the introduction of a COVID-19 certificate. Implementation of a COVID-19 certificate, irrespective of its characteristics, will most likely be met with significant resistance from a large share of the population. The support of younger citizens and those who plan to get vaccinated seems most sensitive to the specific freedoms granted by a COVID-19 certificate. Public support can potentially be increased by allowing holders of a certificate to shop without appointment and to visit bars and restaurants.

Declarations

Funding The data collection was sponsored by the TU Delft COVID-19 Response fund.

Conflict of interest Authors have no conflict of interest to declare.

Ethics approval Ethical approval for this study was granted by Delft University of Technology (Nr. 1487).

Consent to participate Respondents provided written consent to participate in the study.

Consent for publication (from patients/participants) Respondents provided written consent for the use and reporting (i.e. publication) of their data.

Availability of data and material Data are available upon reasonable request to the corresponding author.

Code availability Code is available upon reasonable request to the corresponding author.

Authors' contributions NM obtained funding and ethical approval. JV, JvE, EdBG and NM designed the experiment and the accompanying survey. JV programmed the survey. JV and NM oversaw the data collection. JV analysed the data, and JV, JvE, EdBG and NM interpreted the findings. JV and NM drafted the manuscript. JV, JvE, EdBG and NM critically reviewed and approved the final manuscript.

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